## 73.09.02.010\_FR\_EPC – EPC FINAL PERFORMANCE TEST REPORT

### **Grand River Energy Center Unit 3**

#### KED PROJECT NO. 2014-071

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#### **EPC – FINAL PERFORMANCE TEST REPORT**

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#### REFERENCES

Engineer, Procure and Construct Contract (EPC Contract) ASME PTC Test Codes: 1-2011, 4.4-2008, 6.2-2011,19.1-2005, 19.2-2010, 19.3-2004, 19.5-2004, 22-2005, 46-1996 ASTM Standards: D1945-1996, D3588-1998 AGA Report 8 ASME Steam Tables – 1997 ASHRAE Psychrometric Properties – 2009 GPA 2145-2009

#### EXECUTIVE SUMMARY

#### 1.1 Overview

The Engineer, Procure and Construct (EPC) testing at the Grand River Energy Center Unit 3 (GREC U3) project was conducted from 23:00 to 24:00 on July 6<sup>th</sup>, 2017 and from 3:15 to 5:15 on July 7<sup>th</sup> 2017 to verify the facilities capabilities to satisfy Kiewit's EPC contractual guarantees with the Grand River Dam Authority (GRDA). The facility includes one MHI M501J Combustion Turbine Generators (CTG), one Heat Recovery Steam Generators (HRSG) with supplemental firing capability, one axial exhaust Steam Turbine Generator (STG) and associated balance of plant (BOP) equipment. The CTGs are natural gas fired only. Performance testing was conducted with the CTG at base load, with the plant operating as outlined in the test procedure over three (3) separate one (1) hour test periods to determine the following:

• Facility-Wide Unfired Net Electrical Output and Heat Rate

The performance test data collected during the test periods indicates failing results. Details about the calculations performed for this performance test are included in Section 4 of this report. A summary of the performance test results are included below:

Parameter	Units	Guarantee	Measured Test Results	Corrected Test Results	Margin	Pass / Fail
Unfired Net Electrical Output	kW	449,960	444,232	450,521	561	Pass
Unfired Net Heat Rate	Btu/kWh LHV	5,723	5,800.1	5,714.4	8.6	Pass

Any major deviations from the test requirements and/or procedures are documented in Section 4. These deviations were agreed to by all parties to the test. The major deviations along with brief discussions of the reason for deviations are included below:

- Section 2.3 and Appendix C of the procedure state that the auxiliary power will be measured using a temporary instrument at five-minute time intervals. All parties to the test agreed to use the station instruments (which have been validated using temporary instruments) for the HRSG Aux Power measurement and to use the STG Aux Power measurements taken using a temporary instrument one time after the performance test.
- All parties to the test agreed two closed cooling water heat exchangers will be in service during testing as one heat exchanger was insufficient to support plant operation.

- All parties to the test agreed the fuel gas heater 3 way gas bypass valve will not be closed during the testing. This is inconsistent with the thermal design of the plant, but required by MHPSA to support CTG operation.
- All parties to the test agreed that an IGV inspection shall not be performed within 24 fired hours of the start of testing.
- All parties to the test agreed that a separate pretest need not be performed.
- All parties to the test agreed that in order to accurately measure the cooling steam going to the gas turbine, the HP backup steam warming line and the associated DSH (03-V035635 and 03-TV-035636) were to be closed for the duration of the testing.
- All parties to the test agreed that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.

The following deviations from the test requirements and/or procedures occurred during the performance test. The deviations along with brief discussions of the reason for deviation are included below:

• None

#### TEST DESCRIPTION

#### 2.1 Test Overview

The objective of the EPC Performance Test was to determine the capability of the facility to satisfy the guarantees set forth in the contractual agreement to GRDA. All performance testing was conducted with the CTGs at base load with the chiller off and the HRSG unfired.

The Performance Test for the GREC U3 EPC was conducted from 23:00 to 24:00 on July 6<sup>th</sup>, 2017 and from 3:15 to 5:15 on July 7<sup>th</sup> 2017. The performance test was conducted over three (3) one (1) hour test periods to determine the following:

• Facility-Wide Unfired Net Electrical Output and Heat Rate

#### 2.2 Test Facility Information

The Grand River Energy Center Unit 3 is a new power production facility located on the property of the existing Grand River Energy Center near Chouteau, Oklahoma. The facility consists of one MHI M501J Combustion Turbine Generator (CTG), one three-pressure Heat Recovery Steam Generator (HRSG) with supplemental firing capability, one axial exhaust Steam Turbine Generator (STG) and associated Balance of Plant (BOP) equipment.

#### 2.3 Test Boundary

A schematic of the scope for the performance tests is shown below:



#### **Facility Net Output and Heat Rate Test**

#### 2.4 Key Party Representatives

The following parties and their designated representatives were present for the Grand River Energy Center Unit 3

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Performance Tests.

Kiewit:	Adam McLand	Decker, Isborough	Parag	Pathak,	Chris	Stelzer,	Russ
GRDA:	Jammie	Burrow					
B&V:	Travis E	Brockmeye	er, Erik Ke	eltner			

#### TEST EQUIPMENT

#### 3.1 Equipment Overview

To the greatest extent possible the test data was monitored and recorded by the permanent plant instrumentation using the Facility's Distributed Control System (DCS). Temporary test instrumentation and metering equipment was used where there was not permanent plant instrumentation and/or where performance test instrument accuracy was required. Data from the DCS was recorded electronically at 10-second time intervals and temporary test instruments was recorded electronically at 30-second time intervals.

#### 3.2 Equipment Information

The general information for the temporary and permanent plant instrumentation used during the performance test is included in Appendix D and includes the following:

- Measured Parameter
- Instrument Location
- Instrument Tag Number

#### 3.3 DAS Description

Performance test data were recorded from permanent plant instruments via the DCS, temporary test instrumentation, and manual data taken by personnel. Temporary instrument measurements were compiled to centralized computers provided by McHale Performance. Following the completion of the performance test, this data was distributed to all key witnessing parties. Data was gathered every 10 or 30 seconds.

#### 3.4 Calibration Summary

Instruments used for data collection were classified as Primary or Secondary before commencement of the performance test. A Primary instrument is any instrument used in the performance test calculations. All other instruments recording data during testing are considered secondary instruments.

All Primary instruments were calibrated by a third party within 6 months prior to the start of testing with the exception of flow meters. Primary instruments were calibrated to a NIST traceable standard. Secondary instruments having factory calibrations were acceptable. Secondary instruments were required for loop calibration before commencement of testing.

Copies of the calibration certificates were provided to interested parties upon request. The calibration certificates are included in Appendix E.

#### TEST DEVIATIONS AND DISCUSSION

#### 4.1 Major Test Deviations

The following deviations from the test requirements and/or procedures are documented along with brief discussions of the reason for deviation below:

#### 4.1.1 Test Deviations Discussed Prior to Testing

The following major deviations from the test requirements and/or procedures were discussed and agreed to by all parties to the test prior to testing. The major deviations along with brief discussions of the reason for deviation are included below:

- Section 2.3 and Appendix C of the procedure state that the auxiliary power will be measured using a temporary instrument at five-minute time intervals. All parties to the test agreed to use the station instruments (which have been validated using temporary instruments) for the HRSG Aux Power measurement and to use the STG Aux Power measurements taken using a temporary instrument one time after the performance test.
- All parties to the test agreed two closed cooling water heat exchangers will be in service during testing as one heat exchanger was insufficient to support plant operation.
- All parties to the test agreed the fuel gas heater 3 way gas bypass valve will not be closed during the testing. This is inconsistent with the thermal design of the plant, but required by MHPSA to support CTG operation.
- All parties to the test agreed that an IGV inspection shall not be performed within 24 fired hours of the start of testing.
- All parties to the test agreed that a separate pretest need not be performed.
- All parties to the test agreed that in order to accurately measure the cooling steam going to the gas turbine, the HP backup steam warming line and the associated DSH (03-V035635 and 03-TV-035636) were to be closed for the duration of the testing.
- All parties to the test agreed that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.

#### 4.1.2 Test Deviations Found During Testing

The following major deviations from the test requirements and/or procedures occurred during the performance test. The major deviations along with brief discussions of the reason for deviation are included below:

• None

#### 4.2 Test Discussion

The following are not test deviations, but are items of note:

- At this time, testing was only conducted for the unfired conditions.
- The vacuum pump heat exchangers were be run on service water in between test runs, and switched to circulating water for the test runs to minimize fouling of the strainers and heat exchangers.

#### 4.2.1 Other Test Deviations

The following are not deviations to the CTG test, but are deviations to the other tests performed simultaneously. They are included to give a more complete picture of the testing.

#### STG Test

- Section 3.5.2.7 of the procedure states the unfired  $f_{Design}$  is 0.0693. All parties to the test agreed the correct value is 0.0369.
- Section 2.3 and Appendix C of the procedure state that the auxiliary power will be measured using a temporary instrument at five-minute time intervals. All parties to the test agreed to use the STG Aux Power measurements taken using a temporary instrument one time after the performance test.
- One of the steam turbine LP balance pipe sensing lines on DP2 was plugged and could not be cleared. All parties to the test agreed to use the design value for the flows through the LP balance piping.
- All parties to the test agreed that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.
- The data collected during the N2 packing test did not evaluate into a result that made sense. The data predicts approximately 36% N2 packing leakage. MHPS believes the location of the HP to LP balance piping is influencing the measurements taken during the N2 packing test. For results purposes, the N2 packing leakage was calculated as follows:

$$Q_{N2} = Q_{HP_FW} + Q_{HP_TCA} + Q_{HP_DSH} - Q_{HP_FGH} - Q_{HP_CS} - Q_{HP_Gland} - Q_{HP_to_LP} - Q_{CRH} - U_{N2}$$

Where  $U_{N2}$  is the uncertainty of the calculated N2 flow and  $Q_{CRH\_Measured}$  is the CRH flow measured using the CRH flow element.

- The stability of the LP steam flow was outside the procedure limits during test run 2. In order to meet the procedure stability criteria, the analysis period for test run 2 was changed from 3:15-4:15 to 3:45-4:15.
- The leakage out of the cycle was greater than the test code requirement of 0.25% of the condensate flow. This leakage has been subtracted from calculated flows on a flow weighted basis.

#### HRSG Test

- Appendix C of the procedure states the auxiliary power will be measured using a temporary instrument. All parties to the test agreed to use the station instruments (which have been validated using temporary instruments) for this measurement.
- All parties to the test agreed that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.
- The HP feedwater flow did not meet the stability criteria for variation during a test run listed in the test procedure for any of the test runs.
- The TCA flow did not meet the stability criteria for variation from the reference conditions listed in the test procedure for any of the test runs.
- The TCA duty did not meet the stability criteria for variation from the reference conditions listed in the test procedure for any of the test runs
- The measured HRH temperature at the STG was used to calculate the HRSG performance as the HRH temperature measured at the HRSG was suspect as it was lower than the temperature at the STG.
- The Ammonia Vaporizer power was not measured during the performance test. The vaporizer supplier provided a curve of power consumption vs ammonia flow which was used to add to the measured HRSG aux power.

#### CTG Test

- All parties to the test agreed the fuel gas heater 3 way gas bypass valve will not be closed during the testing. This is inconsistent with the thermal design of the plant, but required by MHPSA to support CTG operation.
- All parties to the test agreed that an IGV inspection shall not be performed within 24 fired hours of the start of testing.
- All parties to the test agreed that a separate pretest need not be performed.

- All parties to the test agreed that in order to accurately measure the cooling steam going to the gas turbine, the HP backup steam warming line and the associated DSH (03-V035635 and 03-TV-035636) shall be closed for the duration of the testing.
- All parties to the test agreed that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.
- All parties to the test agreed that the CTG is not required to operate only in exhaust temperature control mode, but rather operation on either blade path temperature control or exhaust temperature control is acceptable.

#### DATA COLLECTION AND CALCULATIONS

#### 5.1 Data Collection

Performance test data were recorded on the DCS, temporary test instrumentation, and manual data were taken by personnel. Data from the DCS and temporary test instruments were recorded electronically. Manual data were recorded on data sheets and was scanned for storage and distribution.

All the data and information gathered were used to correct the measured test results to the base reference conditions listed in Appendix A of the Test Procedures. Data used to calculate the corrected performance results for the Performance Tests were provided to the key witnessing parties.

#### 5.2 Data Reduction

Performance test data collected were arithmetically averaged for each test period. The averaged data were used to correct the initial test results of each test period. After all corrections were completed, the corrected results were arithmetically averaged for comparison to the contractual guarantee values.

Data collected were analyzed for bad data and outliers. The methods contained in ASME PTC 19.1 were used to conduct the outlier analysis. No data was excluded as a result of this analysis.

#### 5.3 Definition of Terms

The following is a summary of the terms used in the computation of test results

FGH – Fuel gas heater

DSH – Desuperheater

TCA – Turbine cooling air cooler

Design – Subscript indicates design value

#### 5.3.1 **Power Measurements**

P <sub>CTG</sub>	=	CTG Generator Gross Power Output, kW
P <sub>STG</sub>	=	STG Generator Gross Power Output, kW
P <sub>UAT</sub>	=	Aux Transformer Low Side Power, kW
P <sub>RAT</sub>	=	Reserve Aux Transformer Low Side Power, kW
PF <sub>CTG</sub>	=	CTG Generator Power Factor
PF <sub>STG</sub>	=	STG Generator Power Factor
PF <sub>CTG_GSU</sub>	=	CTG GSU Power Factor
PF <sub>STG_GSU</sub>	=	STG GSU Power Factor
PF <sub>UAT</sub>	=	Aux Transformer Power Factor
PF <sub>RAT</sub>	=	Reserve Aux Transformer Power Factor
HZ <sub>CTG</sub>	=	CTG generator frequency, Hz

 $\mathsf{P}_{\mathsf{Non}\_\mathsf{Design}}$ = Non-Design Aux Loads in Operation, kW

#### 5.3.2 **Boundary Measurements**

T <sub>DB_CTG</sub>	=	Ambient dry bulb temperature at CTG, Deg F
T <sub>WB_CTG</sub>	=	Ambient wet bulb temperature at CTG, Deg F
P <sub>Baro</sub>	=	Barometric pressure, psia
T <sub>DB_CT</sub>	=	Cooling tower dry bulb inlet temperature, Deg F
T <sub>WB_CT</sub>	=	Cooling tower wet bulb temperature, Deg F
T <sub>FG</sub>	=	Fuel gas temperature at metering station outlet, Deg F
P <sub>FG</sub>	=	Fuel gas pressure upstream compressor suction, psig
N <sub>Fuel_x</sub>	=	Fuel gas composition, mole % (x=components)

#### 5.3.3 Flow Measurements

$Q_{FG\_ACF}$	=	Plant fuel gas flow, ACF/h
P <sub>FG</sub>	=	Plant fuel gas pressure, psia
T <sub>FG</sub>	=	Plant fuel gas temperature, Deg F
P <sub>DB</sub>	=	Duct burner fuel gas pressure, psia
T <sub>DB</sub>	=	Duct burner fuel gas temperature, Deg F
DP <sub>DB</sub>	=	Duct burner fuel gas DP, inH2O

#### 5.3.4 Corrected CTG Test Data

P <sub>Corr_CTG</sub>	=	Corrected CTG Net Output, kW			
HR <sub>Corr_CTG</sub>	=	Corrected CTG Net Heat Rate, Btu/kWh			
T <sub>Corr_CTG</sub>	=	Corrected CTG Exhaust Temp, Deg F			
EF <sub>Corr_CTG</sub>	=	Corrected CTG Exhaust Flow, kW			
E <sub>Corr_CC</sub>	=	Corrected CTG Combustor Cooler Energy, mmBtu/h			
E <sub>Corr_TAC</sub>	=	Corrected CTG TAC Energy, mmBtu/h			
These values were obtained from concurrent CTG testing					

#### 5.3.5 Corrected HRSG Test Data

$Q_{Corr_HP}$	=	Corrected HP Steam Flow, lb/h		
Q <sub>Corr_IP</sub>	=	Corrected IP Steam Flow, lb/h		
Q <sub>Corr_LP</sub>	=	Corrected LP Steam Flow, lb/h		
T <sub>Corr_HP</sub>	=	Corrected HP Steam Temp, Deg F		
T <sub>Corr_HRH</sub>	=	Corrected HRH Steam Temp, Deg F		
T <sub>Corr_IP</sub>	=	Corrected IP Steam Temp, Deg F		
T <sub>Corr_LP</sub>	=	Corrected LP Steam Temp, Deg F		
DP <sub>Corr_HRSG</sub>	=	Corrected HRSG Backpressure, inH2O		
DP <sub>Corr_RHTR</sub>	=	Corrected Reheater Pressure Drop, psi		
P <sub>HRSG_Aux</sub>	=	Corrected HRSG Aux Power, kW		
These values were obtained from concurrent HRSG testing				

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#### 5.3.6 Corrected STG Test Data

P<sub>Corr\_STG</sub> = Corrected STG Net Output, kW This values was obtained from concurrent STG testing

#### 5.3.7 Calculated Values

=	CTG GSU Transformer losses, kW
=	STG GSU Transformer losses, kw
=	Aux Transformer losses, kW
=	Reserve Aux Transformer losses, kW
=	CTG Excitation Current from V curve, A
=	STG Excitation Current from V curve, A
=	CTG excitation power, kW
=	STG excitation power, kW
=	Net Plant Output, kW
=	Net Plant Heat Rate, Btu/kWh
=	Plant fuel gas flow, lb/h
=	Duct burner fuel gas flow, lb/h
=	Fuel gas heating value, Btu/lb LHV
=	Net Plant Heat Input, Btu/h
=	Duct burner heat input, Btu/h
=	Corrected Net Plant Output, kW
=	Corrected Net Plant Heat Rate, Btu/kWh

#### 5.4 Correction Factors

Corrections were made to the performance of plant equipment using additive and multiplicative correction factors.

#### 5.4.1 Additive Corrections

The following corrections were made to the performance of plant using additive correction factors.

#### Corrections for OFE performance

Corrections were based on the corrected performance of each parameter as determined using the appropriate equipment test procedure with the exception that any degradation correction (if present) was not applied.

ΔP <sub>CTG</sub>	=	Correction for power output of CTG during test, kW
ωP <sub>CTG</sub>	=	Correction for power output of CTG during test, Btu/h
ΔP <sub>STG</sub>	=	Correction for power output of STG during test, kW
ΔP <sub>HRSG</sub>	=	Correction for auxiliary power of HRSG during test, kW
ΔHR <sub>CTG</sub>	=	Correction for heat rate of CTG during test, kW
ωHR <sub>CTG</sub>	=	Correction for heat rate of CTG during test, Btu/h

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$\Delta ET_{CTG}$	=	Correction for exhaust temp of CTG during test, kW
$\Delta EF_{CTG}$	=	Correction for exhaust flow of CTG during test, kW
ΔTCA <sub>CTG</sub>	=	Correction for TCA cooler energy during test, kW
ΔSCE <sub>CTG</sub>	=	Correction for steam cooling energy during test, kW
$\Delta RHDP_{HRSG}$	=	Correction for HRSG RHTR pressure drop during test, kW
$\Delta DP_{HRSG}$	=	Correction for HRSG backpressure during test, kW
$\omega DP_{HRSG}$	=	Correction for HRSG backpressure during test, Btu/h
$\Delta Q_{HP}$	=	Correction for HRSG HP steam flow during test, kW
$\Delta T_{HP}$	=	Correction for HRSG HP steam temp during test, kW
ΔQT <sub>RHTR</sub>	=	Correction for HRSG IP added flow and reheater temperature during test, kW
$\Delta QT_{LP}$	=	Correction for HRSG LP flow and temp during test, kW

#### Corrections for plant performance

$\Delta 2_{GSU}$ =	Correction for GSU Losses, kW
$\Delta 2_{\text{Gen}}$ =	Correction for generator power factor, kW
Δ5 <sub>A</sub> =	Correction for ambient conditions at cooling tower, kW
Δ6 <sub>OD</sub> =	Correction for off design auxiliary loads in operation, kW
Δ6 <sub>FGC</sub> =	Correction for fuel gas pressure, kW
∆7 =	Correction for duct burner duty different than design, kW
ω7 =	Correction for duct burner duty different than design, Btu/h

#### 5.4.2 Multiplicative Corrections to Power

The following corrections were made to the performance of plant using multiplicative correction factors.

α1&3	=	Correction for ambient temperature and RH at CTG
α2	=	Correction for barometric pressure
α4	=	Correction for fuel supply temperature
α5	=	Correction for fuel composition
α6	=	Correction for speed/frequency
Multiplicative	Co	rrections to Heat Input

# $\beta 1\&3$ =Correction for ambient temperature and RH at CTG $\beta 2$ =Correction for barometric pressure $\beta 5$ =Correction for fuel composition $\beta 6$ =Correction for speed/frequency

#### 5.4.4 Corrections for Degradation

No corrections for degradation were applied. Specifically, the OFE equipment corrected results for use in calculating the Corrected Facility Net Results were calculated without application of any degradation corrections.

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5.4.3

#### 5.5 Calculations

The Corrected Net Output and Heat Rate were calculated as follows:

#### 5.5.1 Miscellaneous Calculations

$$P_{CTG_{Excite}} = 12.5 + 6.4 + 20.8 * \frac{A_{CTG_{Excite}} * \frac{\sqrt{2}}{\sqrt{3}}}{2890} + \frac{A_{CTG_{Excite}}^2 * 0.1113 + 2 * A_{CTG_{Excite}}}{1000}$$

 $P_{STG\_Excite} = 11.2 + 5.69 + 10.67 * \frac{A_{STG\_Excite} * \frac{\sqrt{2}}{\sqrt{3}}}{2870} + \frac{A_{STG\_Excite}^2 * 0.0966 + 2 * A_{STG\_Excite}}{1000}$ 

#### 5.5.2 Corrected Facility Net Electrical Output

 $P_{PN} = P_{CTG} + P_{STG} - P_{UAT} - P_{RAT} - P_{CTG\_Excite} - P_{STG\_Excite} - P_{CTG\_GSU\_Loss} - P_{STG\_GSU\_Loss} - P_{UAT\_Loss} - P_{RAT\_Loss}$ 

$$\begin{split} P_{Corr\_PN} &= \left(P_{PN} + P_{Non\_Design} + \Delta 2_{GSU} + \Delta 2_{Gen} + \Delta 5_A + \Delta 6_{OD} + \Delta 6_{FGC} + \Delta 7\right) * \\ &\alpha 1 \& 3 * \alpha 2 * \alpha 4 * \alpha 5 * \alpha 6 + \Delta P_{STG} + \Delta P_{CTG} + \Delta P_{HRSG} + \Delta HR_{CTG} + \Delta ET_{CTG} + \\ &\Delta EF_{CTG} + \Delta TCA_{CTG} + \Delta SCE_{CTG} + \Delta RHDP_{HRSG} + \Delta DP_{HRSG} + \Delta Q_{HP} + \Delta T_{HP} + \\ &\Delta QT_{RHTR} + \Delta QT_{LP} \end{split}$$

#### 5.5.3 Corrected Facility Net Heat Rate

$$HI_{PN} = HV_{FG} * Q_{FG}$$

$$HR_{PN} = \frac{HI_{PN}}{P_{PN}}$$

$$HR_{corr_PN} = \frac{(HI_{PN} + \omega7) * \beta1\&3 * \beta2 * \beta5 * \beta6 + \omega HR_{cTG} + \omega P_{cTG} + \omega DP_{HRSG}}{P_{corr_PN}}$$

Additional detail regarding the calculation can be found in Appendix A.

#### TEST RESULTS AND CONCLUSIONS

#### 6.1 Test Results

The calculated test results for the STG Tests are listed in the tables below:

Parameter	Units	Guarantee	Measured Test Results	Corrected Test Results	Margin	Pass / Fail
Unfired Net Electrical Output	kW	449,960	444,232	450,521	561	Pass
Unfired Net Heat Rate	Btu/kWh LHV	5,723	5,800.1	5,714.4	8.6	Pass

#### 6.2 Test Conclusions

The Corrected Unfired Net Electrical Output greater than the Guarantee value and the Corrected Unfired Net Heat Rate less than the Guarantee value has indicated the facility's ability to satisfy the Kiewit contractual guarantees to GRDA.

## **APPENDIX A**

# **TEST CALCULATIONS**

Linked Bow					17	27	37	
	1	1	-		1/	27	37	1
Description	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Power Measurements			°,	Ū.				
CTG generator gross power output	kW	CTGDAS	ACTUAL POWER	315,362.7	307,546.5	311,860.0	313,016.5	
CTG generator gross power factor	-	CTGDAS	POWER FACTOR	0.900	0.997	0.996	0.997	Verify leading/lagging, Lagging
CTG generator frequency	HZ	CTGDAS	FREQUENCY	60.0	60.0	60.0	60.0	,
STG generator gross power output	kW	PwrDAS	STG Meter-MW	150.888.29	142,949,1	143,925,2	143,994,0	
STG generator gross power factor	-	PwrDAS	STG Meter-PE	0 900	0 999	0.998	0 999	Verify leading /lagging lagging
UAT low side power	kW	PwrDAS	UAT Power	14.012.8	8.564.0	8.579.3	8,568,8	
UAT low side power factor	-	PwrDAS	Device 3-PF	0.900	0.810	0.810	0.810	
RAT low side power	kW			0.0	0.0	0.0	0.0	Offline
BAT low side power factor	-			0.900	0.81	0.81	0.81	Equal to LIAT PE
				0.500	0.01	0.01	0.01	
CTG excitation current	А	CTGDCS	GT GENERATOR FIELD CURRENT	65.00	2.020.5	2.045.3	2.040.1	
					.,	.,	-,	
STG excitation current	А	STGDCS	30CHC00CE021	600.00	1,407.3	1,416.0	1,408.9	
					_,,	_,0.0	2, . 50.5	
Non-design auxiliary loads	kW	DCS	1	0.00	0.00	0.00	0.00	
			1	2100	2.00	2.00	5.00	
Pressure Measurements								
Barometric pressure	nsia	CTGDAS	Baro	14,367	14,426	14.424	14.424	
Fuel gas pressure upstream compressor suction	psig	DCS	03-PIT-650617.UNIT3@NFT3	424.00	695,780	695.230	695.223	
· · · · 0 · · · · · · · · · · · · · · ·	F0							
Temperature Measurements								
Ambient dry bulb temperature at CTG	Deg F	CTGDAS	CTG Ambient Temp	59.00	79.3	75.4	74.1	
Ambient RH at CTG	%	TCDAS	CTG Inlet BH	65.00%	76 19%	81 11%	84 12%	
Cooling tower dry bulb temperature	Deg F	TowerDAS	Tower DBT	59.00	77.1	73.1	72.0	
Cooling tower wet hulb temperature	Deg F	TowerDAS	Tower WBT	52.00	73.2	70.7	70.2	
Evel gas temperature at outlet of regulating station	Deg F	DCS	03-TT-560500 LINIT3@NET3	40.00	68.7	67.9	67.8	At enable gas yard
Tuel gas temperature at outlet of regulating station	Degi	000	05 11 500500.01115@1215	40.00	00.7	07.5	07.0	At chable gas yard
CTG Test Data								
Corrected CTG net power output	kW		1	314,200	325,123	325,603	325,414	
Corrected CTG net heat rate (LHV)	btu/kWb		1	8 195	8 326	8 130	8 120	
Corrected CTG exhaust flow	lh/h	1	1	4 765 000	4 943 461	4 930 019	4 915 961	
Corrected CTG exhaust temperature	Deg F	1	1	1 189 0	1 172 9	1 174 2	1 174 4	
Corrected CTG rotor air cooler energy	mmhtu/h	1	1	37 95	27 92	37 07	29.00	
Corrected CTG cooling steam energy	mmbtu/h		1	26.00	28.00	28 71	28 62	
concerce ero coomig steam energy	minota/ii		1	20.96	20.90	20.71	20.02	
HRSG Test Data			1					
Corrected HRSG HP steam flow rate	lh/h		1	631 030 0	617 730 0	673 671 0	623 001 0	
Corrected HRSG HP steam temperature	Deg F		1	1 052 0	1 046 6	1 0/15 2	1 0/15 2	
Corrected HRSG IP steam flow rate	lb/h		1	137 460 0	1/6 739 0	1/17 736 0	1/18 224 0	
Corrected HRSG IP steam flow temperature	Deg F		1	570.0	572 /	572 5	572 5	
Corrected HRSG HRH steam tomporature			1	1 051 5	1 050 9	1 047 0	10470	
Corrected HRSG LB steam flow rate	lb/h		1	64 700 0	1,000.0	69 160 0	68 402 0	
Corrected HPSG I B steam temperature			1	04,700.0	507.0	507.7	00,493.0 507.0	
Corrected HPSG gas side prossure drop	in H2O	1	1	480.2	507.0	507.7	507.2	
Corrected HPSG repeater pressure drop	nn120 nci		1	10.0	15.4	15.0	15.7	
Corrected HBSC Auxiliant Dewor	h21	1	1	15.4	14.9	15.0	15.0	
Corrected HKSG Auxiliary Power	ĸvv			928.00	368.70	368.90	367.30	
STC Test Data								
	1.44	1	1	150 330 0	140 5 4	140 700	146.600	CTC and Test Burn in 20
corrected STG net power output	кW			150,330.0	146,544	146,768	146,600	SIG 2nd Lest Kun IS 30 mins
			1					
Design Data			1					
SIG Invristor loss	KW		1	11.20	11.20	11.20	11.20	Design value
CIG INVISTOR LOSSES	KW	1		12.50	12.50	12.50	12.50	Design value

GREC U3 Net Plant Test Input Data Summary								
Linked Row			-	-	17	27	37	
Flow Measurements								
Plant Fuel Gas Flow								
Meter Type	-			Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic	
Tap Type	-			N/A	N/A	N/A	N/A	
Inlet Diameter	in			10.0210	10.0210	10.0210	10.0210	
Throat Diameter	in			10.0210	10.0210	10.0210	10.0210	
Diameter Measurement Temperature	Deg F			72	72	72	72	Assumed
Calibration Temperature	Deg F			48.4	48.4	48.4	48.4	
Inlet Material	-			553vv	553vv	\$\$3vv	\$\$377	
Throat Material				CC2vv	CC2vv	SC2vv	SSOAA	
Fluid Type				Vapor	Vanor	Vapor	Vanor	
Lipstroom Prossuro	ncia	DCS	02 ENRI DSI LINIT2@NET2	450.0	906 Q	940 9	941 Q	
Downstream Temporature	psia Dog F	DCS		430.0	600.5	67.0	67.0	
Motor Reported Flow Pate	Deg F	DCS	03-11-500500.0N115@NE13	07.0	45.22	42.42	07.0	
weter Reported Flow Rate	KACF/N	DCS	03-F1-560500B.0N113@NE13	80.8	45.23	42.43	42.53	
HBSG DB Fuel Cas								
Meter Type				Orifice	Orifice	Orifice	Orifice	
				Elango	Elango	Elango	Flango	
lab Type	in.			1 lange 4 0260	1 lange 4 0260	1 lange 4 0260	1 lange 4 0260	
Threat Diameter	in in			4.0200	4.0200	4.0200	4.0200	
Discustor Manual Transaction	III D 5			2.0970	2.0970	2.0970	2.0970	A
Calibertian Temperature	Deg F			12	12	12	12	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Iniet Material	-			CS	CS	CS	CS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Flow Pressure	psia	MainDAS	DB fuel flow Pressure	340.5	345.4	341.1	340.5	
Flow Temperature	Deg F	DCS	03-TT-980840.UNIT3@NET3	78.9	85.9	79.4	78.9	
Flow DP	inH2O	MainDAS	DB fuel flow DP	0.0	0.0	0.0	0.0	Offline
Eval Analysis (lab)								ASTM D1045
Nathana Clia				02.2000/	00.20%	00.000/	00.020/	A3110 D1943
Methane, CH4	mole %			93.280%	90.29%	90.00%	89.93%	
Ethane, C2H6	mole %			3.535%	6.85%	7.02%	7.03%	
Propane, C3H8	mole %			0.530%	0.33%	0.36%	0.35%	
Iso-Butane, I-C4H10	mole %			0.039%	0.01%	0.01%	0.01%	
N-Butane, n-C4H10	mole %			0.072%	0.02%	0.03%	0.03%	
Iso-Pentane, i-C5H12	mole %			0.009%	0.00%	0.01%	0.01%	
N-Pentane, n-C5H12	mole %			0.008%	0.00%	0.01%	0.01%	
N-Hexane, n-C6H14	mole %			0.016%	0.01%	0.01%	0.01%	
Heptane, C7H16	mole %			0.000%	0.00%	0.00%	0.00%	
Octane, C8H18	mole %			0.000%	0.00%	0.00%	0.00%	
Nonane, C9H20	mole %			0.000%	0.00%	0.00%	0.00%	
Decane, C10H22	mole %			0.000%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %			1.971%	1.80%	1.86%	1.90%	
Carbon Monoxide, CO	mole %			0.000%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %			0.540%	0.63%	0.65%	0.66%	
Water, H2O	mole %			0.000%	0.00%	0.00%	0.00%	1
Hydrogen Sulphide, H2S	mole %			0.000%	0.00%	0.00%	0.00%	1
Hydrogen, H2	mole %			0.000%	0.00%	0.00%	0.00%	1
Helium, He	mole %			0.000%	0.04%	0.04%	0.04%	1
Oxygen, O2	mole %			0.000%	0.00%	0.00%	0.00%	1
Argon, Ar	mole %			0.000%	0.01%	0.01%	0.01%	1
		I		5.00078	0.01/8	0.01/6	0.01/0	1
		1	I		•	•		1

	GREC	U3 Net Pla	nt Test Flow	<b>Calculation</b>	ns				
Tag Test Run Test Run									
Description	Unit	Number	Design	1	Test Run 2	3	Notes		
			Ŭ						
Plant Fuel Flow									
Design Information									
Meter Type	-		Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic			
Тар Туре	-		N/A	N/A	N/A	N/A			
Inlet Diameter	in		10.0210	10.0210	10.0210	10.0210			
Throat Diameter	in		10.0210	10.0210	10.0210	10.0210			
Diameter Measurement Temperature	Deg F		72.0	72.0	72.0	72.0			
Calibration Temperature	Deg F		48.4	48.4	48.4	48.4			
Inlet Material	-		SS3xx	SS3xx	SS3xx	SS3xx			
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx			
Fluid Type	-		Vapor	Vapor	Vapor	Vapor			
Measured Parameters									
Upstream Pressure	psia		450.0	806.9	840.8	841.9			
Downstream Temperature	Deg F		67.8	68.7	67.9	67.8			
Meter Reported Flow Rate	KACFM		86.8	45.2	42.4	42.5			
Fuel Analysis (lab)									
Methane, CH4	mole %		93 28%	90 29%	90.00%	89 93%			
Ethane, C2H6	mole %		3 53%	6 85%	7 02%	7 03%			
Propage C3H8	mole %		0.53%	0.03%	0.36%	0.35%			
Iso-Butane i-C/H10	mole %		0.03%	0.03%	0.01%	0.01%			
N-Butane n-C/H10	mole %		0.04%	0.01%	0.01%	0.01%			
ke Dentane i CEH12	mole %		0.01%	0.02/0	0.03%	0.0370			
N Dentano, n CEU12	mole %		0.01%	0.00%	0.01%	0.01%			
N-Peritaile, II-CSH12			0.01%	0.00%	0.01%	0.01%			
N-Hexalle, II-COH14	mole %		0.02%	0.01%	0.01%	0.01%			
Ostana, CALLA	mole %		0.00%	0.00%	0.00%	0.00%			
Negara COURS	mole %		0.00%	0.00%	0.00%	0.00%			
Nonane, C9H20	mole %		0.00%	0.00%	0.00%	0.00%			
Nitrogen N2	mole %		0.00%	0.00%	0.00%	0.00%			
Nitrogen, NZ	mole %		1.97%	1.80%	1.86%	1.90%			
Carbon Monoxide, CO	mole %		0.00%	0.00%	0.00%	0.00%			
Carbon DIOXIGE, CO2	mole %		0.54%	0.63%	0.65%	0.66%			
Water, H2U	mole %		0.00%	0.00%	0.00%	0.00%			
Hydrogen Sulphiae, H2S	mole %		0.00%	0.00%	0.00%	0.00%			
Hydrogen, H2	mole %		0.00%	0.00%	0.00%	0.00%			
Hellum, He	mole %		0.00%	0.04%	0.04%	0.04%			
Oxygen, O2	mole %		0.00%	0.00%	0.00%	0.00%			
Argon, Ar	mole %		0.00%	0.01%	0.01%	0.01%			
Calculated Parameters									
Gas MW (Lab Composition)	lb/lb mole		17.14	17.51	17.56	17.57			
Fluid Density (Lab Composition)	lb/ft^3	ρSCF_Lab	0.045	0.046	0.046	0.046	SCF		
Fluid Density (Lab Composition)	lb/ft^3	ρACF_Lab	1.452	2.813	2.964	2.972	ACF		
Calculated Flow	lb/h		126,093	127,242	125,776	126,378	QACF*pACF_Lab		
Calculated Flow	gpm		10,825	5,639	5,290	5,302			

GREC Net Plant Test Transformer Loss Calculation									
		Тад				-			
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes		
Inputs									
CTG generator gross power output	kW		315,362.666	307,546.520	311,859.982	313,016.512			
CTG generator gross power factor	-		0.900	0.997	0.996	0.997			
CTG generator frequency	HZ		60.000	60.005	59.999	60.003			
STG generator gross power output	kW		150,888.293	142,949.099	143,925.248	143,994.017			
STG generator gross power factor	-		0.900	0.999	0.998	0.999			
UAT low side power	kW		14,012.816	8,564.022	8,579.314	8,568.830			
UAT low side power factor	-		0.900	0.810	0.810	0.810			
RAT low side nower	kW/		0.000	0.000	0.000	0.000			
RAT low side power factor	-		0.900	0.810	0.810	0.810			
	1.1.4		204 250	200.002	202.201	204.440			
CTG GSU Power	кvv		301,350	298,982	303,281	304,448	Gen-UAT		
	-		0.900	0.997	0.996	0.997	Gen PF		
			334.83	299.96	304.45	305.37			
CTG GSU VA at design PF	IVIVA		334.83	332.20	336.98	338.28			
STG GSU Power	kW		150,888	142,949	143,925	143,994	Gen-RAT		
STG GSU Power Factor	-		0.900	0.999	0.998	0.999	Gen PF		
STG GSU VA	MVA		167.65	143.16	144.18	144.19			
STG GSU VA at design PF			167.65	158.83	159.92	159.99			
UAT VA	MVA		15.57	10.57	10.59	10.58			
UAT VA at design PF			15.57	9.52	9.53	9.52			
RAT VA	MVA		0.00	0.00	0.00	0.00			
RAT VA at design PF			0.00	0.00	0.00	0.00			
Calculations									
CTG GSU Transformer Loss	kW		691.16	590.88	603.16	605.70			
STG GSU Transformer Loss	kW		341.62	292.97	294.60	294.60			
UAT Transformer Loss	kW		40.74	29.30	29.33	29.31			
RAT Transformer Loss	kW		32.40	32.40	32.40	32.40			
CTG GSU Transformer Loss at design PF	kW		691.16	683.21	697.69	701.65			
STG GSU Transformer Loss at design PF	kW		341.62	321.75	324.05	324.21			
UAT Transformer Loss at test PF	kW		40.74	29.30	29.33	29.31			
RAT Transformer Loss at test PF	kW		32.40	32.40	32.40	32.40			
Corrected Transformer Loss	kW		0.00	(121.10)	(123.98)	(125.56)			
				,	,,	,,			

CTG GSU. Tap 3 at	t 85C	
MVA	No-load losses (w)	Load losses (w)
249	183,260	280,880
332		499,340
415		780,220
X2	Х	С
4.53041	-0.12048	20.00000
×	MVA	334.83
hec	Curve Fit	507,899
0	Total Loss	691,159

STG GSU. Tap 3 a	t 85C	
MVA	No-load losses (w)	Load losses (w)
159	116,890	205,210
212		364,820
256		570,040
X2	х	С
17.03692	-3309.18879	3.007E+05
×	MVA	167.65
hec	Curve Fit	224,733
Ū	Total Loss	341,623

UAT. Tap 3 at 850	:	
MVA	No-load losses (w)	Load losses (w)
	19,520	
30		78,776
	r	
X2	Х	С
87.52889	0.00000	0.000
~	MVA	15.57
heck	Curve Fit	21,219

RAT. Tap N at 85	c	
MVA	No-load losses (w	Load losses (w)
21	32,300	62,230
28		110,080
35		171,500
X2	х	С
138.46939	50.71429	100.000
138.46939	50.71429	100.000
138.46939 ¥	50.71429 MVA	100.000
138.46939 č	50.71429 MVA Curve Fit	100.000 0.00 100

	1					
Description	Unit	Design	Test Run 1	Test Run 2	Test Run 3	Notes
nputs	0	Design		i cot nun 2	i cot nun o	notes
Power Measurements						
CTG generator gross power output	kW	315,363	307,547	311,860	313,017	
CTG generator gross power factor	-	0.900	0.997	0.996	0.997	
CTG generator frequency	HZ	60.000	60.005	59.999	60.003	
STG generator gross power output	kW	150,888	142,949	143,925	143,994	
STG generator gross power factor	-	0.900	0.999	0.998	0.999	
UAT low side power	kW	14,013	8,564	8,579	8,569	
OAT low side power factor	-	0.900	0.810	0.810	0.810	
RAT low side power	K)A/	0	0	0	0	
RAT low side power factor	-	0.900	0.810	0.810	0.810	
that low side power lactor		0.500	0.010	0.010	0.010	
CTG excitation current	А	65	2.020.46	2045.34876	2040.064463	
STG excitation current	A	600	1,407.26	1416.029752	1408.93	
Non-design auxiliary loads	kW	0	0	0	0	
Pressure Measurements						
Barometric pressure	psia	14.367	14.426	14.424	14.424	
Fuel gas pressure upstream compressor suction	psig	424.0	695.8	695.2	695.2	
Comporatura Magguramente						
Ambient dry bulb temperature at CTG	Dec	E0.00	70.21	75 30	74.00	
Ambient RH at CTG	%	65 00%	76 10%	73.38 81 11%	74.00 84 12%	
Cooling tower dry bulb temperature	Deg F	59.00	77.07	73.07	71.99	
Cooling tower wet bulb temperature	Deg F	52.41	73.21	70.66	70.16	
Fuel gas temperature at outlet of regulating station	Deg F	40.00	68.72	67.94	67.78	
TG Test Data						
Corrected CTG equipment net power output	kW	314,200.0	325,123.2	325,603.4	325,413.7	
Corrected CTG equipment net heat rate (LHV)	btu/kWh	8,195.0	8,326.4	8,130.4	8,138.8	
Corrected CTG exhaust flow	lb/h	4,765,000	4,943,461	4,930,019	4,915,961	
Corrected CTG exhaust temperature	Deg F	1,188.0	1,173.8	1,174.2	1,174.4	
Corrected CTG rotor air cooler energy	mmbtu/h	32.85	37.83	37.97	38.08	
Corrected CTG cooling steam energy	mmbtu/n	26.98	28.98	28.71	28.62	
IRSG Toot Data						
Corrected HRSG HP steam flow rate	lb/b	631.030	617 730	623 621	623 001	
Corrected HRSG HP steam temperature	Deg F	1 052 00	1 046 60	1 045 20	1 045 30	
Corrected HRSG IP steam flow rate	lb/h	137.460	146,738	147.736	148.224	
Corrected HRSG IP steam flow temperature	Deg F	570.00	573.40	573.49	573.53	
Corrected HRSG HRH steam temperature	Deg F	1,051.50	1,050.80	1,047.90	1,047.30	
Corrected HRSG LP steam flow rate	lb/h	64,700	68,082	68,169	68,493	
Corrected HRSG LP steam temperature	Deg F	486.20	507.00	507.70	507.20	
Corrected HRSG gas side pressure drop	inH2O	16.00	15.44	15.58	15.73	
Corrected HRSG reheater pressure drop	psi	15.40	14.90	15.00	15.00	
Corrected HRSG Auxiliary Power	kW	928.00	368.70	368.90	367.30	
IG Test Data						
corrected STG equipment net power output	ĸw	150,330	146,544	146,768	146,600	
Docian Data						
STG Thuristor loss	kw/	11.5	11.3	11.7	11.7	
CTG Thyristor Losses	K VV	11.2	11.2	11.2	11.2	
CTG THYTISTOL LUSSES		12.5	12.5	12.5	12.5	
Calculated Flows						
Plant Fuel Gas Flow	lb/h	126,093.3	127,242.2	125,776.2	126,377.5	
HRSG DB Fuel Gas	lb/h	0.0	0.0	0.0	0.0	
uel Analysis (lab)						
Methane, CH4	mole %	93.28%	90.29%	90.00%	89.93%	
Ethane, C2H6	mole %	3.53%	6.85%	7.02%	7.03%	
Propane, C3H8	mole %	0.53%	0.33%	0.36%	0.35%	
ISO-BUTANE, I-C4H1U	mole %	0.04%	0.01%	0.01%	0.01%	
N-Butane, N-C4H1U	mole %	0.07%	0.02%	0.03%	0.03%	
N-Pentane n-C5H12	mole %	0.01%	0.00%	0.01%	0.01%	
N-Heyane n-C6H14	mole %	0.01%	0.00%	0.01%	0.01%	
Hentane, C7H16	mole %	0.02%	0.01%	0.01%	0.01%	
Octane, C8H18	mole %	0.00%	0.00%	0.00%	0.00%	
Nonane, C9H20	mole %	0.00%	0.00%	0.00%	0.00%	
Decane, C10H22	mole %	0.00%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %	1.97%	1.80%	1.86%	1.90%	
Carbon Monoxide, CO	mole %	0.00%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %	0.54%	0.63%	0.65%	0.66%	
Water, H2O	mole %	0.00%	0.00%	0.00%	0.00%	
Hydrogen Sulphide, H2S	mole %	0.00%	0.00%	0.00%	0.00%	
Hydrogen, H2	mole %	0.00%	0.00%	0.00%	0.00%	
Helium, He	mole %	0.00%	0.04%	0.04%	0.04%	
Oxygen, O2	mole %	0.00%	0.00%	0.00%	0.00%	

Columbations.	GI	REC Net Plant Tes	st Output and He	at Rate Calculati	on	
Calculations Mice Calculations						
Ambient WBT at CTG	%	52.41	73.44	71.01	70.47	
	,.	52.11	75.14	/1.01	70.17	
Fuel gas heating value LHV	Btu/lb	20,422.4	20,401.3	20,367.9	20,348.2	
Fuel C/H Ratio	-	3.05	3.09	3.10	3.10	
Power Calculations						
STG Excitation						
Generator MVA	MVA	167.7	143.2	144.2	144.2	
Excitation current	А	1,792.4	1,352.7	1,359.3	1,356.4	From V Curve. Verify leading/lagging
Field loss	kW	314	179	181	180	R is 0.0966 Ω
Thyristor loss	kW	11.2	11.2	11.2	11.2	
Excitation transformer Loss	kW	8.5	7.3	7.3	/.3	5.69 kW NLL, 28/0A rated LS, 10.6/8 kW rated loss
Iotal SIG excitation loss	ĸvv	334	198	200	199	
CTG Excitation						
Generator MVA	MVA	350.4	308.6	313.1	314.0	
Excitation current	Δ	2 680 5	1 981 7	2 006 8	2 002 2	From V Curve Verify leading / lagging
Field Losses	kW	805.085	441.068	452.244	450.169	R is 0.1113 $\Omega$
Thyristor Losses	kW	12.50	12.50	12.50	12.50	
Excitation Transformer Losses	kW	18.33	12.92	13.09	13.06	6.4 kW NLL, 2890A rated LS, 20.8 kW rated loss
Total CTG excitation loss	kW	835.9	466.5	477.8	475.7	
CTG GSU Transformer Loss	kW	691.2	590.9	603.2	605.7	
STG GSU Transformer Loss	kW	341.6	293.0	294.6	294.6	
UAT Transformer Loss	kW	40.7	29.3	29.3	29.3	
RAT Transformer Loss	kW	32.4	32.4	32.4	32.4	
Plant Net Power Output	кW	449,962.7	440,321.6	445,568.9	446,805.0	
Heat Input Calculations						
Duct humer best input	mmD+/I-	_				
Plant Heat Input	mmRtu/h	2 575	2 506	0.0	0.0	
	notu/n	2,375	2,590	2,502	2,372	
Plant Net Heat Rate	Btu/kWh	5.723.0	5.895.5	5.749.5	5.755.4	
		2,. 25.0	2,22.5.5	2,1.313	-,	
Unfired Corrections						
Unfired Power Corrections						
Additive Power Corrections for Plant						
Correction for GSU Losses	kW	0.00	-121.10	-123.98	-125.56	Test - Design. Only GSU losses
Correction for CTG generator power factor	kW	0.00	-157.54	-156.69	-157.93	Test - Design.
Correction for STG generator power factor	kW	0.00	-48.01	-47.85	-48.07	Test - Design.
Correction for ambient conditions at cooling tower	kW	0.00	-47.12	-63.38	-55.45	
Correction for off design auxiliary loads	kW	0.00	0.00	0.00	0.00	No off design loads
Correction for fuel gas pressure	kW	0.00	-1,928.00	-1,928.00	-1,928.00	Compressor Off
Correction for duct burner duty different than design	kW	-	-	-	-	Unfired
Correction for power output of CTG	L\\/	0.00	11 012 00	11 407 16	11 205 02	
Correction for power output of STG	kw/	0.00	3 811 95	3 586 /1	3 755 56	
Correction for auxiliary power of HRSG	kW	0.00	-559.30	-559 10	-560.70	Test - Design
Correction for heat rate of CTG	kW	0.00	-63.52	31 22	27.15	rest - Design
Correction for exhaust temp of CTG	kW	0.00	2,955,90	2.871.79	2.840.81	
Correction for exhaust flow of CTG	kW	0.00	-4.776.47	-4.418.43	-4.043.98	
Correction for TCA cooler energy	kW	0.00	-645.34	-663.26	-677.61	Extrapolating
Correction for steam cooling energy	kW	0.00	-299.15	-257.90	-244.01	Extrapolating
Correction for HRSG reheater pressure drop	kW	0.00	-12.99	-10.39	-10.39	Extrapolating
Correction for HRSG backpressure	kW	0.00	-79.23	-59.42	-38.20	
Correction for HRSG HP steam flow	kW	0.00	999.40	556.80	596.64	
Correction for HRSG HP steam temp	kW	0.00	197.59	252.43	247.77	
Correction for HRSG IP added flow and RHTR temp	kW	0.00	-1,315.26	-1,233.50	-1,257.95	Extrapolating
Correction for LP flow and temp	kW	0.00	-329.13	-338.48	-358.75	Extrapolating
Multiplicative Power Corrections for Plant						
Correction for ambient temp and RH at CTG	-	1.000000	1.058027	1.046337	1.042411	Extrapolating
Correction for barometric pressure	-	1.000000	0.995773	0.995940	0.995960	
Correction for fuel supply temperature	-	1.000000	0.999873	0.999876	0.999877	
Correction for fuel composition	-	0.999968	1.000592	1.000597	1.000563	Extrapolating
Correction for speed/frequency	-	1.000000	0.999956	1.000010	0.999971	
Sum of plant additive newer corrections	L\\/	0.00	2 201 77	2 210 90	2 215 01	
Sum of OEE additive power corrections	KWV KW/	0.00	-11 128 63	-2,319.89	-2,313.01	
Product of multiplicative power corrections	-	0.999968	1.053997	1.042592	1.038627	
Unfired Heat Input Corrections						
Additive Heat Input Corrections for Plant						
Correction for duct burner duty different than design	Btu/h	-	-	-	-	Unfired
	1	1	I			
Additive Heat Input Corrections for OFE						
Correction for power output of CTG	mmBtu/h	0.00	-89.53	-93.46	-91.91	
Correction for heat rate of CTG	mmBtu/h	0.00	-41.30	20.30	17.66	
Correction for HRSG backpressure	mmBtu/h	0.00	0.00	0.00	0.00	
Multiplicative Heat land Constant	1	1	I			
Correction for ambient tome and PU at CTC	L	1 000000	1.046670	1 036700	1 000000	Extranolating
Correction for barometric prossure	E	1.000000	0.005972	1.030/88	0.006055	Ever aborgening
Correction for fuel composition	Ľ	0.000000	1 000/72	1 000472	1 000445	
Correction for speed/frequency	-	1.000000	0.999947	1.000011	0.999965	
	1		2.333347		2.555505	
Sum of plant additive heat input corrections	mmBtu/h	0.00	0.00	0.00	0.00	
Sum of OFE additive heat input corrections	mmBtu/h	0.00	-130.83	-73.16	-74.25	
Product of multiplicative heat input corrections	-	0.999997	1.042787	1.033177	1.029668	
1		1	1			
Unfired Results	1	1	I			
Plant Net Power Output	kW	449,962.73	440,321.62	445,568.90	446,805.03	
Corrected Plant Net Power Output	kW	449,948.26	450,542.77	450,388.99	450,629.84	
	1	1	I			
Plant Heat Input	mmBtu/h	2,575.1	2,595.9	2,561.8	2,571.6	
Corrected Plant Heat Input	mmBtu/h	2,575.1	2,576.1	2,573.6	2,573.6	
Fidilt Net Heat Kate	Btu/kWh	5,723.0	5,895.5	5,749.5	5,755.4	
Confected Flant Net Field Rate	DLU/KWN	5,723.1	5,/1/.9	5,/14.2	5,/11.1	

	GREC U3 Unfired Net Plant Test Results									
		Tag					Average TR			
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	1-3	Pass/Fail	Notes	
Plant Net Output										
Measured Plant Net Output	kW		449,963	440,322	445,569	446,805	444,232			
Corrected Plant Net Output	kW		449,948	450,543	450,389	450,630	450,521			
Guarantee Plant Net Output	kW		449,960	449,960	449,960	449,960	449,960			
Margin (units)	kW		-12	583	429	670	561	Pass	Positive is passing	
Margin (%)	%		0.00%	0.13%	0.10%	0.15%	0.12%	F d S S	Positive is passing	
Plant Net Heat Rate										
Measured Plant Net Heat Rate (LHV)	btu/kWh		5,723.0	5,895.5	5,749.5	5,755.4	5,800.1			
Corrected Plant Net Heat Rate (LHV)	btu/kWh		5,723.1	5,717.9	5,714.2	5,711.1	5,714.4			
Guarantee Plant Net Heat Rate (LHV)	btu/kWh		5,723.0	5,723.0	5,723.0	5,723.0	5,723.0			
Margin (units)	btu/kWh		-0.1	5.1	8.8	11.9	8.6	Pace	Positive is passing	
Margin (%)	%		0.00%	0.09%	0.15%	0.21%	0.15%	1 0 3 5	Positive is passing	

inked Row		L	-	-	17	27	37	
Description	Unit	Data	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
ower Measurements	onic	Jource	rag Number	Design	rest Kull 1	Test Run 2	rescharts	Notes
Generator Gross Power Output	kW	CTGDAS	ACTUAL POWER	314,700.0	307,546.5	311,860.0	313,016.5	
Power Factor	-	CTGDAS	POWER FACTOR	0.900	0.997	0.996	0.997	Note if leading or lagging. Lagging
Frequency Maccured Excitation Current	Hz	CTGDAS	FREQUENCY	60.0	60.00	60.0	60.0 2.040.1	Chack only
Auxiliary Power	kW	CIGDUS	GI GENERATOR FIELD CORRENT	500.0	2,020.3	2,045.3	2,040.1	check only
ressure Measurements								
Barometric Pressure	psia	CTGDAS	Baro	14.367	14.426	14.424	14.424	
Static Inlet Chiller Coil Loss Static Exhaust Prossure Loss	InH2O	CTGDAS	Chiller DP CTG Exhaust DB	1.000	0.646	0.645	0.649	
Static Exhaust Pressure Loss	IIIH20	CIGDAS	CTG Exhaust Dr	10.000	13.330	13.330	15.024	
Fuel Supply Pressure	psia	DCS	03-PIT-922611.UNIT3@NET3	650.000	706.0	705.4	705.5	
	-							
TCA Inlet Pressure	psia	MainDAS	TCA Inlet Pressure Corr	3000.0	2,664.2	2,672.0	2,666.7	
TCA Outlet Pressure	psia	DCS	03-PIT-065606.UNIT3@NET3	3000.0	2,604.8	2,613.8	2,607.9	
CT Cooling Steam Outlet Pressure	psia	DCS	03-PIT-034602.UNIT3@NFT3	419.9	430.7	432.4	433.0	DF + Outlet pressure
emperature Measurements								
Ambient DB Temp	Deg F	CTGDAS	CTG Ambient Temp	59.0	79.3	75.4	74.1	
Ambient RH	%	TCDAS	CTG Inlet RH	65.00%	76.19%	81.11%	84.12%	All 9 instruments
Compressor Inlet Temp	Deg F	CTGDAS	CTG CIT	59.0	79.3	75.3	74.2	5 1
Compressor Inlet RH	% Dog E	TCDAS	CTG Inlet RH	65.00%	76.19%	81.11%	84.12%	Equal to ambient RH
Eventering at turbine	Deg F	TCDAS	HRSG Inlet Temp	449.0	454.9	455.5	455.0	Average temporary TCs
							_,	······································
TCA Inlet Temperature	Deg F	DCS	03-TE-065601.UNIT3@NET3	323.8	332.4	332.6	333.0	
TCA Outlet Temperature	Deg F	DCS	03-TE-065607.UNIT3@NET3	600.5	589.1	591.6	590.6	
T Cooling Steam Inlet Temperature	Deg F	MainDAS	CT CS Inlet Temp	565.6	570.7	570.9	571.1	
CT Cooling Steam Outlet Temperature	Deg F	MainDAS	CT CS Outlet Temp	926.4	940.5	937.3	936.3	
ther Measurements								
Fired Hours	h	CTGDCS	GT OPERATION HOUR (GAS)	0	997.9	1.002.1	1.003.1	
Number of starts	#	CTGDCS	GT START No (GAS)	0	42.0	42.0	42.0	
Number of load rejections	#	CTGDCS	TOTAL EQUIVALENT COUNT OF LD OFF (GAS)	0	0.0	0.0	0.0	
Number of trips	#	CTGDCS	TOTAL EQUIVALENT COUNT OF TRIP (GAS)	0	66.0	66.0	66.0	
Number of rapid loads	#	CTGDCS	TOTAL EQUIVALENT COUNT OF RAPID LOAD O	0	11.0	11.0	11.0	
Equivalent Degradation Hours for permanent degradation, EDH1	h		EDH1		2,238.0	2,243.0	2,244.0	From MHPS Historical Tabulation
Equivalent Degradation Hours for recoverable degradation by ma	h		EDH2	4 765 000 0	1,090.0	1,095.0	1,096.0	From MHPS Historical Tabulation
CTG exhaust flow uncertainty from HRSG energy balance	%			4,703,000.0	4,055,828.7	4,733,427.4	4,733,209.4	From HRSG test
erd exhaust now uncertainty nom misd energy balance	<i>7</i> 0			0.0076	0.76%	0.70%	0.78%	i foir fills test
ow Measurements								
uel Gas Flow								03-FIT-992601
Meter Type	-			Turbine	Turbine	Turbine	Turbine	
Meter Diameter	in			10.00	10.00	10.00	10.00	
Flow Pressure	psia	CTGDAS	FG Supply Press	600.0	706.2	705.6	705.6	
Flow Temperature	Deg F	CTGDAS	FG Supply Temp	40.0	68.3	63.4	63.1	
Starting Pulse Cout	Pulses		=CTGDCSIAH76	0.0	881618	103149	393195	
Ending Pulse Coul	Puises			340,817.0	1/3108	393195	0838/1	
CA Flow								
Meter Type	-			ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	03-FE-065618
Тар Туре	-			Throat	Throat	Throat	Throat	
Inlet Diameter	in			5.1880	5.1880	5.1880	5.1880	
Throat Diameter	in			2.5635	2.5635	2.5635	2.5635	
Diameter Measurement Temperature	Deg F			74	74	74	74	Assumed
Calibration Temperature	Deg F			106	106	106	106	Assumed
Iniet Material	-			CS SS3yy	SSByy	CS SSRvv	CS SSByy	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	TCA Flow Pressure Corr	3,000.0	1,888.1	1,893.0	1,894.6	
Flow Temperature	Deg F	DCS	03-TE-065607.UNIT3@NET3	323.8	589.1	591.6	590.6	
Flow DP	inH2O	MainDAS	TCA Flow DP	32.7	68.3	67.0	67.9	
Cooling Steam Flow								
Cooling Steam Flow				Vonturi	Vonturi	Vooturi	Vonturi	03 55 035633
Tan Tyne	-			Throat	Throat	Throat	Throat	03-FE-035622
nlet Diameter	in			7.981	7.981	7.981	7.981	
Throat Diameter	in			5.428	5.428	5.428	5.428	
Diameter Measurement Temperature	Deg F			72	72	72	72	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Inlet Material	-			CS	CS	CS	CS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type Flow Pressure	- nsia	MainDAS	CTG Cooling Steam Flow Pressure Corr	vapor A10.0	vapor coo 4	vapor Epi p	vapor E22.4	
Flow Temperature	Deg F	DCS	03-TE-035623.UNIT3@NFT3	419.9	528.4	531.2	532.1	
Flow DP	inH2O	MainDAS	CTG Cooling Steam Flow DP	157.3	124.2	125.5	125.9	
			-					
ant Fuel Gas Flow								
Meter Type	-			Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic	
Гар Туре	-	1		N/A	N/A	N/A	N/A	
nlet Diameter	in			10.0210	10.0210	10.0210	10.0210	
Throat Diameter	in Dee 5			10.0210	10.0210	10.0210	10.0210	6d
Diameter Measurement Temperature	Deg F			72	72	72	72	Assumed
Januration Temperature	ueg F			48.4	48.4	48.4	48.4	
Throat Material	_			SS3xx	SS3xx	SS3xx	SS3xx	
luid Type	-			Vapor	Vapor	Vapor	Vapor	
Upstream Pressure	psia	DCS	03-ENBL-PSI.UNIT3@NET3	450.0	806.9	840.8	841.9	
Downstream Temperature	Deg F	DCS	03-TT-560500.UNIT3@NET3	67.8	68.7	67.9	67.8	
	~	l		00.0	45.00	42.42	42.52	1
Meter Reported Flow Rate	KACF/h	DCS	03-F1-500500B.0INI13@INE13	6.06	45.23	42.45	42.55	

Fuel Analysis	1 1	1		1		ASTM D1945
Methane, CH4	mole %	93.280%	90.29%	90.00%	89.93%	
Ethane, C2H6	mole %	3.535%	6.85%	7.02%	7.03%	
Propane, C3H8	mole %	0.530%	0.33%	0.36%	0.35%	
Iso-Butane, i-C4H10	mole %	0.039%	0.01%	0.01%	0.01%	
N-Butane, n-C4H10	mole %	0.072%	0.02%	0.03%	0.03%	
Iso-Pentane, i-C5H12	mole %	0.009%	0.00%	0.01%	0.01%	
N-Pentane, n-C5H12	mole %	0.008%	0.00%	0.01%	0.01%	
N-Hexane, n-C6H14	mole %	0.016%	0.01%	0.01%	0.01%	
Heptane, C7H16	mole %	0.000%	0.00%	0.00%	0.00%	
Octane, C8H18	mole %	0.000%	0.00%	0.00%	0.00%	
Nonane, C9H2O	mole %	0.000%	0.00%	0.00%	0.00%	
Decane, C10H22	mole %	0.000%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %	1.971%	1.80%	1.86%	1.90%	
Carbon Monoxide, CO	mole %	0.000%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %	0.540%	0.63%	0.65%	0.66%	
Water, H2O	mole %	0.000%	0.00%	0.00%	0.00%	
Hydrogen Sulphide, H2S	mole %	0.000%	0.00%	0.00%	0.00%	
Hydrogen, H2	mole %	0.000%	0.00%	0.00%	0.00%	
Helium, He	mole %	0.000%	0.04%	0.04%	0.04%	
Oxygen, O2	mole %	0.000%	0.00%	0.00%	0.00%	
Argon, Ar	mole %	0.000%	0.01%	0.01%	0.01%	

	GREC U3 CTG Flow Calculations for HRSG & EPC											
		Tag										
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes					
TCA Flow							03-FE-065618					
Design Information												
Meter Type	-		ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle						
Тар Туре	-		Throat	Throat	Throat	Throat						
Inlet Diameter	in		5.1880	5.1880	5.1880	5.1880						
Throat Diameter	in		2.5635	2.5635	2.5635	2.5635						
Diameter Measurement Temperature	Deg F		74.0	74.0	74.0	74.0						
Calibration Temperature	Deg F		106.0	106.0	106.0	106.0						
Inlet Material	-		CS	CS	CS	CS						
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx						
Fluid Type	-		Liquid	Liquid	Liquid	Liquid						
Measured Parameters												
Upstream Pressure	psia		3,000.0	1,888.1	1,893.0	1,894.6						
Downstream Temperature	Deg F		323.8	589.1	591.6	590.6						
DP	inH2O		32.7	68.3	67.0	67.9						
Calculated Parameters												
Fluid Density	lb/ft^3		57.24	43.70	43.50	43.59						
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000056	0.000056	0.000056						
Calculated Flow	lb/h		105,578	134,057	132,444	133,457	105,578.05					
Calculated Flow	gpm		230	382	380	382						

#### Calibration Data Meter Serial Number Meter Location Tap Set

er				20171-0	)9				
				FW from	ТСА				
	1	L	2		3		4		
	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	
1	1,688,016	0.9972	1,688,016	0.9972	1,688,016	0.9974	1,688,016	0.9977	
2	1,563,992	0.9971	1,563,992	0.9971	1,563,992	0.9973	1,563,992	0.9976	
3	1,436,064	0.9969	1,436,064	0.9969	1,436,064	0.9972	1,436,064	0.9975	
4	1,307,741	0.9968	1,307,741	0.9968	1,307,741	0.9971	1,307,741	0.9974	
5	1,187,818	0.9967	1,187,818	0.9966	1,187,818	0.9969	1,187,818	0.9972	
6	1,061,224	0.9964	1,061,224	0.9963	1,061,224	0.9967	1,061,224	0.9969	
7	934,926	0.9963	934,926	0.9962	934,926	0.9966	934,926	0.9968	
8	809,963	0.9963	809,963	0.9962	809,963	0.9966	809,963	0.9968	
9	684,209	0.9965	684,209	0.9964	684,209	0.9968	684,209	0.997	
10	559,839	0.9973	559,839	0.9971	559,839	0.9974	559,839	0.9976	
11	1,626,844	0.9972	1,626,844	0.9971	1,626,844	0.9974	1,626,844	0.9976	
12	1,499,559	0.997	1,499,559	0.997	1,499,559	0.9973	1,499,559	0.9975	
13	1,374,447	0.997	1,374,447	0.9969	1,374,447	0.9973	1,374,447	0.9974	
14	1,248,249	0.9968	1,248,249	0.9968	1,248,249	0.9972	1,248,249	0.9973	
15	1,121,754	0.9965	1,121,754	0.9964	1,121,754	0.9968	1,121,754	0.997	
16	996,593	0.9964	996,593	0.9964	996,593	0.9967	996,593	0.9969	
17	873,458	0.9963	873,458	0.9963	873,458	0.9966	873,458	0.9969	
18	747,062	0.9964	747,062	0.9964	747,062	0.9968	747,062	0.997	
19	622,247	0.9968	622,247	0.9967	622,247	0.9971	622,247	0.9973	
20	497,926	0.9975	497,926	0.9974	497,926	0.9978	497,926	0.9979	
21	172,349	0.9974	172,349	0.9971	172,349	0.9973	172,349	0.9976	
22	122,789	0.9936	122,789	0.9931	122,789	0.9926	122,789	0.9936	
23	334,718	0.9982	334,718	0.998	334,718	0.9983	334,718	0.9986	

	GREC U3 CTG Flow Calculations for HRSG & EPC											
		Tag										
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes					
CT Cooling Steam Flow							03-FE-035622					
Design Information												
Meter Type	-		Venturi	Venturi	Venturi	Venturi						
Тар Туре	-		Throat	Throat	Throat	Throat						
Inlet Diameter	in		7.981	7.981	7.981	7.981						
Throat Diameter	in		5.428	5.428	5.428	5.428						
Diameter Measurement Temperature	Deg F		72.0	72.0	72.0	72.0						
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A						
Inlet Material	-		CS	CS	CS	CS						
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx						
Fluid Type	-		Vapor	Vapor	Vapor	Vapor						
Measured Parameters												
Upstream Pressure	psia		419.9	528.4	531.2	532.1						
Downstream Temperature	Deg F		560.0	570.2	570.7	570.9						
DP	inH2O		157.3	124.2	125.5	125.9						
Calculated Parameters												
Fluid Density	lb/ft^3		0.75	0.96	0.96	0.96						
Fluid Viscosity	lbm/(ft*s)		0.000013	0.000013	0.000013	0.000013						
Calculated Flow	lb/h		129,494	130,348	131,362	131,716	129,494.82					
Calculated Flow	gpm		21,479	16,993	17,033	17,053						

GREC U3 CTG Flow Calculations for HRSG & EPC											
	Tag										
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes				
Plant Fuel Flow											
Design Information											
Meter Type	-		Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic					
Тар Туре	-		N/A	N/A	N/A	N/A					
Inlet Diameter	in		10.0	10.0	10.0	10.0					
Throat Diameter	in		10.0	10.0	10.0	10.0					
Diameter Measurement Temperature	Deg F		72.0	72.0	72.0	72.0					
Calibration Temperature	Deg F		48.4	48.4	48.4	48.4					
Inlet Material	-		SS3xx	SS3xx	SS3xx	SS3xx					
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx					
Fluid Type	-		Vapor	Vapor	Vapor	Vapor					
Measured Parameters											
Upstream Pressure	psia		450.0	806.9	840.8	841.9					
Downstream Temperature	Deg F		67.8	68.7	67.9	67.8					
Meter Reported Flow Rate	KACFM		86.8	45.2	42.4	42.5					
Fuel Analysis (lab)											
Methane, CH4	mole %		93,28%	90.29%	90.00%	89 93%					
Ethane C2H6	mole %		3 53%	6.85%	7 02%	7 03%					
Propage C3H8	mole %		0.53%	0.33%	0.36%	0.35%					
Iso-Butane i-C/H10	mole %		0.04%	0.01%	0.01%	0.01%					
N-Butane n-C/H10	mole %		0.04%	0.01%	0.01%	0.01%					
Iso-Pentane i-C5H12	mole %		0.07%	0.02%	0.05%	0.03%					
N-Pentane n-C5H12	mole %		0.01%	0.00%	0.01%	0.01%					
N-Hexane n-C6H14	mole %		0.01%	0.00%	0.01%	0.01%					
Hentane C7H16	mole %		0.02%	0.01%	0.01%	0.01%					
Octane C8H18	mole %		0.00%	0.00%	0.00%	0.00%					
Nonane (9H20	mole %		0.00%	0.00%	0.00%	0.00%					
Decane C10H22	mole %		0.00%	0.00%	0.00%	0.00%					
Nitrogen N2	mole %		1 97%	1.80%	1.86%	1 90%					
Carbon Monovide, CO	mole %		0.00%	0.00%	0.00%	0.00%					
Carbon Dioxida, CO2	mole %		0.00%	0.00%	0.00%	0.00%					
Water H2O	mole %		0.04%	0.03%	0.05%	0.00%					
Hydrogen Sulphide, H2S	mole %		0.00%	0.00%	0.00%	0.00%					
Hydrogen H2	mole %		0.00%	0.00%	0.00%	0.00%					
Helium He	mole %		0.00%	0.00%	0.00%	0.00%					
	mole %		0.00%	0.04%	0.04%	0.04%					
Argon Ar	mole %		0.00%	0.00%	0.00%	0.00%					
Algon, Al	mole %		0.00%	0.01%	0.01%	0.01%					
Calculated Parameters											
Gas MW (Lab Composition)	lb/lb mole		17.14	17.51	17.56	17.57					
Fluid Density (Lab Composition)	lb/ft^3	ρSCF_Lab	0.045	0.046	0.046	0.046	SCF				
Fluid Density (Lab Composition)	lb/ft^3	ρACF_Lab	1.452	2.813	2.964	2.972	ACF				
Calculated Flow	lb/h		126,093	127,242	125,776	126,378	QACF*pACF_Lab				
Calculated Flow	gpm		10,825	5,639	5,290	5,302					

GREC U3 CTG Exhaust Flow by CTG Energy Balance Calculation for HRSG & EPC										
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes			
Power Measurements	L111		214 700 0	207 546 5	211 960 0	212 016 5				
Power Factor	-		0.90	1.00	1.00	1.00				
Frequency	Hz		60.0	60.0	60.0	60.0				
Measured Excitation Current	A		65.0	2,020.5	2,045.3	2,040.1				
Auxiliary Power	v		500.0	114.2	115.0	113.0				
Prossure Measurements										
Barometric Pressure	psia		14.367	14.426	14.424	14.424				
Static Inlet Chiller Coil Loss	inH2O		1.000	0.646	0.645	0.649				
Static Inlet Loss	inH2O		5.000	5.000	5.000	5.000				
Static Exhaust Pressure Loss	InH2O		16.000	15.356	15.550	15.624				
Fuel Supply Pressure	psia		650.000	706.016	705.446	705.451				
TCA Inlet Pressure	psia		3000.0	2664.2	2672.0	2666.7				
TCA Outlet Pressure	psia		3000.0	2604.8	2613.8	2607.9				
CT Cooling Steam Inlet Pressure	psia		517.6	528.0	530.8	531.7				
CT Cooling steam Outlet Pressure	psia		419.9	430.7	432.4	433.0				
Temperature Measurements										
Ambient DB Temp	Deg F		59.0	79.3	75.4	74.1				
Ambient RH	%		65.00%	76.19%	81.11%	84.12%				
Compressor Inlet Temp	Deg F		59.0	79.3	75.3	74.2				
Compressor Inlet KH	70 Deg F		65.00%	/6.19%	81.11%	84.12%				
Fxhaust Temp	Deg F		1.188.0	1.191.5	1.188.9	1.188.2	Using temporary TCs			
	0 -			_,		_,				
TCA Inlet Temperature	Deg F		323.8	332.4	332.6	333.0				
TCA Outlet Temperature	Deg F		600.5	589.1	591.6	590.6				
CT Cooling Steam Outlet Temperautre	Deg F		565.6	570.7	5/0.9	5/1.1				
Cr cooling steam outlet remperature	Degi		520.4	540.5	557.5	530.3				
Fuel Analysis										
Methane, CH4	mole %		93.28%	90.29%	90.00%	89.93%				
Ethane, C2H6	mole %		3.53%	6.85%	7.02%	7.03%				
Propane, C3H8	mole %		0.53%	0.33%	0.36%	0.35%				
N-Butane, n-C4H10	mole %		0.07%	0.02%	0.03%	0.03%				
Iso-Pentane, i-C5H12	mole %		0.01%	0.00%	0.01%	0.01%				
N-Pentane, n-C5H12	mole %		0.01%	0.00%	0.01%	0.01%				
N-Hexane, n-C6H14	mole %		0.02%	0.01%	0.01%	0.01%				
Heptane, C/H16	mole %		0.00%	0.00%	0.00%	0.00%				
Nonane, C9H20	mole %		0.00%	0.00%	0.00%	0.00%				
Decane, C10H22	mole %		0.00%	0.00%	0.00%	0.00%				
Nitrogen, N2	mole %		1.97%	1.80%	1.86%	1.90%				
Carbon Monoxide, CO	mole %		0.00%	0.00%	0.00%	0.00%				
Carbon Dioxide, CO2	mole %		0.54%	0.63%	0.65%	0.66%				
Hydrogen Sulphide, H2S	mole %		0.00%	0.00%	0.00%	0.00%				
Hydrogen, H2	mole %		0.00%	0.00%	0.00%	0.00%				
Helium, He	mole %		0.00%	0.04%	0.04%	0.04%				
Oxygen, O2	mole %		0.00%	0.00%	0.00%	0.00%				
Argon, Ar	mole %		0.00%	0.01%	0.01%	0.01%				
Calculated Flows										
CTG Fuel Flow	lb/h		126,093.3	127,242.2	125,776.2	126,377.5	Using Enable Meter			
TCA Flow	lb/h		105,578.0	134,056.6	132,444.5	133,456.6				
CT Cooling Steam Flow	lb/h		129,494.0	130,348.0	131,362.2	131,716.1				
Calculations										
TCA Inlet Enthalpy	btu/lb		299.52	307.67	307.89	308.27				
TCA Outlet Enthalpy	btu/lb		610.67	596.63	600.00	598.59				
TCA Energy	btu/h		32,850,159.22	38,736,613.22	38,687,933.71	38,744,640.09				
CT Cooling Steam Inlet Enthaloy	htu/lb		1 275 20	1 277 61	1 277 50	1 277 51				
CT Cooling Steam Outlet Enthalpy	btu/lb		1,483.74	1,490.97	1,489.17	1,488.65				
CT Cooling Steam Energy	btu/h		26,979,981.60	27,810,977.58	27,805,230.71	27,809,438.88				
Compressor inlet pressure	psia		14.186	14.245	14.243	14.243				
Conceptor Loss	L\A/		2 400 00	2 276 46	2 207 42	3 304 55				
Generator Losses	KVV kW/		2,466.22	2,276.46	2,297.12	2,301.22				
2C Cooler Losses			000	000	000	000				
4S Cooler Losses										
Total CTG Losses	mmBtu/h		61.877	68.595	68.540	68.601	Includes TCA and CT Cooling Steam			
Poculte										
CTG Exhaust Enthalpy	btu/lb		302.36	300.18	300.47	300.54				
CTG Exhaust Flow	lb/h		4,827,144	4,990,106	4,822,703	4,840,786				
	I									

	GREC U3 CTG Calculations for HRSG & EPC									
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes			
Inputs			-							
Power Measurements										
Generator Gross Power Output	kW		314,700.0	307,546.5	311,860.0	313,016.5				
Power Factor	-		0.900	0.997	0.996	0.997				
Frequency	Hz		60,000	60.005	59,999	60.003				
Measured Excitation Current	А		65.000	2020.459	2045.349	2040.064				
Auxiliary Power	v		500.000	114 200	115 000	113 000				
Pressure Measurements										
Barometric Pressure	nsia		14,367	14.426	14.424	14.424				
Static Inlet Chiller Coil Loss	inH2O		1.000	0.646	0.645	0.649				
Static Inlet Loss	inH2O		5.000	5.000	5.000	5.000				
Static Exhaust Pressure Loss	InH2O		16.000	15,356	15,550	15.624				
Fuel Supply Pressure	psia		650.000	706.016	705.446	705.451				
· · · · · · · · · · · · · · · · · · ·										
TCA Inlet Pressure	psia		3000.000	2664.245	2671.983	2666.711				
TCA Outlet Pressure	psia		3000.000	2604.759	2613.794	2607.934				
CT Cooling Steam Inlet Pressure	psia		517.560	527.964	530.801	531.664				
CT Cooling Steam Outlet Pressure	psia		419.860	430.652	432.422	432.963				
<b>0</b>										
Temperature Measurements										
Ambient DB Temp	Deg F		59.000	79.310	75.384	74.063				
Ambient RH	%		65.00%	76,19%	81,11%	84.12%				
Compressor Inlet Temp	Deg F		59.000	79,303	75,251	74,170				
Compressor Inlet RH	%		65.00%	76.19%	81,11%	84.12%				
Fuel temp at turbine	Deg F		449,000	454.883	455,459	454,999				
Exhaust Temp	Deg F		1188.000	1191,506	1188.907	1188,187				
	-0									
TCA Inlet Temperature	Deg F		323.841	332.378	332.578	332.962				
TCA Outlet Temperature	Deg F		600,516	589.089	591.616	590.558				
CT Cooling Steam Inlet Temperautre	Deg F		565,634	570.652	570.906	571.060				
CT Cooling Steam Outlet Temperautre	Deg F		926.356	940.512	937.254	936.315				
	Ū									
Other Measurements										
CTG exhaust flow from HRSG energy balance	lb/h		4,765,000	4,699,829	4,755,427	4,755,269				
CTG exhaust flow uncertainty from HRSG energy balance	%		1.00%	0.78%	0.78%	0.78%				
, 0,										
Fuel Analysis										
Methane, CH4	mole %		93.28%	90.29%	90.00%	89.93%				
Ethane, C2H6	mole %		3.53%	6.85%	7.02%	7.03%				
Propane, C3H8	mole %		0.53%	0.33%	0.36%	0.35%				
lso-Butane, i-C4H10	mole %		0.04%	0.01%	0.01%	0.01%				
N-Butane, n-C4H10	mole %		0.07%	0.02%	0.03%	0.03%				
Iso-Pentane, i-C5H12	mole %		0.01%	0.00%	0.01%	0.01%				
N-Pentane, n-C5H12	mole %		0.01%	0.00%	0.01%	0.01%				
N-Hexane, n-C6H14	mole %		0.02%	0.01%	0.01%	0.01%				
Heptane, C7H16	mole %		0.00%	0.00%	0.00%	0.00%				
Octane, C8H18	mole %		0.00%	0.00%	0.00%	0.00%				
Nonane, C9H20	mole %		0.00%	0.00%	0.00%	0.00%				
Decane, C10H22	mole %		0.00%	0.00%	0.00%	0.00%				
Nitrogen, N2	mole %		1.97%	1.80%	1.86%	1.90%				
Carbon Monoxide, CO	mole %		0.00%	0.00%	0.00%	0.00%				
Carbon Dioxide, CO2	mole %		0.54%	0.63%	0.65%	0.66%				
Water, H2O	mole %		0.00%	0.00%	0.00%	0.00%				
Hydrogen Sulphide, H2S	mole %		0.00%	0.00%	0.00%	0.00%				
Hydrogen, H2	mole %		0.00%	0.00%	0.00%	0.00%				
Helium, He	mole %		0.00%	0.04%	0.04%	0.04%				
Oxygen, O2	mole %		0.00%	0.00%	0.00%	0.00%				
Argon, Ar	mole %		0.00%	0.01%	0.01%	0.01%				
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes			
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Calculated Flows										
CTG Fuel Flow	lb/h		126,093.3	127,242.2	125,776.2	126,377.5	Using Enable Meter			
TCA Flow	lb/h		105.578.0	134.056.6	132,444.5	133,456,6	ů –			
CT Cooling Steam Flow	lb/h		129,494.0	130,348.0	131.362.2	131,716,1				
			123,131.0	100,010.0	101,002.2	101,710.1				
CTC Exhaust Flow (CTC onorgy halance)	lh/h		4 765 000	4 000 106	4 922 702	4 940 796				
CTG exhaust flow (CTG energy balance)	0/		4,705,000	4,990,100	4,022,705	4,640,780				
CIG exhaust flow uncertainty from CIG energy balance	% 		1.00%	1.76%	1.33%	1.60%				
CTG Exhaust Flow (HRSG energy balance)	lb/h		4,765,000	4,699,829	4,755,427	4,755,269	Not used for CTG results. HRSG and Plant test only			
CTG exhaust flow uncertainty from HRSG energy balance	%		1.00%	0.78%	0.78%	0.78%				
Uncertainty Weighted CTG Exhaust Flow	lb/h		4,765,000	4,747,969	4,772,811	4,771,706	Not used for CTG results. HRSG and Plant test only			
Uncertainty Weighted CTG Exhaust Flow uncertainty	%		1.00%	0.95%	0.92%	0.94%				
Additive Corrections				4,778,509	4,800,071	4,801,479				
Output Corrections										
Correction for generator power factor	kW		0	150	153	156	Loss @ Design PF - Test PF all at Test MW			
Correction for off design auxiliary power	kW		0	0	0	0	Non design aux loads in operation			
Sum of additive corrections	kW		0	150	153	156	<b>.</b>			
			-							
Nultiplicative Corrections										
Output Corrections										
Ambient Temperature (Chiller Off)	ON		1.000000	0.937771	0.949793	0.953837				
Compressor Inlet Temperature (Chiller On)	055		1 000000	1 000000	1 000000	1 000000				
Ambient Relative Humidity (Chiller Off)	ON		1.000000	1 000000	1 001174	1 001242				
Amorent Relative Furnicity (Chiller Off)	OFF		1.000000	1.000904	1.0011/4	1.001342				
Compressor inlet kelative Humidity (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Ambient Pressure	ON		1.000004	1.004351	1.004180	1.004159				
Frequency	ON		0.999969	1.000018	0.999960	1.000001				
LHV and C/H Ratio	ON		1.000010	0.999179	0.999011	0.998954				
Inlet Chiller Module DP	ON		1.000000	1.001262	1.001265	1.001251				
Exhaust DP (Chiller Off)	ON		1.000000	1.000591	1.000413	1.000345				
Exhaust DP (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Fuel Gas Temperautre at CTG	OFF									
Degredation	OFF		1 000000	1 000000	1 000000	1 000000				
Degredation	011		1.000000	1.000000	1.000000	1.000000				
Product Output corrections			0.9999905	0.943092	0.955500	0.939010				
Heat Pate Corrections						1				
Ambient Temperature (Chiller Off)			1 000000	1 017100	1 012410	1 012204				
Ambient remperature (Chiller Off)			1.000000	1.01/186	1.013418	1.012204				
Compressor Inlet Temperature (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Ambient Relative Humidity (Chiller Off)	ON		1.000000	1.000699	1.000902	1.001030				
Compressor Inlet Relative Humidity (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Ambient Pressure	ON		1.000017	0.999828	0.999835	0.999836				
Frequency	ON		1.000093	1.000100	1.000092	1.000098				
LHV and C/H Ratio	ON		1.000003	1.000288	1.000349	1.000370				
Inlet Chiller Module DP	ON		1.000000	0.999634	0.999633	0.999637				
Exhaust DP (Chiller Off)	ON		1 000000	0 999411	0 999580	0 999657				
Exhaust DP (Chiller On)	OFF		1 000000	1 000000	1 00000	1 00000				
Evel Gas Temperautre at CTG	ON		0.000000	1.000000	0.000401	1.000000				
Descalation	OFF		0.333835	0.333490	0.999401	0.333489				
Degrecation	OFF		1.000000	1.000000	1.000000	1.000000				
Product Heat Rate Corrections			0.999948	1.016632	1.013277	1.012321				
Exhaust Flow Corrections										
Exhlust Flow Corrections	011		1 000000	0.057007	0.005 450	0.000000				
Ambient remperature (Chiller On)	ON		1.000000	0.957087	0.965456	0.968262				
Compressor Inlet Temperature (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Ambient Relative Humidity (Chiller Off)	ON		1.000000	0.998373	0.997914	0.997625				
Compressor Inlet Relative Humidity (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000				
Ambient Pressure	ON		1.000006	1.004190	1.004024	1.004004				
Frequency	ON		1.000000	1.000081	0.999985	1.000053				
LHV and C/H Ratio	ON		1.000001	0.999959	0.999913	0.999887				
Inlet Chiller Module DP	ON		1 000000	1 000919	1 000921	1 000911				
Exhaust DB (Chiller Off)	055		1.000000	1.000313	1.000321	1.000911				
Exhaust DP (Chiller On)										
Exhaust DP (Chiller On)	OFF									
Fuel Gas Temperautre at CTG	OFF									
Degredation	OFF		1.000000	1.000000	1.000000	1.000000				
Product Exhaust Flow Corrections			1.000008	0.960454	0.968112	0.970656				
Product Exhaust Flow Corrections			1.000008	0.960454	0.968112	0.970656				

		GRE	C U3 CTG Calcula	tions for HRSG 8	EPC		
escription	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Exhaust Temperature Corrections							
Ambient Temperature (Chiller Off)	ON		0.000004	17.252128	13.639801	12.458315	
Compressor Inlet Temperature (Chiller On)	OFF		0.000000	0.000000	0.000000	0.000000	
Ambient Relative Humidity (Chiller Off)	ON		0.000000	1.509210	1.948985	2.224173	
Compressor Inlet Relative Humidity (Chiller On)	OFF		0.000000	0.000000	0.000000	0.000000	
Ambient Pressure	ON		-0.001659	-0.126971	-0.122076	-0.121479	
Frequency	ON		-0.113840	-0.140011	-0.108882	-0.130840	
LHV and C/H Ratio	ON		0.001028	-0.096316	-0.099912	-0.096420	
Inlet Chiller Module DP	ON		0.000000	-0 247516	-0 248085	-0 245470	
Exhaust DR (Chiller Off)			0.000000	-0.462808	-0 222087	-0.269517	
Exhaust DP (Chiller On)			0.000000	-0.402808	-0.322387	-0.209317	
Exhaust DP (Chiller On)	OFF		0.000000	0.000000	0.000000	0.00000	
Fuel Gas Temperautre at CTG	OFF						
Degredation	OFF		0.000000	0.000000	0.000000	0.000000	
Sum Exhaust Temperature Corrections			-0.114467	17.687715	14.686845	13.818761	
TCA Cooler Heat Duty Corrections							
Ambient Temperature (Chiller Off)	ON		1.000000	1.020209	1.016131	1.014773	
Compressor Inlet Temperature (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000	
Ambient Relative Humidity (Chiller Off)	ON		1.000000	0.998793	0.998416	0.998181	
Compressor Inlet Relative Humidity (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000	
Ambient Pressure	ON	1	1.000008	1.004140	1.003976	1.003956	
Frequency	ON		0 999922	1 000147	0 999879	1 000068	
LHV and C/H Batio	ON		1 00001	0 000633	0 999514	0 000/69	
Inlet Chiller Medule DR			1.000001	1.000866	1 000969	1.000850	
			1.000000	1.000800	1.000808	1.000839	
Exhaust DP (Chiller Off)	OFF						
Exhaust DP (Chiller On)	OFF						
Fuel Gas Temperautre at CTG	OFF						
Product TCA Cooler Heat Duty Corrections			0.999931	1.023847	1.018821	1.017336	
Cooling Steam Heat Duty Corrections							
Ambient Temperature (Chiller Off)	ON		1.000000	0.953890	0.962548	0.965490	
Compressor Inlet Temperature (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000	
Ambient Relative Humidity (Chiller Off)	ON		1.000000	1.001603	1.002078	1.002375	
Compressor Inlet Relative Humidity (Chiller On)	OFF		1.000000	1.000000	1.000000	1.000000	
Ambient Pressure	ON		0.999992	1.004150	1.003986	1.003966	
Frequency	ON		0.999996	1.000052	0.999985	1.000032	
LHV and C/H Ratio	ON		0.999994	0.999370	0.999247	0.999207	
Inlet Chiller Module DP	ON		1.000000	1.000926	1.000928	1.000918	
Exhaust DP (Chiller Off)	OFF						
Exhaust DP (Chiller On)	OFF						
Evel Gas Temperautre at CTG	055						
Product Cooling Steam Heat Duty Corrections	011		0 000091	0 050710	0 068549	0 071773	
Froduct Cooling Stealli fleat Daty Corrections			0.333981	0.939719	0.306548	0.3/1//3	
Calculations							
Measured Excitation Current	^		6E 00	2 020 40	2.045.25	2.040.00	Peference
			240.07	2,020.40	2,045.35	2,040.00	
Ivicabuleted Evolution Current	A		349.67	308.56	313.06	313.96	Free V Curse
	A 		2,6/6.5	1,981.7	2,006.8	2,002.2	From v Curve
Generator Excitation Power	кW		833.5	466.5	477.8	475.7	
Field Losses	кW		802.695	441.068	452.244	450.169	K IS U.1113 Ω @ 95 C
Thyristor Losses	kW		12.50	12.50	12.50	12.50	Constant from procedure
Excitation Transformer Losses	kW		18.29	12.93	13.09	13.06	6.420 kW NLL, 2890A rated LS, 20.764 kW rated loss
Fuel Heating Value (LHV)	btu/lb		20,422.37	20,401.32	20,367.93	20,348.21	
TCA Inlet Enthalpy	btu/lb		299.52	307.67	307.89	308.27	
TCA Outlet Enthalpy	btu/lb		610.67	596.63	600.00	598.59	
TCA Energy	btu/h		32,850,159	38,736,613	38,687,934	38,744,640	
	btu/lb		1,275.39	1,277.61	1,277.50	1,277.51	
CT Cooling Steam Inlet Enthalpy							
CT Cooling Steam Inlet Enthalpy CT Cooling Steam Outlet Enthalpy	btu/lb		1,483.74	1,490.97	1,489.17	1,488.65	
CT Cooling Steam Inlet Enthalpy CT Cooling Steam Outlet Enthalpy CT Cooling Steam Energy	btu/lb btu/h		1,483.74 26,979,982	1,490.97 27,810,978	1,489.17 27,805,231	1,488.65 27,809,439	

	GREC U3 CTG Calculations for HRSG & EPC												
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes						
Results													
Gas Turbine Generator Gross Power Output	kW		314,700	307,547	311,860	313,017							
Gas Turbine Generator Net Power Output	kW		313,867	307,080	311,382	312,541	Gross-Excitation						
Gas Turbine Generator Net Equiment Power Output	kW		313,367	306,966	311,267	312,428	Net Generator-Aux						
Corrected Gas Turbine Generator Net Equipment Power Output	kW		313,372	325,123	325,603	325,414	(Net Equipment - Additive Corr)/Multiplicative Corr						
Gas Turbine Heat Consumption Rate (LHV)	BTU/h		2,575,123,601	2,595,907,654	2,561,800,692	2,571,557,073							
Gas Turbine Generator Net Heat Rate (LHV)	BTU/kWh		8,205	8,454	8,227	8,228							
Gas Turbine Generator Net Equipment Heat Rate (LHV)	BTU/kWh		8,218	8,457	8,230	8,231							
Corrected Gas Turbine Generator Net Equipment Heat Rate (LHV)	BTU/kWh		8,218	8,326	8,130	8,139							
Gas Turbine Exhaust Temperature	Deg F		1,188.0	1,191.5	1,188.9	1,188.2							
Gas Turbine Corrected Exhaust Temperature	Deg F		1,188.1	1,173.8	1,174.2	1,174.4							
Gas Turbine Exhaust Flow Rate	lb/h		4,765,000	4,747,969	4,772,811	4,771,706	Uncertainty weighted average of CTG and HRSG for plant test						
Corrected Gas Turbine Exhaust Flow Rate	lb/h		4,764,964	4,943,461	4,930,019	4,915,961							
Turbine Cooling Air Heat Duty	btu/h		32,850,159	38,736,613	38,687,934	38,744,640							
Corrected Turbine Cooling Air Heat Duty	btu/h		32,852,442	37,834,395	37,973,228	38,084,410							
Steam Cooling Heat Duty	btu/h		26,979,982	27,810,978	27,805,231	27,809,439							
Corrected Steam Cooling Heat Duty	btu/h		26,980,488	28,978,257	28,708,160	28,617,215							
1	1												

	GREC U3 CTG Unfired Results for HRSG & EPC												
Description	Unit	Guarantee	Test Run 1	Test Run 2	Test Run 3	Average TR 1-3	Pass/Fail	Notes					
Equipment Net Power Output Corrected Equipment Net Power Output Margin Margin	kW kW kW %	- 314,200 - -	306,966 325,123 10,923 3.48%	311,267 325,603 11,403 3.63%	312,428 325,414 11,214 3.57%	310,220 325,380 11,180 3.56%	- - Pass						
Equipment Net Heat Rate (LHV) Corrected Equipment Net Heat Rate (LHV) Margin Margin	BTU/kWh BTU/kWh BTU/kWh %	- 8,195	8,457 8,326 -131 -1.60%	8,230 8,130 65 0.79%	8,231 8,139 56 0.69%	8,306 8,199 -4 -0.04%	Fail						
Gas Turbine Exhaust Temperature Corrected Gas Turbine Exhaust Temperature Margin	Deg F Deg F Deg F	- 1,188.0	1,191.5 1,173.8 -14.2	1,188.9 1,174.2 -13.8	1,188.2 1,174.4 -13.6	1,189.5 1,174.1 -13.9	Fail	Temporary TCs					
Gas Turbine Exhaust Flow Rate Corrected Gas Turbine Exhaust Flow Rate Margin Margin	lb/h lb/h lb/h %	- 4,765,000 - -	4,747,969 4,943,461 178,461 3.75%	4,772,811 4,930,019 165,019 3.46%	4,771,706 4,915,961 150,961 3.17%	4,764,162 4,929,814 164,814 3.46%	Pass	Uncertainty weighted average of CTG and					
Turbine Cooling Air Heat Duty Corrected Turbine Cooling Air Heat Duty Margin Margin Steam Cooling Heat Duty	Btu/h Btu/h Btu/h % Btu/h	- 32,850,000 - -	38,736,613 37,834,395 4,984,395 15.17% 27,810,978	38,687,934 37,973,228 5,123,228 15.60%	38,744,640 38,084,410 5,234,410 15.93% 27,809,439	38,723,062 37,964,011 5,114,011 15.57% 27,808,549	Pass						
Corrected Steam Cooling Heat Duty Margin Margin	Btu/h Btu/h %	26,980,000 - -	28,978,257 1,998,257 7.41%	28,708,160 1,728,160 6.41%	28,617,215 1,637,215 6.07%	28,767,877 1,787,877 6.63%	Pass						

Description	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Temperature Measurements								
HP steam temp	Deg F	MainDAS	HRSG HP Steam Temp	1,052.00	1,046.6	1,043.9	1,043.6	
CRH steam temp	Deg F	MainDAS	CRH Steam Temp (HRSG Inlet)	662.20	677.4	676.4	676.2	
HRH steam temp	Deg F	MainDAS	STG HRH Steam Temp	1,051.50	1,050.8	1,047.9	1,047.3	STG HRH temp
IP steam temp	Deg F	MainDAS	HRSG IP Steam Temp	570.00	572.2	572.6	572.7	
LP steam temp	Deg F	MainDAS	LP Steam Flow Temp	486.20	517.2	517.8	517.0	
Condensate before FGH return temp	Deg F	DCS	03-TE-052608.UNIT3@NET3	93.69	110.4	109.1	109.5	
Condensate temp	Deg F	MainDAS	Condensate flow entering HRSG Temp	99.00	131.8	129.3	129.2	Downstream FGH return
BEWP suction temp	Deg E	DCS	03-TE-060605.UNIT3@NET3	316.6	325.8	325.9	326.2	A nump running
IP EW temp	Deg F	MainDAS	IP FW Temp	318.1	327.7	328.0	328.3	
HP FW temp	Deg F	MainDAS	HP FW Temp	320.6	330.3	330.6	330.8	
HP EW to EGH supply temp	Deg E	nes	02-TE-062607 LINIT2@NET2	521.018	524.6	525.2	525.5	
HP FW return from EGH supply temp	Deg F	DCS	03-TE-062607.0NIT3@NET3	175 252	202.0	286.0	284.0	
TCA sustion town	Dog F	DCS	03 TE 062610 UNIT2@NET2	216.64	235.5	200.0	204.0	R nump rupping
TCA succion temp	Degr	DCS	03-TE-003015.0NITS@NET3	310.04	323.3	323.7	320.0	B pump running
I CA supply temp	Deg F	DCS	03-TE-065601.UNIT3@NET3	323.84	332.4	332.6	333.0	
ICA return temp	Deg F	DCS	03-1E-065607.0N113@NE13	600.52	589.1	591.6	590.6	
CTG coling steam supply temp	Deg F	MainDAS	CT CS Inlet Temp	565.634	570.7	570.9	571.1	
CTG cooling steam return temp	Deg F	MainDAS	CT CS Outlet Temp	925.70	940.5	937.3	936.3	
DB fuel temp	Deg F	DCS	03-TT-980840.UNIT3@NET3	59.00	85.9	79.4	78.9	
CTG exhaust temp	Deg F	TCDAS	HRSG Inlet Temp	1,186.0	1,191.5	1,188.9	1,188.2	
Stack temp	Deg F	TCDAS	HRSG stack temp	177.8	191.2	190.1	190.5	
CTG compressor inlet temp	Deg F	CTGDAS	CTG CIT	59.0	79.3	75.3	74.2	
CTG compressor inlet RH	%	TCDAS	CTG Inlet RH	65.00%	76.19%	81.11%	84.12%	Equal to ambient RH
CTG ambient temp	Deg F	CTGDAS	CTG Ambient Temp	59.00	79.3	75.4	74.1	
CTG ambient RH	%	TCDAS	CTG Inlet RH	65.00%	76.19%	81.11%	84.12%	All 9 instruments
Pressure Measurements								
HP steam pressure	nsia	MainDAS	HP Steam Pressure (HRSG Outlet) Corr	1.752.2	1,769.4	1.774.2	1,775.6	
CRH steam pressure	nsia	MainDAS	CRH Steam Pressure (HRSG Inlet) Corr	422.6	424.1	425.8	426.3	
HBH steam pressure	psia I	MainDAS	HPH Steam Pressure (HRSG Outlet) Corr	422.0	410.9	423.0	412.0	
IN steam pressure	psia i	MainDAS	I D Change Flow Deserving Com	407.2	410.8	412.4	415.0	
Condensate before FCU active accesses	psia i	NamDAS	LP Steam Flow Pressure Corr	79.0	91.1	91.5	91.7	
Condensate before FGH return pressure	psia i	DCS	03-P11-052609.UNI13@NE13	450.0	574.9	574.7	574.2	
Condensate pressure	psia I	DCS	03-PIT-108609.UNIT3@NET3	450.0	524.4	524.1	523.5	Downstream FGH return
BFWP suction pressure	psia I	DCS	03-PIT-060604.UNIT3@NET3	86.0	130.6	131.0	131.3	
IP FW pressure	psia I	DCS	03-PIT-104604.UNIT3@NET3	550.5	818.3	820.3	820.9	
HP FW pressure	psia I	DCS	03-PIT-101616.UNIT3@NET3	1,908.1	1,938.6	1,944.5	1,946.0	
HP FW to FGH supply pressure	psia I	MainDAS	HP FW Flow to FGH Pressure Corr	1,878.3	1,905.5	1,911.3	1,912.8	
HP FW return from FGH supply pressure	psia I	DCS	03-PIT-062616.UNIT3@NET3	500.0	1,905.8	1,911.6	1,913.2	
TCAP suction pressure	psia I	DCS	03-PIT-063608.UNIT3@NET3	86.0	135.3	135.8	136.1	
TCA supply pressure	psia I	MainDAS	TCA Inlet Pressure Corr	2,000.0	2,664.2	2,672.0	2,666.7	
TCA return pressure	psia	DCS	03-PIT-065606.UNIT3@NET3	2.000.0	2,590.3	2,599.4	2,593,5	
CTG cooling steam supply pressure	nsia I	DCS	03-PIT-035616.UNIT3@NFT3	517.6	532.0	534.8	535.7	
CTG cooling steam return pressure	nsia	DCS	03-PIT-034602 UNIT3@NET3	419.0	430.7	432.4	433.0	
DB fuel pressure	nsia	MainDAS	DB fuel flow Pressure	20.0	345 4	341.1	340.5	
CTG compressor inlet pressure loss	inH2O			20.0 E O	545.4	541.1	540.5	Estimated
Parametric processor	ncia	CTODAS	Para	5.0	5.0	5.0	5.0	Latinated
barometric pressure	psia (	LIGDAS		14.370	14.426	14.424	14.424	
nnoo backpressure		IVIDITIDAS	nnao backpressure	16.0	15.5	15.7	15.9	
HP arum pressure	psia I	DCS	HP Drum pressure	1,848.5	1,867.5	1,872.7	1,874.2	
IP drum pressure	psia I	DCS	IP Drum pressure	530.1	539.7	542.6	543.5	
LP drum pressure	psia I	DCS	LP Drum pressure	85.5	97.7	98.3	98.5	
	1							
Level Measurements								
Starting HP Drum Level	in		'=DCS!YO436	20	14.27	14.79	14.48	
Ending HP Drum Level	in			20	14.70	14.48	14.49	
Starting IP Drum Level	in		'=DCS!YP436	20	19.85	19.50	19.66	
Ending IP Drum Level	in			20	19.97	19.66	19.74	
Starting LP Drum Level	in		'=DCS!YQ436	20	54.31	54.12	53.63	
Ending LP Drum Level	in			20	53.95	53.63	53.95	
÷	1							
Other Measurements	1							
HRSG Auxiliary Power	kW/			079	368 71	368.99	367.25	
N2 packing leakage flow	lb/b			11 600	500.71	500.00	507.55	
HDS to cooling stoom DSH flow	ID/II	DCS	03 EIT 02E601 UNIT2@NET2	11,080	59,923	59,923	59,923	03 EIT 03E601
CTC Exhaust Cas Flaw (CTC Facara Palanas)	10/11	003	05-F11-055001.UNI13@INE13	0.0	435.1	293.9	230.9	Correction with the set of and Carbo ( 10)
CIG Exnaust Gas Flow (CTG Energy Balance)	ib/h			4,826,706	4,990,106	4,822,703	4,840,786	From CIG Testing using temp TC grid and Enable fuel flow
(TG Exhaust Gas Flow Uncertainty (CTG Energy Balance)	%		1	1.00%	1.76%	1.33%	1.60%	From CTG Testing using temp TC grid and Enable fuel flow

Description	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
IOW Measurements								02 55 101604
IP FW Flow				0.10	0.10	0.10	0.10	03-FE-101604
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Тар Туре	-			Flange	Flange	Flange	Flange	
Inlet Diameter	in			7.7430	7.7430	7.7430	7.7430	
Throat Diameter	in			4,9659	4,9659	4,9659	4,9659	
Diameter Measurement Temperature	Deg E			68.0	68.0	68.0	68.0	Assumed
Diameter Weasurement remperature	Degr			00.0	08.0	00.0	08.0	Assumed
Calibration Temperature	Deg F			120.0	120.0	120.0	120.0	Calibrated
Inlet Material	-			CS	CS	CS	CS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	nsia	MainDAS	HP FW Flow Pressure Corr	1 908 1	2 199 3	2 203 6	2 206 2	
Flow Tressure	Dog E	DCS	02 TE 061622 UNIT2@NET2	220.6	220 5	220 7	221.1	
	Degr		03-12-001023.01113@11213	520.0	550.5	550.7	551.1	
FIOW DP	inH2O	MainDAS	HP FW Flow DP SQRT	187.8	202.4	205.5	203.6	
HP FW to FGH Flow								03-FE-062605
Meter Type	-			ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	
Tan Tuno				Threat	Threat	Threat	Threat	
Tap Type	-			inroat	i nroat	Throat	Throat	
mier plameter	in	1		3.6230	3.6230	3.6230	3.6230	
Throat Diameter	in			1.7939	1.7939	1.7939	1.7939	
Diameter Measurement Temperature	Deg F			73	73	73	73	
Calibration Temperature	Deg F			106	106	106	106	
Inlet Material	0 '			CS 100	CS 100	CS 100	rs .	
The set Meterial	Ĩ	1		C5			CC2	
inroat Material	-	1		553XX	SS3XX	553XX	SSSXX	
Fluid Type	-	1		Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	HP FW Flow to FGH Pressure Corr	1,870.0	1,905.5	1,911.3	1,912.8	
Flow Temperature	Deg F	DCS	03-TE-062607.UNIT3@NET3	521.0	524.6	525.2	525-5	
Flow DP	inH2O	MainDAS	HP FW Flow to FGH DP SORT	77.0	206.6	202.5	200.3	
TIOW DI	111120	ManibAs		11.0	200.0	202.5	200.5	
HP FW from TCA Flow								
Meter Type	-			ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	03-FE-065618
Tap Type	-			Throat	Throat	Throat	Throat	
Inlet Diameter	in			5 1880	5 1880	5 1880	5 1880	
Therest Dismoster				3.5000	2.5025	3.5035	2.5025	
Inroat Diameter	in –			2.5035	2.5035	2.5035	2.5035	
Diameter Measurement Temperature	Deg F			74	74	74	74	Assumed
Calibration Temperature	Deg F			106	106	106	106	Assumed
Inlet Material	-			CS	CS	CS	CS	
Throat Material				\$\$3yy	SSAVY	SS3vv	SS3vv	
Fluid Ture -				Linut al	Laura	Laura	Laura	
Fluid Type	*			Liquid	Liquia	Liquia	Liquia	
Flow Pressure	psia	MainDAS	TCA Flow Pressure Corr	1,908.1	1,888.1	1,893.0	1,894.6	
Flow Temperature	Deg F	DCS	03-TE-065607.UNIT3@NET3	320.6	589.1	591.6	590.6	
Flow DP	inH2O	MainDAS	TCA Flow DP SQRT	32.7	68.3	67.0	67.9	
HP DSH Flow								
Mater Ture		1		0.15	Orifier	0.00	Out the second	02 55 402607
weter type	-			Urifice	UTITICE	Unifice	Unifice	U3-FE-103007
Тар Туре	-	1		Flange	Flange	Flange	Flange	
Inlet Diameter	in			2.2920	2.2920	2.2920	2.2920	
Throat Diameter	in			1,3582	1,3582	1,3582	1.3582	
Diameter Measurement Temperature	Deg E	1		69.0	69.0	69.0	69.0	Assumed
Calibration Tomporature	Degr	1		08.0	00.0	08.0	08.0	Calibrated
canoration remperature	Deg F			68.5	08.5	08.5	08.5	calibrateu
Inlet Material	-			CS	CS	cs	cs	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-	1		Liquid	Liquid	Liquid	Liquid	
Flow Pressure	nsia	MainDAS	HP DSH flow pressure Corr	2,269.0	2,172 5	2,178.6	2,180 3	
Elow Tomporature	p310	DCS	03 TE 103609 UNIT2@NET2	2,209.0	2,172.3	2,170.0	2,100.5	
now remperature	Deg F	ULS	US-1E-103008.0N113@NE13	318.0	285.1	280.9	280.6	
FIOM Db	inH2O	rvlainDAS	HP USH flow DP SQRT	0.0	0.1	0.1	0.1	spray intermittent during testing
HP to LP Leakage 1 Flow								DP2A
Meter Type	-	1		Orifice	Orifice	Orifice	Orifice	
Tan Type				Corner	Corner	Corner	Corner	
lalat Diseaster	-			E C C C C	5 0 (70	E O CTO	E O TRO	
met Diameter	in			5.0470	5.0470	5.0470	5.0470	
Throat Diameter	in			3.7874	3.7874	3.7874	3.7874	
Diameter Measurement Temperature	Deg F	1		68	68	68	68	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Inlot Material	0.0			IAC	IAC	IAC	IAC	
met waterial	-	1		IAS	IMD COD	IMD COD	145	
inroat Material	-	1		SS3xx	SS3XX	553xx	553xx	
Fluid Type	-	1		Vapor	Vapor	Vapor	Vapor	
Flow Pressure	psia	MainDAS	HP to LP Leakage flow 1 Pressure Corr	70.0	91.0	91.4	91.6	
Flow Townshing	Deg E			650.0	639.0	639.0	639.1	Calc from CBH enthaloy and measured pressure
FIOW LEMOPLATURE					0.00.0	0.00.0	000.1	entering and measured pressure
Flow DP		STODES	CTC Rol Dino DD1		240 -	045.5	246.0	Error in instrument, Use design university for flow

escription	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
IP to LP Leakage 2 Flow				•				DP2B
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Тар Туре	-			Corner	Corner	Corner	Corner	
Inlet Diameter	in			5.0470	5.0470	5.0470	5.0470	
Throat Diameter	in			3.7874	3.7874	3.7874	3.7874	
Diameter Measurement Temperature	Deg F			68	68	68	68	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Inlet Material	-			IAS	IAS	IAS	IAS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Flow Pressure	psia	MainDAS	HP to LP Leakage flow 2 Pressure Corr	70.0	90.6	90.9	91.1	
Flow Temperature	Deg F			659.9	637.9	638.0	638.0	Calc from CRH enthalpy and measured pressure
Flow DP	inH2O	STGDCS	STG Bal Pipe DP2	9.4	4.4	4.5	4.6	
P FW Flow								03-FE-104630
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Tan Type	-			Flange	Flange	Flange	Flange	
Inlet Diameter	in			3.8460	3.8460	3.8460	3.8460	
Throat Diameter	in			2 2695	2 2695	2 2695	2 2695	
Diameter Measurement Temperature	Deg F			68.0	68.0	68.0	68.0	Assumed
Calibration Temperature	Deg F			72.0	72.0	72.0	72.0	Calibrated
Inlet Material	Degr			CS 72.0	rs /2.0	CS 72.0	/2.0	calibrated
Throat Material		1	1	C3	CC3vv	CC3vv	C3 vv	
Fluid Tupo		1	1	Liquid	Liquid	Liquid	Liquid	
Flow Processo	-	MainDAC	ID EW/ flow processo Corr	Liquia				
riow riessuit	psia Data F	MainDAS	IP FW How pressure Corr	550.5	/96.5	/9/.6	/9/.9	1
Flow Temperature	Deg F	MainDAS	IP FW flow Temp	318.1	473.3	474.0	474.0	
Flow DP	inH2O	MainDAS	IP FW flow DP SQRT	203.9	259.7	265.0	267.3	
T Cooling Steam Flow								
Meter Type	-			Venturi	Venturi	Venturi	Venturi	03-FE-035622
Тар Туре	-			Throat	Throat	Throat	Throat	
Inlet Diameter	in			7.981	7.981	7.981	7.981	
Throat Diameter	in			5.428	5.428	5.428	5.428	
Diameter Measurement Temperature	Deg F			68	68	68	68	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Inlet Material	-			CS	CS	CS	CS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Flow Pressure	psia	MainDAS	CTG Cooling Steam Flow Pressure Corr	419.9	528.4	531.2	532.1	
Flow Temperature	Deg F	DCS	03-TE-035623.UNIT3@NET3	550.0	570.2	570.7	570.9	
Flow DP	inH2O	MainDAS	CTG Cooling Steam Flow DP SQRT	225.5	124.2	125.5	125.9	
			-					
IPS to CT Cooling Steam Flow								03-EE-035604
Meter Type	-			Venturi	Venturi	Venturi	Venturi	
Tan Type	-			Throat	Throat	Throat	Throat	
Inlet Diameter	in	1	1	4 9070	4 8070	4 8070	4 8070	
Throat Diameter	in	1	1	3 3700	3 3700	3 3700	3 3700	
Diameter Mascurament Temperature	Deg F	1	1	20 0	5.5750	5.5750	5.5790	Assumed
Calibration Temperature	Deg F	1	1	08.0	08.0	N/A 08.0	08.0	Calibrated
Inlet Material	Deg F	1	1					cambrateu
Threat Material		1	1	IAS	140	140	14.5	
Thread Waterian	-	1	1	IAS	IA5	IA5 Managa	IAS Veren	
Fluid Type	-	MainDAC	UD Shares to CT and line shares flow Dava	vapor	vapor	vapor	vapor	
How Pressure	psia	MainDAS	HP Steam to CT cooling steam flow Pressure Corr	1,700.0	1,768.0	1,772.9	1,774.2	1
How remperature	Deg F	MainDAS	HKSG HP Steam Temp	1,070.0	1,046.6	1,043.9	1,043.6	
Flow DP	inH2O	MainDAS	HP Steam to CT cooling steam flow DP	0.5	0.0	0.0	0.0	Valve closed
		1	1				1	
P Steam Flow		1	1				1	03-FE-110636
Meter Type	-	1	1	Venturi	Venturi	Venturi	Venturi	
Тар Туре	-	1	1	Throat	Throat	Throat	Throat	
Inlet Diameter	in	1	1	11.9830	11.9830	11.9830	11.9830	
Throat Diameter	in	1	1	7.0853	7.0853	7.0853	7.0853	1
Diameter Measurement Temperature	Deg F	1	1	68.0	68.0	68.0	68.0	Assumed
Calibration Temperature	Deg F	1	1	45.5	45.5	45.5	45.5	Calibrated
Inlet Material		1	1	cs	CS	CS	CS	
Throat Material	-	1	1	SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-	1	1	Vapor	Vapor	Vapor	Vapor	
Flow Pressure	nsia	MainDAS	LP Steam Flow Pressure Corr	77 1	01 1	01 5	01 7	1
Flow Temperature	psia Dog E	MainDAS	LP Steam Flow Temp	//	51.1	51.5	51.7	
Flow DD	Deg F	MainDAS	LP Steam Flow DB SORT	482.9	517.2	51/.8	517.0	1
	INH20	IVIdITIDAS	LF Steam FIOW DF SUKT	/9.0	54.8	- DU./	01.8	

			GREC HRSG Test Input Data S	ummary				
Linked Row		T	-	-	17	27	37	
Description	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Condensate Flow Entering HRSG								03-FE-108604
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Тар Туре	-			Flange	Flange	Flange	Flange	
Inlet Diameter	in			10.0200	10.0200	10.0200	10.0200	
Throat Diameter	in			5.8995	5.8995	5.8995	5.8995	
Diameter Measurement Temperature	Deg F			68	73	73	73	
Calibration Temperature	Deg F			N/A	106	106	106	
Inlet Material	-			cs	cs	cs	cs	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Elow Pressure	nsia	MainDAS	Condensate flow entering HRSG Pressure Corr	450.0	567.5	567.0	566.9	
Flow Temperature	Deg E	MainDAS	Condensate flow entering HRSG Temp	100.5	121.9	120.2	120.2	
Flow DB	inH2O	MainDAS	Condensate flow entering HRSC DD SORT	204.2	228.0	220.0	229.5	
TIOW DF	111120	MambAS	condensate now entering midd bridgin	204.2	220.0	230.0	220.5	
DD First Flow								02 55 000040
DB Fuel Flow				0.10	0.10	0.10	0.10	03-FE-980840
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Тар Туре	-			Flange	Flange	Flange	Flange	
Inlet Diameter	in			4.0260	4.0260	4.0260	4.0260	
Throat Diameter	in			2.6970	2.6970	2.6970	2.6970	
Diameter Measurement Temperature	Deg F			68	73	73	73	
Calibration Temperature	Deg F			N/A	106	106	106	
Inlet Material	-			CS	CS	CS	CS	
Throat Material	-	1		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Flow Pressure	nsia	MainDAS	DB fuel flow Pressure	300.0	345.4	341.1	340.5	
Flow Temperature	Deg F	DCS	03-TT-980840 LINIT3@NET3	70.0	85.9	79.4	78.9	
Flow DB	inH2O	MainDAS	DB fuel flow DB	.0.0	-0.1	-0.1	-0.1	Off
FIGW DF	IIIH20	IVIAIIIDAS	DB Idel llow DP	0.0	-0.1	-0.1	-0.1	01
CTC Fuel Cas Flam								02 517 002601
CTG Fuel Gas Flow								03-FII-992601
Meter Type	-			Turbine	Turbine	Turbine	Turbine	
Meter Diameter	in			10.00	10.00	10.00	10.00	
Flow Pressure	psia	CTGDAS	FG Supply Press	600.0	706.2	705.6	705.6	
Flow Temperature	Deg F	CTGDAS	FG Supply Temp	40.0	68.3	63.4	63.1	
Starting Pulse Cout	Pulses			318,041.0	881,618.0	103,149.0	393,195.0	
Ending Pulse Cout	Pulses			597,171.0	173,168.0	393,195.0	683,871.0	
Plant Fuel Gas Flow								
Meter Type	-			Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic	
Tan Type				Ν/Δ	N/A	N/A	N/A	
Inlet Diameter	in			10.0210	10.0210	10.0210	10.0210	
Throat Diameter	in			10.0210	10.0210	10.0210	10.0210	
Diameter Massurement Temperature	Dog E			10.0210	10.0210	10.0210	10.0210	Accumed
Calibertian Tama anti-un	Degi			40.4	40.4	40.4	40.4	Assumed
	Degr			40.4	40.4	40.4	40.4	
	-			553XX	553XX	553XX	553XX	
Inroat Material	-			SS3XX	SS3XX	SS3XX	SS3XX	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Upstream Pressure	psia	DCS	03-ENBL-PSI.UNIT3@NET3	450.0	806.9	840.8	841.9	
Downstream Temperature	Deg F	DCS	03-TT-560500.UNIT3@NET3	67.8	68.7	67.9	67.8	
Meter Reported Flow Rate	KACF/h	DCS	03-FT-560500B.UNIT3@NET3	86.8	45.23	42.43	42.53	
	1			1				
Fuel Analysis	1	1		1	1	1	1	ASTM D1945
Methane, CH4	mole %	DCS	03-XY-992273.UNIT3@NET3	93.280%	90.29%	90.00%	89.93%	
Ethane, C2H6	mole %	DCS	03-XY-992274.UNIT3@NET3	3.535%	6.85%	7.02%	7.03%	
Propane, C3H8	mole %	DCS	03-XY-992275.UNIT3@NET3	0.530%	0.33%	0.36%	0.35%	
Iso-Butane, i-C4H10	mole %	DCS	03-XY-992276.UNIT3@NET3	0.039%	0.01%	0.01%	0.01%	
N-Butane, n-C4H10	mole %	DCS	03-XY-992277.UNIT3@NET3	0.072%	0.02%	0.03%	0.03%	
Iso-Pentane, i-C5H12	mole %	DCS	03-XY-992278.UNIT3@NET3	0.009%	0.00%	0.01%	0.01%	
N-Pentane, n-C5H12	mole %	DCS	03-XY-992279.UNIT3@NET3	0.008%	0.00%	0.01%	0.01%	
N-Heyape p-C6H14	mole %	DCS	03-XY-992280.UNIT3@NET3	0.016%	0.01%	0.01%	0.01%	
Hentane (7H16	mole %	505		0.000%	0.00%	0.01%	0.00%	
Octano C9H19	mole %			0.000%	0.00%	0.00%	0.00%	
Name COU20	mole %	1		0.000%	0.00%	0.00%	0.00%	
Nonane, C9R20	more %	1		0.000%	0.00%	0.00%	0.00%	
Decane, CIOH22	mole %		02 XX 002202 IBUT2 ONFT2	0.000%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %	DCS	05-A 1 -992282.UNI13@NE13	1.971%	1.80%	1.86%	1.90%	
Carbon Monoxide, CO	mole %	1		0.000%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %	DCS	03-XY-992281.UNIT3@NET3	0.540%	0.63%	0.65%	0.66%	
Water, H2O	mole %			0.000%	0.00%	0.00%	0.00%	
Hydrogen Sulphide, H2S	mole %	DCS	03-XY-992284.UNIT3@NET3	0.000%	0.00%	0.00%	0.00%	
Hydrogen, H2	mole %			0.000%	0.00%	0.00%	0.00%	
Helium, He	mole %			0.000%	0.04%	0.04%	0.04%	
Oxygen, O2	mole %			0.000%	0.00%	0.00%	0.00%	
Argon, Ar	mole %	1		0.000%	0.01%	0.01%	0.01%	
<b>v</b> .,								
	i		l		1			

		GREC U	3 HRSG Flow Ca	lculations			
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
HP FW Flow							
Design Information							03-FE-101604
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Flange	Flange	Flange	Flange	
Inlet Diameter	in		7.7430	7.7430	7.7430	7.7430	
Throat Diameter	in		4.9659	4.9659	4.9659	4.9659	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		120.0	120.0	120.0	120.0	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		1,908.1	2,199.3	2,203.6	2,206.2	
Downstream Temperature	Deg F		320.6	330.5	330.7	331.1	
DP	inH2O		187.8	202.4	205.5	203.6	
Calculated Parameters							
Fluid Density	lb/ft^3		57.08	56.83	56.82	56.81	
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000112	0.000112	0.000112	
Calculated Flow	lb/h		610,391	632,203	637,142	634,126	610,209.49
Calculated Flow	gpm		1,333	1,387	1,398	1,392	

	17769	-01 Elow	
	TIP FW	FIOW	
1		2	
Inlet Re	Cd	Inlet Re	Cd
311,150	0.605	311,150	0.6052
386,257	0.6038	386,257	0.6049
456,231	0.6043	456,231	0.6043
533,408	0.6044	533,408	0.6033
602,964	0.6043	602,964	0.603
667,309	0.6042	6.67E+05	0.6046
742,020	0.6037	7.42E+05	0.6044
803,433	0.604	8.03E+05	0.6048
862,114	0.6046	8.62E+05	0.604
928,944	0.6042	9.29E+05	0.604
1,024,286	0.6044	1.02E+06	0.604
1,065,251	0.6043	1.07E+06	0.604
1,143,311	0.6038	1143311	0.604
1,235,619	0.6038	1235619	0.604
1,259,580	0.6035	1259580	0.604
1,365,260	0.6035	1365260	0.603
1,414,187	0.6039	1414187	0.604
1,470,232	0.6034	1470232	0.603
1,577,685	0.6033	1577685	0.603
1,630,434	0.6031	1630434	0.603

		GREC U	3 HRSG Flow Ca	lculations			
Description	Unit	Tag	Docign	Tort Pup 1	Tost Pup 2	Tort Pup 2	Notor
	onin	Number	Design	Test Rull I	Test Rull 2	Test Rull 3	Notes
HP FW to FGH Flow							03-FE-062605
Design Information							
Meter Type	-		ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	
Тар Туре	-		Throat	Throat	Throat	Throat	
Inlet Diameter	in		3.623	3.623	3.623	3.623	
Throat Diameter	in		1.794	1.794	1.794	1.794	
Diameter Measurement Temperature	Deg F		73.0	73.0	73.0	73.0	
Calibration Temperature	Deg F		106.0	106.0	106.0	106.0	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		1,870.0	1,905.5	1,911.3	1,912.8	
Downstream Temperature	Deg F		521.0	524.6	525.2	525.5	
DP	inH2O		77.0	206.6	202.5	200.3	
Calculated Parameters							
Fluid Density	lb/ft^3		48.38	48.19	48.15	48.14	
Fluid Viscosity	lbm/(ft*s)		0.000067	0.000066	0.000066	0.000066	
Calculated Flow	lb/h		73,202	119,739	118,500	117,857	73,18
Calculated Flow	gpm		189	310	307	305	

			20171	-08			
		-	HP FW tr	o FGH			
1		2	-	3		4	
Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd
1,309,849	0.9967	1,309,849	0.9972	1,309,849	0.9968	1,309,849	0.9969
1,224,140	0.9967	1,224,140	0.9971	1,224,140	0.9968	1,224,140	0.9969
1,139,421	0.9967	1,139,421	0.9971	1,139,421	0.9968	1,139,421	0.9969
1,051,335	0.9966	1,051,335	0.997	1,051,335	0.9967	1,051,335	0.9967
966,864	0.9965	966,864	0.9969	966,864	0.9966	966,864	0.9967
8.81E+05	0.9964	8.81E+05	0.9969	8.81E+05	0.9966	8.81E+05	0.9967
7.95E+05	0.9965	7.95E+05	0.9968	7.95E+05	0.9966	7.95E+05	0.9966
7.07E+05	0.9964	7.07E+05	0.9968	7.07E+05	0.9965	7.07E+05	0.9965
6.25E+05	0.9967	6.25E+05	0.9971	6.25E+05	0.9968	6.25E+05	0.9969
5.39E+05	0.997	5.39E+05	0.9974	5.39E+05	0.9971	5.39E+05	0.9972
1.26E+06	0.9967	1.26E+06	0.9972	1.26E+06	0.9969	1.26E+06	0.9969
1.18E+06	0.9968	1.18E+06	0.9972	1.18E+06	0.9969	1.18E+06	0.9969
1096294.229	0.9968	1096294.229	0.9971	1096294.229	0.9969	1096294.229	0.9968
1007317.185	0.9966	1007317.185	0.997	1007317.185	0.9968	1007317.185	0.9967
1419176.423	0.9965	1419176.423	0.9969	1419176.423	0.9967	1419176.423	0.9966
838325.1697	0.9965	838325.1697	0.9969	838325.1697	0.9967	838325.1697	0.9966
752071.4077	0.9966	752071.4077	0.9969	752071.4077	0.9967	752071.4077	0.9967
667847.7284	0.9967	667847.7284	0.9971	667847.7284	0.9968	667847.7284	0.9968
582881.3359	0.997	582881.3359	0.9973	582881.3359	0.9971	582881.3359	0.997
497469.3155	0.9974	497469.3155	0.9978	497469.3155	0.9976	497469.3155	0.9976

	GREC U3 HRSG Flow Calculations						
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
HP FW from TCA Flow	Unit	Number	Design	Test Null I	Test Rull 2	Test Rull 5	03-FF-065618
Design Information							0512 005010
Meter Type	-		ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	
Tan Type			Throat	Throat	Throat	Throat	
Inlet Diameter	in		5 188	5 188	5 188	5 188	
Throat Diameter	in		2 564	2 564	2 564	2 564	
Diameter Measurement Temperature	Deg F		74.0	74.0	74.0	74.0	
Calibration Temperature	Deg F		106.0	106.0	106.0	106.0	
Inlet Material			CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		1,908.1	1,888.1	1,893.0	1,894.6	
Downstream Temperature	Deg F		320.6	589.1	591.6	590.6	
DP	inH2O		32.7	68.3	67.0	67.9	
Calculated Parameters							
Fluid Density	lb/ft^3		57.08	43.70	43.50	43.59	
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000056	0.000056	0.000056	
Calculated Flow	lb/h		105,471	134,056	132,443	133,456	105,578.0
Calculated Flow	gpm		230	382	380	382	

	201/1-09									
	FW trom TCA									
1		2		3		4				
Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd			
1,688,016	0.9972	1,688,016	0.9972	1,688,016	0.9974	1,688,016	0.9977			
1,563,992	0.9971	1,563,992	0.9971	1,563,992	0.9973	1,563,992	0.9976			
1,436,064	0.9969	1,436,064	0.9969	1,436,064	0.9972	1,436,064	0.9975			
1,307,741	0.9968	1,307,741	0.9968	1,307,741	0.9971	1,307,741	0.9974			
1,187,818	0.9967	1,187,818	0.9966	1,187,818	0.9969	1,187,818	0.9972			
1,061,224	0.9964	1,061,224	0.9963	1,061,224	0.9967	1,061,224	0.9969			
934,926	0.9963	934,926	0.9962	934,926	0.9966	934,926	0.9968			
809,963	0.9963	809,963	0.9962	809,963	0.9966	809,963	0.9968			
684,209	0.9965	684,209	0.9964	684,209	0.9968	684,209	0.997			
559,839	0.9973	559,839	0.9971	559,839	0.9974	559,839	0.9976			
1,626,844	0.9972	1,626,844	0.9971	1,626,844	0.9974	1,626,844	0.9976			
1,499,559	0.997	1,499,559	0.997	1,499,559	0.9973	1,499,559	0.9975			
1,374,447	0.997	1,374,447	0.9969	1,374,447	0.9973	1,374,447	0.9974			
1,248,249	0.9968	1,248,249	0.9968	1,248,249	0.9972	1,248,249	0.9973			
1,121,754	0.9965	1,121,754	0.9964	1,121,754	0.9968	1,121,754	0.997			
996,593	0.9964	996,593	0.9964	996,593	0.9967	996,593	0.9969			
873,458	0.9963	873,458	0.9963	873,458	0.9966	873,458	0.9969			
747,062	0.9964	747,062	0.9964	747,062	0.9968	747,062	0.997			
622,247	0.9968	622,247	0.9967	622,247	0.9971	622,247	0.9973			
497,926	0.9975	497,926	0.9974	497,926	0.9978	497,926	0.9979			
172,349	0.9974	172,349	0.9971	172,349	0.9973	172,349	0.9976			
122,789	0.9936	122,789	0.9931	122,789	0.9926	122,789	0.9936			
334,718	0.9982	334,718	0.998	334,718	0.9983	334,718	0.9986			

		GREC U	3 HRSG Flow Ca	lculations			
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
HP DSH Flow							03-FE-103607
Design Information							
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Flange	Flange	Flange	Flange	
Inlet Diameter	in		2.292	2.292	2.292	2.292	
Throat Diameter	in		1.358	1.358	1.358	1.358	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		68.5	68.5	68.5	68.5	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		2,269.0	2,172.5	2,178.6	2,180.3	
Downstream Temperature	Deg F		318.0	285.1	280.9	280.6	
DP	inH2O		0.0	0.1	0.1	0.1	
Calculated Parameters							
Fluid Density	lb/ft^3		57.26	58.26	58.39	58.40	
Fluid Viscosity	lbm/(ft*s)		0.000118	0.000134	0.000136	0.000137	
Calculated Flow	lb/h		0	1,288	932	907	0.0
Calculated Flow	gpm		0	3	2	2	

	17769-025								
HP DSH Flow									
1		2							
Inlet Re	Cd	Inlet Re	Cd						
287435.4	0.6098	287445.1	0.6084						
257684.7	0.6096	257695.4	0.6085						
223322.8	0.6105	223347.6	0.6086						
189134.8	0.6101	189134.8	0.609						
149605.4	0.6118	149605.4	0.6096						
111860.4	0.6127	111860.4	0.6114						
289973.7	0.6096	289944.9	0.6084						
259521.4	0.6097	259532.1	0.608						
223423.5	0.6107	223498	0.6088						
189048.1	0.6106	189048.1	0.6093						
151524.6	0.6112	151524.6	0.6109						
110386.8	0.6133	108047.6	0.6115						

GREC U3 HRSG Flow Calculations							
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
HP to LP Leakage 1 Flow							
Design Information							
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Corner	Corner	Corner	Corner	
Inlet Diameter	in		5.047	5.047	5.047	5.047	
Throat Diameter	in		3.787	3.787	3.787	3.787	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A	
Inlet Material	-		IAS	IAS	IAS	IAS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Vapor	Vapor	Vapor	Vapor	
Measured Parameters							
Upstream Pressure	psia		70.0	91.0	91.4	91.6	
Downstream Temperature	Deg F		659.9	638.0	638.0	638.1	
DP	inH2O		9.4	318.4	315.5	318.8	
Calculated Parameters							
Fluid Density	lb/ft^3		0.11	0.14	0.14	0.14	
Fluid Viscosity	lbm/(ft*s)		0.000015	0.000015	0.000015	0.000015	
Calculated Flow	lb/h		3,769	23,917	23,872	24,007	3,775.00
Calculated Flow	gpm		4,438	21,160	21,033	21,115	Error in instrument
HP to LP Leakage 2 Flow							
Design Information							
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Corner	Corner	Corner	Corner	
Inlet Diameter	in		5.0	5.0	5.0	5.0	
Throat Diameter	in		3.8	3.8	3.8	3.8	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A	
Inlet Material	-		IAS	IAS	IAS	IAS	
Ihroat Material Fluid Type	-		SS3xx Vapor	Vapor	Vapor	Vapor	
Measured Parameters	Ι.						
Upstream Pressure	psia		70.0	90.6	90.9	91.1	
Downstream Temperature	Deg F		659.9	637.9	638.0	638.0	
DP	inH2O		9.4	4.4	4.5	4.6	
Calculated Parameters							
Fluid Density	lb/ft^3		0.11	0.14	0.14	0.14	
Fluid Viscosity	lbm/(ft*s)		0.000015	0.000015	0.000015	0.000015	
Calculated Flow	lb/h		3,769	2,976	3,002	3,037	3,775.00
Calculated Flow	gpm		4,438	2,647	2,659	2,685	

		GREC U	3 HRSG Flow Ca	lculations			
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
IP FW Flow							03-FE-104630
Design Information							
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Flange	Flange	Flange	Flange	
Inlet Diameter	in		3.846	3.846	3.846	3.846	
Throat Diameter	in		2.270	2.270	2.270	2.270	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		72.0	72.0	72.0	72.0	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		550.5	796.5	797.6	797.9	
Downstream Temperature	Deg F		318.1	473.3	474.0	474.0	
DP	inH2O		203.9	259.7	265.0	267.3	
Calculated Parameters							
Fluid Density	lb/ft^3		56.83	50.44	50.41	50.40	
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000073	0.000073	0.000073	
Calculated Flow	lb/h		129,970	138,587	139,942	140,551	129,975.55
Calculated Flow	gpm		285	343	346	348	

	17769	-06						
IP FW Flow								
1		2						
Inlet Re	Cd	Inlet Re	Cd					
407335.1	0.6088	386194.2	0.6085					
364084.6	0.6091	345174.7	0.609					
314740.6	0.6094	298455.5	0.609					
267561.2	0.6098	253656.1	0.6092					
212686.3	0.6104	201673	0.6096					
156662.8	0.6116	148532.7	0.6109					
410207	0.6088	388894.5	0.6086					
363662.5	0.6088	349466.9	0.6086					
314601.7	0.6096	302320.7	0.6088					
266616.9	0.6095	256189.8	0.6092					
212299.9	0.6105	204012.4	0.6098					
154441.6	0.6117	148413	0.611					

GREC U3 HRSG Flow Calculations							
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
CT Cooling Steam Flow							03-FE-035622
Design Information							
Meter Type	-		Venturi	Venturi	Venturi	Venturi	
Тар Туре	-		Throat	Throat	Throat	Throat	
Inlet Diameter	in		7.981	7.981	7.981	7.981	
Throat Diameter	in		5.428	5.428	5.428	5.428	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Vapor	Vapor	Vapor	Vapor	
Measured Parameters							
Upstream Pressure	psia		419.9	528.4	531.2	532.1	
Downstream Temperature	Deg F		550.0	570.2	570.7	570.9	
DP	inH2O		225.5	124.2	125.5	125.9	
Calculated Parameters							
Fluid Density	lb/ft^3		0.76	0.96	0.96	0.96	
Fluid Viscosity	lbm/(ft*s)		0.000013	0.000013	0.000013	0.000013	
Calculated Flow	lb/h		155.393	130.338	131.352	131.705	129.494.82
Calculated Flow	gpm		25.420	16,991	17.032	17.052	-,
HPS to CT Cooling Steam Flow		1					03-FE-035604
Design Information							
Meter Type	-		Venturi	Venturi	Venturi	Venturi	
Тар Туре	-		Throat	Throat	Throat	Throat	
Inlet Diameter	in		4.9	4.9	4.9	4.9	
Throat Diameter	in		3.4	3.4	3.4	3.4	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A	
Inlet Material	-		IAS	IAS	IAS	IAS	
Throat Material	-		IAS	IAS	IAS	IAS	
Fluid Type	-		Vapor	Vapor	Vapor	Vapor	
Measured Parameters							
Upstream Pressure	psia		1,700.0	1,768.0	1,772.9	1,774.2	
Downstream Temperature	Deg F		1,070.0	1,046.6	1,043.9	1,043.6	
DP	inH2O		0.5	0.0	0.0	0.0	
Calculated Parameters							
Fluid Density	lb/ft^3		1.99	2.12	2.13	2.13	
Fluid Viscosity	lbm/(ft*s)		0.000022	0.000021	0.000021	0.000021	
Calculated Flow	lb/h		4,685	0	0	0	0.00
Calculated Flow	gpm		293	0	0	0	All valves were closed, no flc

GREC U3 HRSG Flow Calculations							
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
LP Steam Flow							03-FE-110636
Design Information							
Meter Type	-		Venturi	Venturi	Venturi	Venturi	
Тар Туре	-		Throat	Throat	Throat	Throat	
Inlet Diameter	in		11.983	11.983	11.983	11.983	
Throat Diameter	in		7.085	7.085	7.085	7.085	
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0	
Calibration Temperature	Deg F		45.5	45.5	45.5	45.5	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Vapor	Vapor	Vapor	Vapor	
Measured Parameters							
Upstream Pressure	psia		77.1	91.1	91.5	91.7	
Downstream Temperature	Deg F		482.9	517.2	517.8	517.0	
DP	inH2O		79.0	59.8	60.7	61.8	
Calculated Parameters							
Fluid Density	lb/ft^3		0.14	0.16	0.16	0.16	
Fluid Viscosity	lbm/(ft*s)		0.000012	0.000013	0.000013	0.000013	
Calculated Flow	lb/h		62,310	58,496	59,034	59,643	62,158.76
Calculated Flow	gpm		55,531	45,706	45,947	46,277	

17769-09								
LP Steam Flow								
1		2						
Inlet Re	Cd	Inlet Re	Cd					
269,692	0.9889	269,692	0.9896					
327,975	0.9878	327,975	0.9895					
382,210	0.9881	382,210	0.9907					
439,548	0.9879	439,548	0.9905					
490,545	0.9882	490,545	0.9901					
551,391	0.9885	551,391	0.9905					
608,325	0.9884	608,325	0.9904					
666,877	0.9878	666,877	0.9898					
724,620	0.9883	724,620	0.9906					
776,966	0.9881	776,966	0.9897					
837,003	0.9887	837,003	0.9908					
893,532	0.9889	893,532	0.9907					
954,243	0.9891	954,243	0.9906					
1,003,891	0.9886	1,003,891	0.9903					
1,057,452	0.9893	1,057,452	0.9908					
1,114,520	0.9897	1,114,520	0.9911					
1,171,858	0.9895	1,171,858	0.9909					
1,229,736	0.9903	1,229,736	0.9914					
1,294,360	0.9899	1,294,360	0.9914					
1,343,603	0.9897	1,343,603	0.9914					

		GREC U	3 HRSG Flow Ca	lculations			
		Tag					
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Condensate Flow Entering HRSG							03-FE-108604
Design Information							
Meter Type	-		Orifice	Orifice	Orifice	Orifice	
Тар Туре	-		Flange	Flange	Flange	Flange	
Inlet Diameter	in		10.020	10.020	10.020	10.020	
Throat Diameter	in		5.900	5.900	5.900	5.900	
Diameter Measurement Temperature	Deg F		68.0	73.0	73.0	73.0	
Calibration Temperature	Deg F		N/A	106.0	106.0	106.0	
Inlet Material	-		CS	CS	CS	CS	
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type	-		Liquid	Liquid	Liquid	Liquid	
Measured Parameters							
Upstream Pressure	psia		450.0	567.5	567.0	566.9	
Downstream Temperature	Deg F		100.5	131.8	129.3	129.2	
DP	inH2O		204.2	228.0	230.0	228.5	
Calculated Parameters							
Fluid Density	lb/ft^3		62.07	61.63	61.67	61.67	
Fluid Viscosity	lbm/(ft*s)		0.000455	0.000337	0.000344	0.000345	
Calculated Flow	lb/h		908,336	956,757	961,255	958,077	907,921.5
Calculated Flow	gpm		1,825	1,936	1,943	1,937	
						1	

Uncalibrated						

GREC U3 HRSG Flow Calculations											
		Tag									
Description	Unit	Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes				
Plant Fuel Flow											
Design Information											
Meter Type	-		Ultrasonic	Ultrasonic	Ultrasonic	Ultrasonic					
Тар Туре	-		N/A	N/A	N/A	N/A					
Inlet Diameter	in		10.0	10.0	10.0	10.0					
Throat Diameter	in		10.0	10.0	10.0	10.0					
Diameter Measurement Temperature	Deg F		72.0	72.0	72.0	72.0					
Calibration Temperature	Deg F		48.4	48.4	48.4	48.4					
Inlet Material	-		SS3xx	SS3xx	SS3xx	SS3xx					
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx					
Fluid Type	-		Vapor	Vapor	Vapor	Vapor					
Measured Parameters											
Upstream Pressure	psia		450.0	806.9	840.8	841.9					
Downstream Temperature	Deg F		67.8	68.7	67.9	67.8					
Meter Reported Flow Rate	KACFH		86.8	45.2	42.4	42.5					
Fuel Analysis (lab)											
Methane, CH4	mole %		93.28%	90.29%	90.00%	89.93%					
Ethane, C2H6	mole %		3.53%	6.85%	7.02%	7.03%					
Propane, C3H8	mole %		0.53%	0.33%	0.36%	0.35%					
Iso-Butane, i-C4H10	mole %		0.04%	0.01%	0.01%	0.01%					
N-Butane, n-C4H10	mole %		0.07%	0.02%	0.03%	0.03%					
Iso-Pentane, i-C5H12	mole %		0.01%	0.00%	0.01%	0.01%					
N-Pentane, n-C5H12	mole %		0.01%	0.00%	0.01%	0.01%					
N-Hexane, n-C6H14	mole %		0.02%	0.01%	0.01%	0.01%					
Heptane, C7H16	mole %		0.00%	0.00%	0.00%	0.00%					
Octane C8H18	mole %		0.00%	0.00%	0.00%	0.00%					
Nonane C9H20	mole %		0.00%	0.00%	0.00%	0.00%					
Decane C10H22	mole %		0.00%	0.00%	0.00%	0.00%					
Nitrogen N2	mole %		1 97%	1.80%	1.86%	1 90%					
Carbon Monoxide CO	mole %		0.00%	0.00%	0.00%	0.00%					
Carbon Dioxide CO2	mole %		0.54%	0.63%	0.65%	0.66%					
Water H2O	mole %		0.00%	0.00%	0.00%	0.00%					
Hydrogen Sulphide, H2S	mole %		0.00%	0.00%	0.00%	0.00%					
Hydrogen H2	mole %		0.00%	0.00%	0.00%	0.00%					
Helium He	mole %		0.00%	0.00%	0.00%	0.04%					
Ovvgen O2	mole %		0.00%	0.04%	0.04%	0.00%					
Argon Ar	mole %		0.00%	0.00%	0.00%	0.00%					
	mole 78		0.00%	0.0178	0.01%	0.01/6					
Calculated Parameters											
Gas MW (Lab Composition)	lb/lb mole		17.14	17.51	17.56	17.57					
Fluid Density (Lab Composition)	lb/ft^3	ρSCF_Lab	0.045	0.046	0.046	0.046	SCF				
Fluid Density (Lab Composition)	lb/ft^3	ρACF_Lab	1.452	2.813	2.964	2.972	ACF				
Calculated Flow	lb/h		126,093	127,242	125,776	126,378	QACF*pACF_Lab				
Calculated Flow	gpm		10,825	5,639	5,290	5,302					

umber         Design           1,052.         662.           1,051.         570.           486.         93.           99.         316.           318.         320.           521.         556.           925.         316.           175.2         316.           925.5         59.           1,186.         177.           65.00         59.           59.         59.           65.00         59.	Test Run 1           0         1,046.61           0         67.42           0         67.42           0         577.19           0         517.18           0         517.18           0         131.77           34         325.78           4         325.48           55         293.86           55         293.86           33         570.65           10         940.51           33         570.65           10         940.51           10         1,191.51           10         79.33           76.19%         76.19%	Test Run 2 1,043.92 676.36 1,047.86 572.58 517.81 109.13 129.32 325.93 337.98 330.58 525.23 285.97 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11%	Test Run 3 1,043.59 676.25 1,047.31 572.72 316.99 109.53 129.21 326.23 328.25 330.84 525.49 283.96 326.00 332.96 550.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	Notes
1,052. 662. 1,051. 570. 486. 93. 93. 93. 93. 93. 94. 316. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 0 59. 0 59. 59. 59. 59. 59. 59. 59. 59. 59. 59.	00         1,046.61           00         677.42           00         572.19           100         577.18           100         517.18           101         131.77           131.77         325.78           14         322.78           14         330.28           15         293.86           14         325.48           15         293.86           14         325.78           15         293.86           14         325.49           15         293.86           14         325.49           15         293.86           16         940.51           10         940.51           10         1,191.51           10         79.33           76.19%         76.19%	1,043.92 676.36 1,047.86 572.58 517.81 109.13 129.32 332.93 332.798 330.58 525.23 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11%	1,043.59 676.25 1,047.31 572.72 316.99 109.53 129.21 326.23 328.25 330.84 525.49 283.96 530.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
1,052. 662. 1,051. 93. 99. 316. 318. 320. 521. 177. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. (1,77.	1,046.61           00         1,046.61           00         677.42           00         572.19           100         577.13           100         517.18           101         131.77           14         325.78           14         327.66           15         23.86           14         322.84           15         23.86           14         322.38           15         23.86           14         322.38           15         25.44.8           16         35.70.65           10         9.40.51           10         85.87           10         1,191.51           10         79.30           %         76.19%	1,043.92 676.36 1,047.86 572.58 517.81 109.13 129.32 325.93 330.58 525.23 285.97 325.69 332.58 551.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11%	1,043.59 676.25 1,047.31 572.72 516.99 109.53 129.21 326.23 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
1,052. 662. 1,051. 570. 486. 93. 99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 59. 59. 59. 59. 59. 59. 59. 59. 59	00         1,046.61           00         677.42           01         657.19           05         517.18           06         517.18           07         325.78           300         517.13           300         131.77           34         325.78           43         325.42           44         330.28           52         524.58           54         325.46           33         570.65           00         94.051           300         1,191.51           300         76.19%           %         76.19%	1,043,92 676,36 1,047,86 572,58 517,81 109,13 325,93 327,98 330,58 525,23 225,97 325,69 332,58 591,62 570,91 937,25 79,43 1,188,91 190,09 75,25 81,11%	1,043.59 676.25 1,047.31 572.72 516.99 109.53 328.25 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
662. 1,051. 570. 486. 93. 99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 59. 59. 59. 59. 59. 59. 59. 59. 59	10         677.42           00         572.19           100         572.19           100         572.19           100         572.19           10         517.18           101.03         30           131.77         34           325.78         325.49           12         524.58           12         524.58           13         325.49           14         322.38           14         322.38           15         293.66           16         35.97.65           10         85.87           10         85.87           10         76.19%           10         79.30           10         79.31           10         76.19%	676.36 1,047.86 572.58 517.81 109.13 325.93 327.98 330.58 525.23 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11%	676.25 1,047.31 572.72 516.99 109.53 129.21 326.23 328.25 330.84 525.49 283.96 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
1,051. 570. 486. 93. 99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. (1,186. 077. 59. 59. 59. 59. 59. 59. 59. 59. 59. 59	i0         1,050.80           i0         572.19           i0         577.18           i9         110.43           i0         131.77           i4         325.78           i4         325.78           i5         293.86           i4         325.44           i5         293.86           i4         325.43           i5         293.86           i4         325.43           i5         293.86           i4         325.43           i5         293.86           i6         3570.65           i0         940.51           i0         1,191.51           i0         1,191.51           i0         79.33           i0         79.33           i0         79.33           i0         76.19%           ii         76.19%	1,047.86 572.58 517.81 109.13 325.93 330.58 525.23 285.97 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11%	1,047.31 572.72 516.99 109.53 129.21 326.23 328.25 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
570. 486. 93. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00 59. 65.00	00         572.19           100         517.18           101         517.18           101         131.77           101         325.78           101         325.78           101         325.78           102         524.58           103         570.65           109         10.11           101         79.30           101         79.30           101         79.30           100         79.30           100         79.30           100         79.30           100         79.30           100         79.30           100         79.30           100         79.30           100         79.30           101         76.19%	572.58 517.81 109.13 129.32 325.93 330.58 525.23 225.69 332.58 591.62 570.91 937.25 79.43 1,188.91 100.09 75.25 81.11%	572.72 516.99 109.53 129.21 326.23 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
486. 93. 99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00 59. 65.00	10         517.18           19         110.43           90         131.77           14         325.78           14         327.66           15         252.42           16         325.46           17         330.22           12         524.58           15         293.86           14         322.38           14         323.28           15         570.65           16         5870           10         85.87           10         79.30           76.19%         76.19%	517.81 109.13 129.32 325.93 327.98 330.58 525.23 325.69 325.59 325.56 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	516.99 109.53 129.21 326.23 328.25 330.84 525.49 283.96 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
93. 99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. ( 65.00 59. 65.00	i9         110.43           00         131.77           i4         325.78           i4         327.66           i4         327.66           i4         320.78           i4         320.78           i5         293.86           i4         325.49           i4         322.38           i5         293.86           i4         322.38           i2         589.09           i3         570.65           i0         940.51           i0         1,191.51           i0         79.33           i0         76.19%           i0         76.19%	109.13 129.32 325.93 337.98 330.58 525.23 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	109.53 129.21 326.23 328.25 330.84 525.49 283.96 530.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
99. 316. 318. 320. 521. 175. 316. 323. 600. 565. 1,186. 177. 59. 65.00 59. 65.00	131.77           131.77           1325.78           1325.78           1327.66           14           327.66           14           30.28           15           14           325.49           14           325.44           325.49           14           325.49           13           13           10           1,191.51           10           76.19%           10           76.19%	129.32 325.93 327.98 330.58 525.23 285.97 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	129.21 326.23 328.25 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
316. 318. 320. 521.1 175. 316.1 323.3 600.1 565.1 925. 59.0 1,186.4 177.7 59.0 65.00 59.0 65.00	325.78           327.66           330.28           330.28           52           52           54           330.28           55           293.86           44           325.49           43           43           55           570.65           50           940.51           50           570.69           91.191.16           50           76.19%           76.19%           76.19%	325.93 327.98 330.58 525.23 2285.97 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	326.23 328.25 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
318. 320. 521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. ( 65.00 59. 65.00	4 327.66 4 330.28 52 524.58 52 293.86 4 325.49 4 332.38 2 589.09 33 570.65 70 940.51 70 940.51 70 1,191.51 79 191.16 70 79.30 % 76.19%	327.98 330.58 525.23 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	328.25 330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
320. 521. 175 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00 59. 65.00	54 330.28 524.58 55 293.86 54 325.49 54 332.38 52 589.00 940.51 50 940.51 50 1,191.51 50 1,191.51 50 79.30 76.19% 76.19%	330.58 525.23 285.97 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	330.84 525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
521. 175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00 59. 65.00	2         524.58           25         293.66           44         325.49           43         32.38           52         589.09           53         570.65           70         940.51           80         1,191.51           91         191.16           90         79.30           %0         76.19%           %0         76.19%	525.23 285.97 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	525.49 283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
175. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00	121:32           155         293.86           14         322.549           143         322.88           152         589.09           153         570.65           100         940.51           100         85.87           190         1,191.51           190         79.30           76.19%         76.19%	285.97 325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38	283.96 326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
1.3. 316. 323. 600. 565. 925. 59. 1,186. 177. 59. 65.00 59.	325.44         325.49           34         325.49           35         70.65           36         70.65           37         940.51           30         1,191.51           30         79.30           37         76.19%           36         76.19%           37         76.19%	325.69 332.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	326.00 332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
323. 600. 565.) 925: 59. 1,186. 177. 59. 65.00 59. 65.00	321.3-2           4332.38           52           589.09           53           570.65           0           940.51           00           1,191.51           99           191.16           00           76.19%           76.19%           76.19%	323.58 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	332.96 590.56 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84.12%	
523 600. 565. 925. 59.1 1,186.1 177. 59.0 65.00 59.0 65.00	<ul> <li>332.36</li> <li>335.70.65</li> <li>940.51</li> <li>940.51</li> <li>940.51</li> <li>1,191.51</li> <li>79.30</li> <li>76.19%</li> <li>76.19%</li> </ul>	532.36 591.62 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	532.30 590.56 571.06 936.31 78.92 1,188.19 190.49 74.12% 84.12% 74.06 84 12%	
500. 565. 925: 599. 1,186. 177. 59.( 65.00 59.( 65.00	22 535.03 570.65 10 940.51 10 85.87 10 1,191.51 19 191.16 10 79.30 % 76.19% 76.19%	570.91 570.91 937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	590.36 571.06 936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84 12%	
505. 925. 59.1 1,186.1 177. 59.0 65.00 59.0	35         370.83           90         940.51           90         85.87           90         1,191.51           19         191.16           100         79.30           %         76.19%           %         76.19%	937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	936.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84 12%	
925. 59. 1,186( 177. 59.0 65.00 59.0 65.00	00 940.51 10 85.87 10 1,191.51 19 191.16 10 79.30 % 76.19% 10 79.31 % 76.19%	937.25 79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	930.31 78.92 1,188.19 190.49 74.17 84.12% 74.06 84 12%	
59. 1,186. 177. 59. 65.00 59.0	00 85.87 1,191.51 19 191.16 10 79.30 % 76.19% 10 79.31 % 76.19%	79.43 1,188.91 190.09 75.25 81.11% 75.38 81.11%	78.92 1,188.19 190.49 74.17 84.12% 74.06 84 12%	
1,186, 177, 59,1 65.00 59,0 65.00	10         1,191.51           19         191.16           10         79.30           %         76.19%           10         79.31           %         76.19%	1,188.91 190.09 75.25 81.11% 75.38 81.11%	1,188.19 190.49 74.17 84.12% 74.06 84 12%	
177. 59.( 65.00 59.( 65.00	'9         191.16           00         79.30           %         76.19%           00         79.31           %         76.19%	190.09 75.25 81.11% 75.38 81.11%	190.49 74.17 84.12% 74.06 84 12%	
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65.00 59.1 65.00	% 76.19% 00 79.31 % 76.19%	81.11% 75.38 81.11%	84.12% 74.06 84 12%	
59.v 65.00	00 79.31 % 76.19%	75.38 81.11%	74.06 84 12%	
65.00	% 76.19%	81.11%	84 12%	
			0111270	
1,752.	1,769.39	1,774.22	1,775.63	
422.4	424.11	425.78	426.28	
407.	410.84	412.45	412.97	
79./	91.08	91.49	91.69	
450.4	574.94	574.68	574.20	
450 (	524.42	524.09	523 55	
450.0	120.64	121.04	121 22	
550	0 212.04	820.20	200.97	
1 009	010.20	1 044 55	1 045 00	
1,906	1,956.50	1,944.55	1,945.99	
1,070.	1,905.50	1,911.20	1,912.02	
500.0	1,905.80	1,911.57	1,913.20	
86.0	135.31	135.81	136.09	
2,000.0	2,664.24	2,671.98	2,666.71	
2,000.0	2,590.33	2,599.37	2,593.51	
517.	531.97	534.78	535.68	
419.8	430.65	432.42	432.96	
20.0	345.44	341.06	340.53	
5.0	5.00	5.00	5.00	Estimated
14.3	14.43	14.42	14.42	
16.0	15.47	15.73	15.86	
1,848.	1,867.54	1,872.68	1,874.15	
530.	2 539.70	542.61	543.51	
85.4	18 97.74	98.25	98.54	
20.0	14.27	1/ 70	1/ /0	
20.0	14.27	14.79	14.40	
20.0	10 10 00	14.48	14.49	
20.4	19.85	19.50	10.24	
20.0	19.97	19.66	19.74	
20.v 20.v	0 53.95	54.12	53.63	
20. 20. 20. 20.				
20. 20. 20. 20.				
20. 20.1 20.1 20.0	0 260 74	368.88	367.35	
20. 20. 20. 20. 928.	308./1	59,923.34	59,923.34	
20. 20. 20. 20. 20. 928. 11,680.	59,923.34	293.91	230.89	
20. 20. 20. 20. 928. 11,680. 0.	0 59,923.34 0 435.05		4,840,786	
20. 20. 20. 928. 11,680. 0. 4,826,70	0 59,923.34 0 435.05 0 4,990,106	4,822,703		
	20.0 20.0 20.0 20.0 20.0 20.0 20.0	20.00 14.77 20.00 14.77 20.00 19.85 20.00 19.97 20.00 54.31 20.00 53.95 928.00 368.71 11,680.00 59,923.34 0.00 435.05	2000 14.70 14.48 20.00 14.70 14.48 20.00 19.85 19.50 20.00 54.31 54.12 20.00 53.95 53.63 928.00 368.71 368.88 11,680.00 59,923.34 59,923.34 0.00 435.05 293.91 4,826,706 4,990,106 4,822,703	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

iti			Devi	Test	Trate	Tank	N
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Calculated Flows							
HP FW flow	lb/h		610,209	632,203	637,142	634,126	
HP FW to FGH flow	lb/h		73,183	119,739	118,500	117,857	
HP FW to TCA flow	lb/h		105.578	134.056	132,443	133.456	
HP DSH flow	lb/b		, 0	1 288	932	907	
Up to ID looke on 1 flow	15/11		2 775	1,200	22 072	34 007	Constitution and Allaine design webse for UD to 10 locks on flow
HP to LP leakage 1 now	ib/n		3,775	23,917	23,872	24,007	Error in instrument. Using design value for HP to LP leakage now
HP to LP leakage 2 flow	lb/h		3,775	2,976	3,002	3,037	Design value used
IP FW flow	lb/h		129,976	138,587	139,942	140,551	
CT cooling steam flow	lb/h		129,495	130,338	131,352	131,705	
HPS to CT Cooling Steam Flow	lb/h		0	0	0	0	Valve was closed, no flow
LP steam flow	lb/h		64,700	58,496	59.034	59.643	
Condensate flow entering HBSG	lb/b		907 922	956 757	961 255	958.077	
DR fuel flow	lb/h		507,522	550,757	501,255	550,077	
DBitterillow	10/11		0	0	0	0	
CIG fuel flow	lb/h		126,087	127,242	125,776	126,378	Using Enable meter
HP Steam Flow (measured)	lb/h		642,605	656,934	659,908	659,722	Not used
CRH Steam Flow (measured)	lb/h		619,289	565,401	567,057	567,516	Not used.Pitot tube DCS measurement
IP Steam Flow (measured)	lb/h		0	0	0	0	Not used
Suel Analysis	1						
Mathana CH4			02.2020	00.2020	00.000	00.000/	
Methane, CH4	mole %		93.28%	90.29%	90.00%	89.93%	
Etnane, C2H6	mole %		3.53%	6.85%	7.02%	7.03%	
Propane, C3H8	mole %		0.53%	0.33%	0.36%	0.35%	
Iso-Butane, i-C4H10	mole %		0.04%	0.01%	0.01%	0.01%	
N-Butane, n-C4H10	mole %		0.07%	0.02%	0.03%	0.03%	
Iso-Pentane, i-C5H12	mole %		0.01%	0.00%	0.01%	0.01%	
N-Pentane n-C5H12	mole %		0.01%	0.00%	0.01%	0.01%	
N Havena a CGU14	mole %		0.01%	0.00%	0.01%	0.01%	
N-Hexane, H-C6H14	mole %		0.02%	0.01%	0.01%	0.01%	
Heptane, C/H16	mole %		0.00%	0.00%	0.00%	0.00%	
Octane, C8H18	mole %		0.00%	0.00%	0.00%	0.00%	
Nonane, C9H20	mole %		0.00%	0.00%	0.00%	0.00%	
Decane, C10H22	mole %		0.00%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %		1.97%	1.80%	1.86%	1.90%	
Carbon Monovida, CO	mole %		0.00%	0.00%	0.00%	0.00%	
	indle 76		0.00%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %		0.54%	0.63%	0.65%	0.66%	
Water, H2O	mole %		0.00%	0.00%	0.00%	0.00%	
Hydrogen Sulphide, H2S	mole %		0.00%	0.00%	0.00%	0.00%	
Hydrogen, H2	mole %		0.00%	0.00%	0.00%	0.00%	
Helium, He	mole %		0.00%	0.04%	0.04%	0.04%	
0x////	mole %		0.00%	0.00%	0.00%	0.00%	
Argon Ar	mole %		0.00%	0.00%	0.00%	0.00%	
Argon, Ar	mole %		0.00%	0.01%	0.01%	0.01%	
Calculations							
Compressor inlet pressure	psia		14.189	14.245	14.243	14.243	
eakaae lookuns							
HP to I P leakage	lh/h		7 550	7 760	7 8 7 7	7 809	
Cland LD lookoff (HD side)			7,350	7,709	1,021	7,608	
Gianu LP leakon (HP side)	n/ai		3,440	3,533	3,564	3,553	
Gland subatmospheric leakoff (HP side)	lb/h		590	613	613	613	
LP gland sealing steam	lb/h		2,680	2,669	2,669	2,669	
Gland subatmospheric leakoff (LP side)	lb/h		1,020	1,024	1,024	1,024	
Flow Calculations	1						Negative indicates water stored in drum
HP drum level change flow	ft2		0	-7	5	0	• • • • • • • • •
IR drum level change flow	40		0	-/	5	1	
in unum level unange now	11.3		0	-2	-3	-1	
LP drum level change flow	tt3		0	14	20	-13	
HP drum density	lb/ft3		40.1	40.0	39.9	39.9	
IP drum density	lb/ft3		50.3	50.2	50.2	50.2	
LP drum density	lb/ft3		56.8	56.4	56.4	56.4	
HP drum level change flow	lh/h		0.0	-290.2	212 0	-2 /	
IP drum level change flow	lb/b		0.0	-100 9	_127.0	69.0	
in unum level unange now	10/11		0.0	-100.8	-13/.8	-08.9	
LP drum level change flow	lb/h		0.0	817.6	1,106.2	-719.7	
Total HP to CRH STG leakage			23,260	71,838	71,927	71,897	
	n . h.		<b>C</b> 24 022	C + 7 - 7 - 7	CF2 22	CT0 CT0	
HP Steam Flow	lb/h		631,030	647,509	652,231	650,630	HP FW + HP DSH + TCA - FGH Extraction + HP Drum Level
CRH Steam Flow	lb/h		618,914	575,670	580,304	578,733	HP Steam - STG leakages- HPS to CT Cooling Steam
IP Steam Flow	lb/h		137,460	138,486	139,804	140,482	IP FW + IP Drum Level
HRH Stoom Flow	lh/h		748 890	714 592	720 402	719 446	CRH Steam + IP Steam + HP cooling steam + HP cooling steam DSF
DDD SIEdIII FIUW			/ -0.030	/ 17,002	/20,702	, 10,740	

GREC U3 CTG Exhaust Flow by HRSG Energy Balance Calculation											
Description	Unit	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes				
Entering Enthalpies											
Condensate enthalpy	btu/lb		68.2	101.1	98.6	98.5					
IP FW enthalpy			289.3	299.6	300.0	300.2					
HP FW enthalpy	DTU/ID		294.3	304.3	304.6	304.9					
CTC seeling steam return anthalaw	btu/lb		1 492 4	1 401 0	1 480 2	1 499 6					
CPH steam onthalow	btu/lb		1,465.4	1,491.0	1,409.2	1,400.0					
CKH steam enthalpy	btu/ib		1,540.0	1,549.0	1,546.5	1,546.2					
Exiting Enthalpies											
BEWP suction enthaloy	htu/lb		287.0	296 5	296.7	297.0					
EGH supply enthalpy	btu/lb		512.2	516.5	517.2	517.5					
TCA suction enthalpy	btu/lb		287.0	296.2	296.4	296.7					
CTG cooling steam supply enthalpy	btu/lb		1.275.4	1.277.2	1.277.1	1.277.1					
HP steam enthalpy	btu/lb		1.514.9	1.511.1	1,509.3	1.509.1					
HRH steam enthalpy	btu/lb		1,551.3	1,550.8	1,549.2	1,548.9					
LP steam enthalpy	btu/lb		1,274.5	1,288.8	1,289.1	1,288.6					
Entering Energies											
Condensate energy	btu/h		61,944,638	96,695,376	94,807,402	94,382,788					
IP FW energy	btu/h		37,604,960	41,524,959	41,976,921	42,199,879					
HP FW energy	btu/h		179,582,054	192,352,238	194,058,870	193,313,373					
TCA return energy	btu/h		64,936,465	79,987,738	79,472,188	79,892,188					
CTG cooling steam return energy	btu/h		192,091,052	194,329,894	195,604,605	196,062,696					
CRH steam energy	btu/h		829,714,454	776,571,161	782,419,090	780,246,550					
Exiting Energies											
BFWP suction energy	btu/h		212,403,047	228,927,311	230,809,132	230,329,896	HP FW + HP DSH + IP FW				
FGH supply energy	btu/h		37,485,637	61,840,961	61,293,183	60,997,067					
TCA suction energy	btu/h		30,296,614	39,709,154	39,259,095	39,602,263					
CTG cooling steam supply energy	btu/h		165,156,426	166,469,477	167,749,853	168,203,257					
HP steam energy	btu/h		955,960,883	978,468,681	984,438,263	981,862,959					
HRH steam energy	btu/h		1,161,747,610	1,108,203,014	1,116,043,560	1,114,339,923					
LP steam energy	btu/h		82,459,263	75,388,961	76,099,956	/6,858,/41					
UPCC water side duty	h.a /h		1 270 625 057	1 277 546 102	1 207 252 000	1 200 000 022					
HRSG water side duty	blu/n		1,2/9,035,85/	1,277,546,193	1,287,353,900	1,280,090,033					
Correction narameters											
Fuel beating value (LHV)	htu/lb		20 422 37	20 401 32	20 367 93	20 348 21					
Duct hurner beat input (LHV)	htu/h		20,422.57	20,401.52	20,507.55	20,540.21					
Buce burner neue input (Erry)	btu/ii		0	0	0	0					
CRH Return Flow %	%		98.08%	88.91%	88.97%	88.95%	% of HP Flow				
TCA Cooler Pressure Drop	psi		0	74	73	73	Check on from where to where				
TCA supply enthalpy	btu/lb		297.7	307.7	307.9	308.3					
TCA Energy Addition	mmBtu/h		33.5	38.7	38.7	38.8	Verify this is just TCA, not pump as well				
FGH return enthalpy	btu/lb		144	267	259	257					
FGH Energy reduction	mmbtu/h		26.92	29.88	30.61	30.72					
HP Pump Temperature Rise	Deg F		4.0	4.5	4.7	4.6					
IP Pump Temperature Rise	Deg F		1.5	1.9	2.0	2.0					
TCA Pump Temperature Rise	Deg F		7.2	6.9	6.9	7.0					
Pasulta											
nesuits											
CTG exhaust flow (CTG energy balance)	lh/h		4 765 000	4 990 106	4 877 702	4 840 796	From CTG Testing using temp TC grid and Enable fuel flow				
CTG exhaust flow uncertainty (CTG energy balance)	%		1,00%	1 76%	1 33%	1,60%	from ere resting using temp regnd and Enable fact now				
CTG exhaust flow (HRSG energy balance)	lh/h		4 765 000	4 600 870	1.55% 4 755 107	4 755 260					
CTG exhaust flow uncertainty (HPSG energy balance)	9/		4,705,000	4,033,823	4,733,427	4,733,203					
CTG exhaust now uncertainty (HRSG energy balance)	™ htu/lb		202.16	201 12	200.69	200.92					
HPSG stack exhaust flow (HPSG energy balance)	lb/b		4 765 000	4 600 920	4 755 427	4 755 260					
HRSG stack enthalov (HRSG energy balance)	htu/lb		30.06	-,055,025	29.25	-,, 55,205					
HRSG heat loss	btu/b		3 441 425	3 434 208	3 463 323	3 460 076					
HRSG heat loss %	%		0.27%	0 27%	0 27%	0 27%					
The first is the	,,,		0.2770	0.2770	0.2770	0.2770					
CTG exhaust composition											
Wet N2	mole %		73.79%	72.66%	72.87%	72.86%					
Wet O2	mole %		10.83%	10.48%	10.75%	10.72%					
Wet CO2	mole %		4.58%	4.63%	4.53%	4.55%					
Water	mole %		9.91%	11.35%	10.97%	11.00%					
Wet SO2	mole %		0.00%	0.00%	0.00%	0.00%					
Wet Ar	mole %		0.88%	0.87%	0.88%	0.88%					
Gas MW	lb/lb mole		28.29	28.14	28.17	28.17					
CTG exhaust flow (Uncertainty Weighted)	lb/h		4,765,000	4,748,007	4,772,823	4,771,718					
CTG exhaust flow uncertainty (Uncertainty Weighted)	%		0.99%	0.96%	0.92%	0.94%					
	1										

sescription	Ginta	rag wumber	Design	rest nun 1	rest null Z	iest nun 5	NOLES
IRSG Rate Program Innuts			1				
Ambient Temperature	Deg F		59.00	79.31	75.38	74.06	
Ambient remperature	Deg.		55.00	75.51	75.50	74.00	
Exhaust Gas Exhaust Temperature	Deg F		1 186 00	1 191 51	1 188 91	1 188 19	
Exhaust Gas Exhaust Flow	lb/b		4 765 000	4 748 007	4 772 823	4 771 718	Uncertainty weighted average of CTG and HRSG
Exhaust Gas Exhaust Composition N2	10/11 9/ .uel		4,703,000	4,748,007	4,772,023	4,771,710	oncertainty weighted average of CTG and HK3G
Exhaust Gas Exhaust Composition N2	% V0I		/3./9	72.66	/2.8/	/2.86	
Exhaust Gas Exhaust Composition 02	% vol		10.98	10.48	10.75	10.72	
Exhaust Gas Exhaust Composition CO2	% vol		4.50	4.63	4.53	4.55	
Exhaust Gas Exhaust Composition H2O	% vol		9.80	11.35	10.97	11.00	
Exhaust Gas Exhaust Composition SO2	% vol		0.00	0.00	0.00	0.00	
Exhaust Gas Exhaust Composition Ar	% vol		0.93	0.87	0.88	0.88	
Exhaust Gas Exhaust Composition Ai	76 VOI		0.93	0.87	0.00	0.00	
Exhaust Gas Exhaust Composition Molecular Weight	% V0I		28.30	28.14	28.17	28.17	
Duct Burner On / Off	(Y/N)		Unchecked	Unchecked	Unchecked	Unchecked	Manual Input
Duct Burner Duty	MMBTU/h		0	0.00	0.00	0.00	
RH Outlet Set Pressure	nsia		407.20	410.84	412.45	412.97	Boundary pressure
			4 752 20	4 700 00		4 775 63	D
HP Outlet Set Pressure	psia		1,752.20	1,769.39	1,774.22	1,775.63	Boundary pressure
	1						
LP Outlet Set Pressure	psia		100.30	91.08	91.49	91.69	Boundary pressure
	1						
CRH Return Fixed Temperature	Deg F	1	662.00	677.42	676.36	676.25	CRH temp at HRSG
CRH Return Flow Return	%	1	96.22	88.01	88 07	88.05	CRH % of HP
CKH Retuil Flow Retuil	/0		50.25	00.91	00.57	00.55	CKH % OF HP
HP Desuperheater Set Temperature	Deg F		1,052.00	1,052.00	1,052.00	1,052.00	Set temp (as measured during test)
RH Steam Bypass Set Temperature	Deg F		1,052.00	1,051.50	1,051.50	1,051.50	Set temp (as measured during test)
HP Steam Drum Blowdown %	%		0.00	0.00	0.00	0.00	Off during test
	,,,		0.00	0.00	0.00	0.00	on during test
	- /						
IP Steam Drum Blowdown %	%		0.00	0.00	0.00	0.00	Off during test
IP to RH Control Valve Inlet Set Pressure	psia		537.00	536.12	539.06	539.93	Set pressure (as measured during test 03-PIT-106621)
Combuster Cooler Return Fixed Temperature	Deg F		925 70	940 51	937.25	936 31	
Combuster Cooler Neturn Fixed Temperature	Deg i		122.70	120.220	424,252	424 705	change (and the state of the st
Compuster Cooler Return Fixed Flow	ib/n		132,500	130,338	131,352	131,705	Steam from compustor cooler to HKSG
CC From IP Extraction Drawoff Flow	lb/h		132,500	129,903	131,058	131,474	Steam from IP to steam cooler
HP Combustor Back Up CV Set Flow	lb/h		132,500	130.338	131.352	131.705	Backup supply to above if IP cannot produce enough steam
······			. ,				
UB Steam to CC Steam Cooling Desugerheater Seren Drawoff Flow	16./6		0	425	204	221	DCI1 flow for LID supply to stoom cooler
HP steam to CC steam cooling besuperneater spray brawon now	10/11		0	435	294	231	DSH now for HP supply to steam cooler
TCA Extraction Drawoff Flow	lb/h		153,900	134,056	132,443	133,456	LP drum to TCA pumps
Condensate Bypass To TCA Cooler Drawoff Flow	lb/h	1	0	0	0	0	Condensate to TCA pumps (startun only)
			Ĭ	0	0	0	
TCA Cooler Fuit Islat Cat Decentre	nein	1	A 445 44	2 500 55	2 500 57	2 502 51	TCA FW/to UD drum processo
ICA CODIER EXIT INIET SET Pressure	psia		2,415.00	2,590.33	2,599.37	2,593.51	ICA FW to HP arum pressure
	1	1	1				
TCA Cooler - (Across TCA Cooler) Set Pressure Drop	psi	1	14.00	14.60	14.60	14.00	
TCA Energy Addition	MMBTU/h	1	32.82	38.74	38.69	38.75	
TCA Cooley (From TCA Burne Discharge to TCA Cooley Islat Cat Descente Date			20.20	20.20	20.20	20.00	
TCA COOLET - (FTOTTTCA PUTTIP DISCHarge to TCA COOLET ITHET SET PRESSURE Drop	hai		50.20	50.20	30.20	50.00	
	L .	1	1				
FGH Control Valve Set Temperature	Deg F		142.00	293.86	285.97	283.96	
FGH Energy Reduction	MMBTU/h		24.42	29.88	30.61	30.72	
···		1		0			
Preheat Bynass Diverted (V/N)	(V/N)	1	Unchacked	Unchacked	Unchacked	Unchecked	Manual Input
Frenear bypass Diverted (T/N)	(1/18)	1	опспескеа	опспескев	опспескеа	опспескев	ivianuai input
	1						
Condensate Fluid Source Fixed Temperature	Deg F		99.00	110.43	109.13	109.53	Upstream FGH return
	1	1	1				
Pressure for Preheater Bypass Minimum Pressure	psia		40.00	40.00	40.00	40.00	40 if not bypassed, 78.7 if bypassed
	I	1	-0.00	10.50	10.00	10.00	
UD Dump Temperature Dice	Deer	1					
HP Pump Temperature Rise	Deg F		5.10	4.50	4.65	4.62	
	1	1	1				
	Deg F		2.50	1.89	2.05	2.03	
IP Pump Temperature Rise	0.						
IP Pump Temperature Rise	8 -						
IP Pump Temperature Rise	Deg F		9.70	6.89	6.89	6.97	

Description	Unite	GREC U3	HRSG Correct	tions Tost Run 1	Tost Pup 2	Tost Pup 2	Notos
HRSG Rate Program Outputs	Jints	rag wunner	Design	rest Run 1	iest Rull Z	iest Auli 3	NOLES
Exhaust Gas Exhaust Temperature	Deg F		1,186.0	1,191.50	1,188.90	1,188.20	
Exhaust Gas Exhaust Flow	lb/h		4,765,000	4,748,010	4,772,820	4,771,720	
Exhaust Gas N2	% vol		73.79	72.67	72.87	72.85	
Exhaust Gas O2	% vol		10.98	10.48	10.75	10.72	
Exhaust Gas CO2	% vol		4.5	4.63	4.53	4.55	
Exhaust Gas 620	% vol		9.8	11.55	10.97	11	
Exhaust Gas Sol	% vol		0.93	0.87	0.88	0.88	
Duct Burner On / Off	-		Off	Off	Off	Off	
Duct Burner Duty	MMBTU/h		0	0	0	0	
RH Outlet Set Pressure	psia		407.2	410.8	412.5	413	
HP Outlet Set Pressure	psia		1,752.20	1,769.40	1,774.20	1,775.60	
CRH Return Fixed Temperature	Deg F		662.2	91.1 677.4	91.5	91.7	
CRH Return Flow Return	%		96.23	88.91	88.97	88.95	
HP Desuperheater Set Temperature	Deg F		1,052	1,052.00	1,052.00	1,052.00	
RH Steam Bypass Set Temperature	Deg F		1,052	1,051.50	1,051.50	1,051.50	
HP Steam Drum Blowdown %	%		0	0	0	0	
IP Steam Drum Blowdown %	%		0	0	520.1	520.0	
Combuster Cooler Return Fixed Temperature	Deg F		925.7	940.5	937.3	936.3	
Combuster Cooler Return Fixed Flow	lb/h		132,500	130,340	131,350	131,710	
CC From IP Extraction Drawoff Flow	lb/h		132,500	129,900	131,060	131,470	
HP Combustor Back Up CV Set Flow	lb/h		132,500	130,340	131,350	131,710	
HP Steam to CC Steam Cooling Desuperheater Spray Drawoff Flow	lb/h		0	440	290	230	
ICA Extraction Drawoff Flow	lb/h lb/b		153,900	134,060	132,440	133,460	
TCA Cooler Exit Inlet Set Pressure	psia		2,415,00	2,590,30	2,599,40	2,593,50	
TCA Cooler - (Across TCA Cooler) Set Pressure Drop	psi		14	14.6	14.6	14	
TCA Energy Addition	MMBTU/h		32.85	38.74	38.69	38.75	
TCA Cooler - (From TCA Pump Discharge to TCA Cooler Inlet Set Pressure Drop	psi		30.2	30.2	30.2	30	
FGH Control Valve Set Temperature	Deg F		141.7	293.9	286	284	
Preheat Bynass Diverted (Y/N)	-		24.42 No	29.66 No	50.01 No	50.72 No	
Condensate Fluid Source Fixed Temperature	Deg F		98.8	110.4	109.1	109.5	
Pressure for Preheater Bypass Minimum Pressure	psia		40	40	40	40	
HP Pump Temperature Rise	Deg F		5.1	4.5	4.65	4.62	
IP Pump Temperature Rise	Deg F		2.5	1.89	2.05	2.03	
TCA Pump Temperature Rise	Deg F		9.7	6.89	6.89	6.97	
Outlet							
HP Outlet In Temperature	Deg F		1,052.0	1,052.00	1,050.70	1,050.30	
HP Outlet In Flow	lb/h		631,030	661,450	659,980	658,920	
RH Outlet In Temperature	Deg F		1,051.5	1,051.50	1,051.50	1,051.50	
IP Outlet Inlet Temperature	Deg F		570.0	568.8	569.1	569.2	
IP Outlet Inlet Flow	Ib/h		137,460	129,730	130,080	130,280	
IP Outlet in Flow	lb/h		64.700	55,590	56.030	56,340	
Static Pressure Drop Out Pressure	inH2O		16	16.03	16.16	16.14	
RH Pressure Drop Pressure Drop	psi		15.4	13.69	13.73	13.71	
FGH Extraction Secondary Temperature	Deg F		533.0	520.8	521.4	521.8	
TCA Injection Out Temperature	Deg F		536.8	587.2	589.7	588.7	Need to exclude control value DR
LP Steam/Water Side Pressure Loss	psi		91.0	100.33	100.38	100.22	Need to exclude control valve DP
	ľ						
Correction Calculations (Guarantee/Software Test)							
HP Steam Flow Correction	-		1.000000	0.954010	0.956135	0.957673	Guarantee/Rate Program
LP Steam Flow Correction	_		1.000000	1.163878	1.154739	1.148385	Guarantee/Rate Program
HP Steam Temperature Correction	-		1.000000	1.000000	1.001237	1.001619	Guarantee/Rate Program
HRH Steam Temperature Correction	-		1.000000	1.000000	1.000000	1.000000	Guarantee/Rate Program
IP Steam Temperature Correction	-		1.000000	1.002110	1.001581	1.001405	Guarantee/Rate Program
LP Steam Temperature Correction	-		1.000000	0.980242	0.980440	0.981033	Guarantee/Rate Program
Gas Side Pressure Loss Correction	[		1.000000	1 12/10/0	1 121631	1 123268	Guarantee/Rate Program
HP Pressure Loss Correction	_		1.000000	0.850451	0.852068	0.856729	Guarantee/Rate Program
LP Pressure Loss Correction	-		1.000000	0.907007	0.906555	0.908002	Guarantee/Rate Program
Uncorrected Values (Test Values)							
HP Steam Flow	lb/h		631,030	647,509	652,231	650,630	
IP Steam Flow	lb/h		64,700	58,496	59.034	59.643	
HP Steam Temperature	Deg F		1,052.00	1,046.61	1,043.92	1,043.59	
HRH Steam Temperature	Deg F		1,051.50	1,050.80	1,047.86	1,047.31	
IP Steam Temperature	Deg F		570.00	572.19	572.58	572.72	
LP Steam Temperature	Deg F		486.20	517.18	517.81	516.99	
Reheater Pressure Loss	nsi		15.00	13.47	13.73	13.80	
HP Pressure Loss	psi		155.92	169.17	170.33	170.36	
LP Pressure Loss	psi		371.00	433.34	432.60	431.86	
Course and a Malune (17 - 1880 - 19 - 19 - 19 - 19 - 19 - 19 - 19 - 1							
Lorrected values ((Test~Guarantee)/Software Test) HP Steam Flow Corrected	lh/h		621 020	617 720	623 621	673 001	Test * Correction
IP Steam Flow Corrected	lb/h		137.460	146,738	147,736	148,224	Test * Correction
LP Steam Flow Corrected	lb/h		64,700	68,082	68,169	68,493	Test * Correction
HP Steam Temperature Corrected	Deg F		1,052.00	1,046.61	1,045.21	1,045.28	Test * Correction
HRH Steam Temperature Corrected	Deg F		1,051.50	1,050.80	1,047.86	1,047.31	Test * Correction
IP Steam Temperature Corrected	Deg F		570.00	573.40	573.49	573.53	lest * Correction
Gas Side Pressure Loss Corrected	inH2O		486.20	506.96	507.68	507.19	Test * Correction
Reheater Pressure Loss Corrected	psi		15.40	13.44	13.38	14.96	Test * Correction
HP Pressure Loss Corrected	psi		155.92	143.87	145.13	145.96	Test * Correction
LP Pressure Loss Corrected	psi		371.00	393.04	392.18	392.13	Test * Correction
	1			1	1		

GREC U3 HRSG Unfired Results												
Description	Unit	Guarantee	Test Run 1	Test Run 2	Test Run 3	Average TR 1-3	Pass/Fail	Notes				
HP Steam Flow Corrected HP Steam Flow Margin Margin	lb/h lb/h lb/h %	- 631,030	647,509 617,730 -13,300 -2.11%	652,231 623,621 -7,409 -1.17%	650,630 623,091 -7,939 -1.26%	650,123 621,481 -9,549 -1.51%	Fail					
IP Steam Flow Corrected IP Steam Flow Margin Margin	lb/h lb/h lb/h %	137,460	138,486 146,738 9,278 6.75%	139,804 147,736 10,276 7.48%	140,482 148,224 10,764 7.83%	139,591 147,566 10,106 7.35%	Pass					
LP Steam Flow Corrected IP Steam Flow Margin Margin	lb/h lb/h lb/h %	64,700	58,496 68,082 3,382 5.23%	59,034 68,169 3,469 5.36%	59,643 68,493 3,793 5.86%	59,058 68,248 3,548 5.48%	Pass					
HP Steam Temperature Corrected HP Steam Temperature Margin	Deg F Deg F Deg F	1,052.0	1,046.6 1,046.6 -5.4	1,043.9 1,045.2 -6.8	1,043.6 1,045.3 -6.7	1,044.7 1,045.7 -6.3	Fail					
HRH Steam Temperature Corrected HRH Steam Temperature Margin	Deg F Deg F Deg F	1,051.5	1,050.8 1,050.8 -0.7	1,047.9 1,047.9 -3.6	1,047.3 1,047.3 -4.2	1,048.7 1,048.7 -2.8	Fail					
IP Steam Temperature Corrected IP Steam Temperature Margin	Deg F Deg F Deg F	570.0	572.2 573.4 3.4	572.6 573.5 3.5	572.7 573.5 3.5	572.5 573.5 3.5	Pass					
LP Steam Temperature Corrected LP Steam Temperature Margin	Deg F Deg F Deg F	486.2	517.2 507.0 20.8	517.8 507.7 21.5	517.0 507.2 21.0	517.3 507.3 21.1	Pass					
Gas Side Pressure Loss Corrected Gas side Pressure Loss Margin Margin	inH20 inH20 inH20 %	16.0	15.47 15.44 0.56 3.47%	15.73 15.58 0.42 2.65%	15.86 15.73 0.27 1.71%	15.69 15.58 0.42 2.61%	Pass					
Reheater Pressure Loss Corrected Reheater Pressure Loss Margin Margin	psi psi %	15.4	13.3 14.9 0.5 3.10%	13.3 15.0 0.4 2.89%	13.3 15.0 0.4 2.89%	13.3 14.9 0.5 2.96%	Pass					
Auxiliary Load Corrected Auxiliary Load Margin Margin	kW kW kW	928	368.7 N/A 559.29 60.27%	368.9 N/A 559.12 60.25%	367.3 N/A 560.65 60.42%	368 N/A 560 60.31%	Pass					

Linked Row			-		17	27	37	
		1						
Description	Unit	Data Source	Tag Number	Design	Test Run 1	Test Run 2	Test Run 3	Notes
STG gross power output	kW	PwrDAS	STG Meter-MW	151 333 0	142 949 1	143 816 7	143 994 0	
STG excitation current	A	STGDCS	30CHC00CE021	600	1,407.3	1,413.2	1,408.9	Check only
STG generator power factor	-	PwrDAS	STG Meter-PF	0.900	0.999	0.998	0.999	
STG Frequency	Hz	PwrDAS	STG Meter-Hz	60.000	60.007	59.998	60.005	Info Only
Temperature Measurements								
HP steam temp	Deg F	MainDAS	STG HP Steam Temp	1,050.00	1,045.7	1,043.1	1,042.9	
CRH steam temp	Deg F	MainDAS	STG CHR Steam Temp	672.00	683.1	681.0	680.9	
HRH steam temp	Deg F	MainDAS	STG HRH Steam Temp	1,050.00	1,050.8	1,047.9	1,047.3	
Hotwell temperature	Deg F	DCS	03-TE-050602.UNIT3@NET3	90.79	118.0	117.0	117.3	
	Ū.		-					
Pressure Measurements		MaiaDAG	UD Stears Deserves (STC lalet) Care	1 720 2	1 764 4	1 700 0	1 770 6	
CRH steam pressure	psia	MainDAS	CRH Steam Pressure (STG Inlet) Corr	432.1	430.3	431.9	432.5	
HRH steam pressure	psia	MainDAS	HRH Steam Pressure (STG Inlet) Corr	398.5	406.4	407.9	408.5	
LP steam pressure	psia	MainDAS	LP Steam Pressure (STG Inlet) Corr	91.4	89.8	90.2	90.4	
STG Exhaust Pressure	psia	MainDAS	STG Exhaust Pressure	0.732	1.088	1.061	1.063	
IP drum pressure	psia	DCS	IP Drum pressure	530.1	554.4	557.1	558.2	
LP drum pressure	psia	DCS	LP Drum pressure	85.5	112.4	113.0	113.2	
Generator H2 Pressure	psig	STGDCS	30MKG01CP101	43.5	44.290	43.978	43.917	
Barometric pressure	psia	DCS	03-ATMOS-PRESSURE.UNIT3@NET3	14.370	14.380	14.380	14.380	
Level Measurements								
Starting HP Drum Level	in		'=DCS!YI76	20	14.27	14.43	14.48	
Ending HP Drum Level	in			20	14.70	14.48	14.49	
Starting IP Drum Level	in		"=DCS!YJ76	20	19.85	19.68	19.66	
Starting LP Drum Level	in		'=DCS!YK76	20	54.31	54.32	53.63	
Ending LP Drum Level	in			20	53.95	53.63	53.95	
Starting Hotwell Level	in		=DCS!Dz76	20	3.55	3.52	2.88	
Ending Hotwell Level	in			20	1.88	2.88	0.81	
Other Measurements								
HPS to cooling steam DSH flow	lb/h	DCS	03-FIT-035601.UNIT3@NET3	0	435.1	296.9	230.9	03-FIT-035601
STG Auxiliary Power	kW	DCS		928	74.1	74.1	74.1	
Mechanical Loss	kW	DCS		1,080	59,923	59,923	59,923	Design value
Design condensate entering HRSG enthalpy	btu/lb	DCS		280	280	280	280	Design value
Design Measurement Point to STG DP	nsi	N/A	N/A	0.00	0.77	0.77	0.77	0.77 unfired 1.04 fired
CRH	psi	N/A	N/A	0.00	-0.35	-0.35	-0.35	-0.35 unfired, -0.48 firedu
HRH	psi	N/A	N/A	0.00	0.45	0.45	0.45	0.45 unfired, 0.58 fired
LP	psi	N/A	N/A	0.00	0.27	0.27	0.27	0.27 unfired, 0.04 fired
Flow Measurements								
HP FW Flow								03-FE-101604
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Тар Туре	-			Flange	Flange	Flange	Flange	
Throat Diameter	in			4.9659	4.9659	4.9659	4.9659	
Diameter Measurement Temperature	Deg F			68.0	68.0	68.0	68.0	Assumed
Calibration Temperature	Deg F			120.0	120.0	120.0	120.0	Calibrated
Inlet Material	-			CS	CS	CS SE2100	CS CS 2000	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	HP FW Flow Pressure Corr	1,908.1	2,199.3	2,205.7	2,206.2	
Flow Temperature	Deg F	DCS	03-TE-061623.UNIT3@NET3	320.6	330.5	330.8	331.1	
Flow DP	inH2O	MainDAS	HP FW Flow DP SQRT	187.8	202.4	203.5	203.6	
HP FW to FGH Flow								03-FE-062605
Meter Type	-			ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	
Тар Туре	-			Throat	Throat	Throat	Throat	
Inlet Diameter Throat Diameter	in			3.6230	3.6230	3.6230	3.6230	
Diameter Measurement Temperature	Deg F			73	73	73	73	
Calibration Temperature	Deg F			106	106	106	106	
Inlet Material	-			CS	CS	CS CC2	CS CC2:::::	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	HP FW Flow to FGH Pressure Corr	1,870.0	1,905.5	1,910.3	1,912.8	
Flow Temperature	Deg F	DCS	03-TE-062607.UNIT3@NET3	521.0	524.6	525.4	525.5	
Flow DP	inH2O	MainDAS	HP FW Flow to FGH DP SQRT	77.0	206.6	199.4	200.3	
HP FW from TCA Flow								
Meter Type	-			ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle	03-FE-065618
Тар Туре	-			Throat	Throat	Throat	Throat	
Inlet Diameter Throat Diameter	in			2 5635	2 5635	2 5635	2 5635	
Diameter Measurement Temperature	Deg F			74	74	74	74	Assumed
Calibration Temperature	Deg F			106	106	106	106	
Inlet Material	-			CS	CS	CS CC2	CS CC2:::::	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	TCA Flow Pressure Corr	1,908.1	1,888.1	1,892.1	1,894.6	
Flow Temperature	Deg F	DCS	03-TE-065607.UNIT3@NET3	320.6	589.1	590.7	590.6	
Flow DP	inH2O	MainDAS	TCA Flow DP SQRT	32.7	68.3	67.4	67.9	
HP DSH Flow								
Meter Type	-			Orifice	Orifice	Orifice	Orifice	03-FE-103607
Tap Type	-			Flange	Flange	Flange	Flange	
Throat Diameter	in	1		2.2920	2.2920	2.2920	2.2920	
Diameter Measurement Temperature	Deg F			68.0	68.0	68.0	68.0	Assumed
Calibration Temperature	Deg F	1		68.5	68.5	68.5	68.5	Calibrated
Inlet Material Throat Material	-			CS SS3vv	CS SS3xv	CS SS3vr	CS SS3vv	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia	MainDAS	HP DSH flow pressure Corr	2,269.0	2,172.5	2,180.1	2,180.3	
Flow Temperature	Deg F	DCS MainDAC	03-TE-103608.UNIT3@NET3	318.0	285.1	279.6	280.6	
	IIIEZU	CAUNIEN	ne don ilow de Solk i	0.0	0.1	0.1	0.1	

Linked Row			GREC U3 STG Test Input Data Summary		17	27	37	
Description	Unit	Data Source	Tag Number	Docign	Tort Run 1	Tort Pup 2	Tort Run 2	Notor
HP to LP Leakage 1 Flow	onic	Data Source	Tag Number	Design	Test Rull I	Test Kull Z	Test Kull 5	DP2A
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Tap Type Inlet Diameter	- in			Corner 5.0470	Corner 5.0470	Corner 5.0470	Corner 5.0470	
Throat Diameter	in			3.7874	3.7874	3.7874	3.7874	
Diameter Measurement Temperature	Deg F			68 N/A	68 N/A	68 N/A	68 N/A	Assumed
Inlet Material	-			IAS	IAS	IAS	IAS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type Flow Pressure	- nsia	MainDAS	HP to LP Leakage flow 1 Pressure Corr	Vapor 70.0	Vapor 91.0	Vapor 91.4	Vapor 91.6	
Flow Temperature	Deg F			659.9	643.6	641.1	640.9	Calculated from CRH enthalpy and measured pres
Flow DP	inH2O	STGDCS	STG Bal Pipe DP1	9.4	318.4	316.3	318.8	Error in instrument.
HP to LP Leakage 2 Flow								DP2B
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Inlet Diameter	- in			5.0470	5.0470	5.0470	5.0470	
Throat Diameter	in			3.7874	3.7874	3.7874	3.7874	
Diameter Measurement Temperature	Deg F			68 N/A	68 N/A	68 N/A	68 N/A	Assumed
Inlet Material	-			IAS	IAS	IAS	IAS	
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type Flow Pressure	- psia	MainDAS	HP to LP Leakage flow 2 Pressure Corr	vapor 70.0	vapor 90.6	vapor 90.9	vapor 91.1	
Flow Temperature	Deg F			659.9	643.5	641.1	640.8	Calculated from CRH enthalpy and measured pres
Flow DP	inH2O	STGDCS	STG Bal Pipe DP2	9.4	4.4	4.5	4.6	
IP FW Flow								03-FE-104630
Meter Type	-			Orifice	Orifice	Orifice	Orifice	
Inlet Diameter	in			3.8460	3.8460	3.8460	3.8460	
Throat Diameter	in			2.2695	2.2695	2.2695	2.2695	
Diameter Measurement Temperature Calibration Temperature	Deg F Deg F			68.0 72.0	68.0 72.0	68.0 72.0	68.0 72.0	Assumed
Inlet Material	-			CS	CS	CS	cs , 2.0	calibrated
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Flow Pressure	psia	MainDAS	IP FW flow pressure Corr	550.5	796.5	797.2	797.9	
Flow Temperature	Deg F	MainDAS	IP FW flow Temp	318.1	473.3	473.9	474.0	
Flow DP	INH20	MainDAS	IP FW flow DP SQRT	203.9	259.7	266.0	267.3	
CT Cooling Steam Flow								
Meter Type Tap Type	-			Venturi Throat	Venturi Throat	Venturi Throat	Venturi Throat	03-FE-035622
Inlet Diameter	in			7.981	7.981	7.981	7.981	
Throat Diameter	in Dog F			5.428	5.428	5.428	5.428	Accumed
Calibration Temperature	Deg F Deg F			N/A	N/A	N/A	N/A	Assumed
Inlet Material	-			CS	CS	CS	CS CS	
Fluid Type	-			SS3XX Vapor	SS3XX Vapor	SS3XX Vapor	SS3XX Vapor	
Flow Pressure	psia	MainDAS	CTG Cooling Steam Flow Pressure Corr	419.9	528.4	531.0	532.1	
Flow Temperature	Deg F inH2O	DCS MainDAS	03-TE-035623.UNIT3@NET3 CTG Cooling Steam Flow DP SORT	926.4	570.2 124.2	570.7 125.4	570.9 125 9	
HPS to CT Cooling Steam Flow Mater Type	_			Venturi	Venturi	Venturi	Venturi	03-FE-035604
Тар Туре	-			Throat	Throat	Throat	Throat	
Inlet Diameter	in ia			4.8970	4.8970	4.8970	4.8970	
Diameter Measurement Temperature	Deg F			5.3790	5.3790	3.3790	5.5790	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	calibrated
Inlet Material Throat Material	-			IAS	IAS IAS	IAS IAS	IAS IAS	
Fluid Type	-			Vapor	Vapor	Vapor	Vapor	
Flow Pressure Flow Temperature	psia Deg F	MainDAS MainDAS	HP Steam to CT cooling steam flow Pressure Corr HRSG HP Steam Temp	1,700.0	1,768.0	1,772.1	1,774.2	
Flow DP	inH2O	MainDAS	HP Steam to CT cooling steam flow DP	0.5	0.0	0.0	0.0	Valve closed
LP Steam Flow								03-FE-110636
Meter Type	-			Venturi	Venturi	Venturi	Venturi	
Tap Type	-			Throat 11 9820	Throat 11 0820	Throat 11 9830	Throat 11 9830	
Throat Diameter	in			7.0853	7.0853	7.0853	7.0853	
Diameter Measurement Temperature	Deg F			68.0	68.0	68.0	68.0	Assumed
Inlet Material	-			43.5 CS	43.5 CS	43.3 CS	43.5 CS	Calibrateu
Throat Material	-			SS3xx	SS3xx	SS3xx	SS3xx	
Fluid Type Flow Pressure	- psia	MainDAS	LP Steam Flow Pressure Corr	vapor 77.1	vapor 91.1	vapor 91.5	vapor 91.7	
Flow Temperature	Deg F	MainDAS	LP Steam Flow Temp	482.9	517.2	517.2	517.0	
FIOW DP	inH2U	IVIAINDAS	LP Steam FIOW DP SQKT	79.0	59.8	61.3	61.8	
Condensate Flow (from STG)								03-FE-052610
Meter Type Tap Type	-			Orifice Flange	Orifice Flange	Orifice Flange	Orifice Flange	
Inlet Diameter	in			12.0000	12.0000	12.0000	12.0000	
Throat Diameter Diameter Measurement Temperature	in Deg F			7.2035	7.2035	7.2035	7.2035	Assumed
Calibration Temperature	Deg F			N/A	N/A	N/A	N/A	
Inlet Material	1			CS	CS SS2vv	CS SS3vv	CS SS2vv	
Fluid Type	-			Liquid	Liquid	Liquid	Liquid	
Flow Pressure	psia Dog F	MainDAS	Condensate flow from STG Pressure Corr	450.0	573.2	573.0	572.8	
Flow DP	inH2O	MainDAS	Condensate flow from STG DP SQRT	204.2	108.9	107.8	107.9	
				1				

GREC U3 STG Flow Calculations											
		Tag		Test Run							
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes				
HP FW Flow											
Design Information							03-FE-101604				
Meter Type	-		Orifice	Orifice	Orifice	Orifice					
Тар Туре	-		Flange	Flange	Flange	Flange					
Inlet Diameter	in		7.743	7.743	7.743	7.743					
Throat Diameter	in		4.966	4.966	4.966	4.966					
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0					
Calibration Temperature	Deg F		120.0	120.0	120.0	120.0					
Inlet Material	-		CS	CS	CS	CS					
Throat Material	_		SS3xx	SS3xx	SS3xx	SS3xx					
Fluid Type			Liquid	Liquid	Liquid	Liquid					
Tulu Type	-		Liquid	Liquid	Liquid	Liquid					
Measured Parameters											
Upstream Pressure	psia		1,908.1	2,199.3	2,205.7	2,206.2					
Downstream Temperature	Deg F		320.6	330.5	330.8	331.1					
DP	inH2O		187.8	202.4	203.5	203.6					
Calculated Parameters											
Fluid Density	lb/ft^3		57.08	56.83	56.82	56.81					
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000112	0.000112	0.000112					
Calculated Flow	lb/h		610,391	632,203	633,946	634,126					
Calculated Flow	gpm		1,333	1,387	1,391	1,392					
HP FW to FGH Flow							03-FE-062605				
Design Information											
Meter Type	-		ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle					
Тар Туре	-		Throat	Throat	Throat	Throat					
Inlet Diameter	in		3.623	3.623	3.623	3.623					
Ihroat Diameter	in Dec 5		1.794	1.794	1.794	1.794					
Calibration Temperature	Deg F		106.0	106.0	73.0	106.0					
Inlet Material	Deg F		0.001	100.0	100.0	100.0					
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx					
Fluid Type	-		Liquid	Liquid	Liquid	Liquid					
Measured Parameters			4.070.0	4 005 5	1.040.0	4.010.0					
Opstream Pressure	psia Deg E	1	1,870.0	1,905.5	1,910.3	1,912.8					
DP	inH2O		77.0	206.6	525.4 199.4	200.3					
Calculated Parameters	L										
Fluid Density	lb/ft^3		48.38	48.19	48.14	48.14					
Fluid Viscosity	lbm/(ft*s)		0.000067	0.000066	0.000066	0.000066					
Calculated FIOW	iD/N	1	/3,202	119,/39	117,576	117,857					

189

gpm

310

305

305

Calculated Flow

Calibration Data										
Meter Serial Number		17769	-01							
Meter Location		HP FW Flow								
Tap Set		1	2							
	Inlet Re	Cd	Inlet Re	Cd						
1	311,150	0.605	311,150	0.6052						
2	386,257	0.6038	386,257	0.6049						
3	456,231	0.6043	456,231	0.6041						
4	533,408	0.6044	533,408	0.6033						
5	602,964	0.6043	602,964	0.6037						
6	6.67E+05	0.6042	6.67E+05	0.6046						
7	7.42E+05	0.6037	7.42E+05	0.6044						
8	8.03E+05	0.604	8.03E+05	0.6048						
9	8.62E+05	0.6046	8.62E+05	0.6047						
10	9.29E+05	0.6042	9.29E+05	0.6043						
11	1.02E+06	0.6044	1.02E+06	0.6041						
12	1.07E+06	0.6043	1.07E+06	0.6047						
13	1143311	0.6038	1143311	0.6041						
14	1235619	0.6038	1235619	0.6044						
15	1259580	0.6035	1259580	0.604						
16	1365260	0.6035	1365260	0.6039						
17	1414187	0.6039	1414187	0.6041						
18	1470232	0.6034	1470232	0.6039						
19	1577685	0.6033	1577685	0.6035						
20	1630434	0.6031	1630434	0.6032						

Meter Serial Number				20171	L-08								
Meter Location				HP FW to FGH									
Tap Set		1		2		3	4	l .					
	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd					
1	1,309,849	0.9967	1,309,849	0.9972	1,309,849	0.9968	1,309,849	0.9969					
2	1,224,140	0.9967	1,224,140	0.9971	1,224,140	0.9968	1,224,140	0.9969					
3	1,139,421	0.9967	1,139,421	0.9971	1,139,421	0.9968	1,139,421	0.9969					
4	1,051,335	0.9966	1,051,335	0.997	1,051,335	0.9967	1,051,335	0.9967					
5	966,864	0.9965	966,864	0.9969	966,864	0.9966	966,864	0.9967					
6	8.81E+05	0.9964	8.81E+05	0.9969	8.81E+05	0.9966	8.81E+05	0.9967					
7	7.95E+05	0.9965	7.95E+05	0.9968	7.95E+05	0.9966	7.95E+05	0.9966					
8	7.07E+05	0.9964	7.07E+05	0.9968	7.07E+05	0.9965	7.07E+05	0.9965					
9	6.25E+05	0.9967	6.25E+05	0.9971	6.25E+05	0.9968	6.25E+05	0.9969					
10	5.39E+05	0.997	5.39E+05	0.9974	5.39E+05	0.9971	5.39E+05	0.9972					
11	1.26E+06	0.9967	1.26E+06	0.9972	1.26E+06	0.9969	1.26E+06	0.9969					
12	1.18E+06	0.9968	1.18E+06	0.9972	1.18E+06	0.9969	1.18E+06	0.9969					
13	1096294	0.9968	1096294	0.9971	1096294	0.9969	1096294.2	0.9968					
14	1007317	0.9966	1007317	0.997	1007317	0.9968	1007317.2	0.9967					
15	1419176	0.9965	1419176	0.9969	1419176	0.9967	1419176.4	0.9966					
16	838325.2	0.9965	838325.2	0.9969	838325.2	0.9967	838325.17	0.9966					
17	752071.4	0.9966	752071.4	0.9969	752071.4	0.9967	752071.41	0.9967					
18	667847.7	0.9967	667847.7	0.9971	667847.7	0.9968	667847.73	0.9968					
19	582881.3	0.997	582881.3	0.9973	582881.3	0.9971	582881.34	0.9971					
20	497469.3	0.9974	497469.3	0.9978	497469.3	0.9976	497469.32	0.9976					

	GREC U3 STG Flow Calculations							
	Γ	Tag		Test Run				
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes	
HP FW from TCA Flow							03-FE-065618	
Design Information								
Meter Type	-		ASMENozzle	ASMENozzle	ASMENozzle	ASMENozzle		
Тар Туре	-		Throat	Throat	Throat	Throat		
Inlet Diameter	in		5.188	5.188	5.188	5.188		
Throat Diameter	in		2.564	2.564	2.564	2.564		
Diameter Measurement Temperature	Deg F		74.0	74.0	74.0	74.0		
Calibration Temperature	Deg F		106.0	106.0	106.0	106.0		
Inlet Material	-		CS	CS	CS	CS		
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx		
Fluid Type	-		Liquid	Liquid	Liquid	Liquid		
Measured Parameters								
Upstream Pressure	psia		1,908.1	1,888.1	1,892.1	1,894.6		
Downstream Temperature	Deg F		320.6	589.1	590.7	590.6		
DP	inH2O		32.7	68.3	67.4	67.9		
Calculated Parameters								
Fluid Density	lb/ft^3		57.08	43.70	43.57	43.59		
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000056	0.000056	0.000056		
Calculated Flow	lb/h		105,471	134,056	132,982	133,456		
Calculated Flow	gpm		230	382	380	382		
HP DSH Flow	1						03-FF-103607	
Desian Information								
Meter Type	-		Orifice	Orifice	Orifice	Orifice		
	-		Flange	Flange	Flange	Flange		
Inlet Diameter	in		2.292	2.292	2.292	2.292		
Throat Diameter	in		1.358	1.358	1.358	1.358		
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0		
Calibration Temperature	Deg F		68.5	68.5	68.5	68.5		
Inlet Material	-		CS	CS	CS	CS		
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx		
Fluid Type	-		Liquid	Liquid	Liquid	Liquid		
Measured Parameters								
Upstream Pressure	psia		2,269.0	2,172.5	2,180.1	2,180.3		
Downstream Temperature	Deg F		318.0	285.1	279.6	280.6		
DP	inH2O		0.0	0.1	0.1	0.1		
Calculated Parameters								
Fluid Density	lb/ft^3		57.26	58.26	58.43	58.40		
Fluid Viscosity	lbm/(ft*s)		0.000118	0.000134	0.000137	0.000137		
Calculated Flow	lb/h		0	1,288	1,093	907		
Calculated Flow	gpm		0	3	2	2		

Calibration D	ata
Meter Serial	Nur

N	leter Location
Т	ap Set

nber	20171-09								
	FW from TCA								
		1	2			3	4		
	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	Inlet Re	Cd	
1	1,688,016	0.9972	3,416,200	0.9972	3,416,200	0.9974	3,416,200	0.9977	
2	1,563,992	0.9971	3,165,200	0.9971	3,165,200	0.9973	3,165,200	0.9976	
3	1,436,064	0.9969	2,906,300	0.9969	2,906,300	0.9972	2,906,300	0.9975	
4	1,307,741	0.9968	2,646,600	0.9968	2,646,600	0.9971	2,646,600	0.9974	
5	1,187,818	0.9967	2,403,900	0.9966	2,403,900	0.9969	2,403,900	0.9972	
6	1,061,224	0.9964	2,147,700	0.9963	2,147,700	0.9967	2,147,700	0.9969	
7	934,926	0.9963	1,892,100	0.9962	1,892,100	0.9966	1,892,100	0.9968	
8	809,963	0.9963	1,639,200	0.9962	1,639,200	0.9966	1,639,200	0.9968	
9	684,209	0.9965	1,384,700	0.9964	1,384,700	0.9968	1,384,700	0.997	
10	559,839	0.9973	1,133,000	0.9971	1,133,000	0.9974	1,133,000	0.9976	
11	1,626,844	0.9972	3,292,400	0.9971	3,292,400	0.9974	3,292,400	0.9976	
12	1,499,559	0.997	3,034,800	0.997	3,034,800	0.9973	3,034,800	0.9975	
13	1,374,447	0.997	2,781,600	0.9969	2,781,600	0.9973	2,781,600	0.9974	
14	1,248,249	0.9968	2,526,200	0.9968	2,526,200	0.9972	2,526,200	0.9973	
15	1,121,754	0.9965	2,270,200	0.9964	2,270,200	0.9968	2,270,200	0.997	
16	996,593	0.9964	2,016,900	0.9964	2,016,900	0.9967	2,016,900	0.9969	
17	873,458	0.9963	1,767,700	0.9963	1,767,700	0.9966	1,767,700	0.9969	
18	747,062	0.9964	1,511,900	0.9964	1,511,900	0.9968	1,511,900	0.997	
19	622,247	0.9968	1,259,300	0.9967	1,259,300	0.9971	1,259,300	0.9973	
20	497,926	0.9975	1,007,700	0.9974	1,007,700	0.9978	1,007,700	0.9979	
21	172,349	0.9974	348,800	0.9971	348,800	0.9973	348,800	0.9976	
22	122,789	0.9936	248,500	0.9931	248,500	0.9926	248,500	0.9936	
23	334,718	0.9982	677,400	0.998	677,400	0.9983	677,400	0.9986	

Meter Serial Number		17769-	025	-				
Meter Location		HP DSH Flow						
Tap Set		1		2				
	Inlet Re	Cd	Inlet Re	Cd				
1	287435.4	0.6098	287445.1	0.6084				
2	257684.7	0.6096	257695.4	0.6085				
3	223322.8	0.6105	223347.6	0.6086				
4	189134.8	0.6101	189134.8	0.609				
5	149605.4	0.6118	149605.4	0.6096				
6	111860.4	0.6127	111860.4	0.6114				
7	289973.7	0.6096	289944.9	0.6084				
8	259521.4	0.6097	259532.1	0.608				
9	223423.5	0.6107	223498	0.6088				
10	189048.1	0.6106	189048.1	0.6093				
11	151524.6	0.6112	151524.6	0.6109				
12	110386.8	0.6133	108047.6	0.6115				
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GREC U3 STG Flow Calculations									
	Tag Test Run								
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes		
HP to LP Leakage 1 Flow									
Design Information									
Meter Type	-		Orifice	Orifice	Orifice	Orifice			
Тар Туре	-		Corner	Corner	Corner	Corner			
Inlet Diameter	in		5.0	5.0	5.0	5.0			
Throat Diameter	in		3.8	3.8	3.8	3.8			
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0			
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A			
Inlet Material	-		IAS	IAS	IAS	IAS			
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx			
Fluid Type	-		Vapor	Vapor	Vapor	Vapor			
Measured Parameters									
Upstream Pressure	psia		70.0	91.0	91.4	91.6			
Downstream Temperature	Deg F		659.9	643.6	641.1	640.9			
DP	inH2O		9.4	318.4	316.3	318.8			
Calculated Parameters									
Fluid Density	lb/ft^3		0.11	0.14	0.14	0.14			
Fluid Viscosity	lbm/(ft*s)		0.000015	0.000015	0.000015	0.000015			
Calculated Flow	lb/h		3,769	23,857	23,866	23,976			
Calculated Flow	gpm		4,438	21,219	21,090	21,144	Error in instrument.		
HP to LP Leakage 2 Flow									
Design Information									
Meter Type	-		Orifice	Orifice	Orifice	Orifice			
Тар Туре	-		Corner	Corner	Corner	Corner			
Inlet Diameter	in		5.0	5.0	5.0	5.0			
Throat Diameter	in		3.8	3.8	3.8	3.8			
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0			
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A			
Inlet Material	-		IAS	IAS	IAS	IAS			
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx			
Fluid Type	-		Vapor	Vapor	Vapor	Vapor			
Measured Parameters									
Upstream Pressure	psia		70.0	90.6	90.9	91.1			
Downstream Temperature	Deg F		659.9	643.5	641.1	640.8			
DP	inH2O		9.4	4.4	4.5	4.6			
Calculated Parameters									
Fluid Density	lb/ft^3		0.11	0.14	0.14	0.14			
Fluid Viscosity	lbm/(ft*s)		0.000015	0.000015	0.000015	0.000015			
Calculated Flow	lb/h		3,769	2,969	3,000	3,033			
Calculated Flow	gpm		4,438	2,655	2,665	2,689			

Calibration Data Meter Serial Num

Meter Location Tap Set

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	GREC U3 STG Flow Calculations							
Tag Test Run								
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes	
IP FW Flow							03-FE-104630	
Design Information								
Meter Type	-		Orifice	Orifice	Orifice	Orifice		
Тар Туре	-		Flange	Flange	Flange	Flange		
Inlet Diameter	in		3.846	3.846	3.846	3.846		
Throat Diameter	in		2.270	2.270	2.270	2.270		
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0		
Calibration Temperature	Deg F		72.0	72.0	72.0	72.0		
Inlet Material	-		CS	CS	CS	CS		
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx		
Fluid Type	-		Liquid	Liquid	Liquid	Liquid		
Measured Parameters								
Upstream Pressure	psia		550.5	796.5	797.2	797.9		
Downstream Temperature	Deg F		318.1	473.3	473.9	474.0		
DP	inH2O		203.9	259.7	266.0	267.3		
Calculated Parameters								
Fluid Density	lb/ft^3		56.83	50.44	50.41	50.40		
Fluid Viscosity	lbm/(ft*s)		0.000116	0.000073	0.000073	0.000073		
Calculated Flow	lb/h		129,970	138.587	140.207	140.551		
Calculated Flow	gpm		285	343	347	348		
CT Cooling Steam Flow							03-FE-035622	
Design Information								
Meter Type	-		Venturi	Venturi	Venturi	Venturi		
Тар Туре	-		Throat	Throat	Throat	Throat		
Inlet Diameter	in		7.981	7.981	7.981	7.981		
Throat Diameter	in		5.428	5.428	5.428	5.428		
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0		
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A		
Inlet Material	-		CS	CS	CS	CS		
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx		
Fluid Type	-		Vapor	Vapor	Vapor	Vapor		
Measured Parameters								
Upstream Pressure	psia		419.9	528.4	531.0	532.1		
Downstream Temperature	Deg F		926.4	570.2	570.7	570.9		
DP	inH2O		225.5	124.2	125.4	125.9		
Calculated Parameters								
Fluid Density	lb/ft^3		0.52	0.96	0.96	0.96		
Fluid Viscosity	lbm/(ft*s)		0.000019	0.000013	0.000013	0.000013		
Calculated Flow	lb/h		129,386	130,338	131,292	131,705		
Calculated Flow	gpm		31,003	16,991	17,032	17,052		

Calibration Data							
Meter Serial Number	17769-06						
Meter Location		IP FW F	low				
Tap Set		1		2			
	Inlet Re	Cd	Inlet Re	Cd			
1	407335.1	0.6088	386194.2	0.6085			
2	364084.6	0.6091	345174.7	0.609			
3	314740.6	0.6094	298455.5	0.609			
4	267561.2	0.6098	253656.1	0.6092			
5	212686.3	0.6104	201673	0.6096			
6	156662.8	0.6116	148532.7	0.6109			
7	410207	0.6088	388894.5	0.6086			
8	363662.5	0.6088	349466.9	0.6086			
9	314601.7	0.6096	302320.7	0.6088			
10	266616.9	0.6095	256189.8	0.6092			
11	212299.9	0.6105	204012.4	0.6098			
12	154441.6	0.6117	148413	0.611			
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Meter Serial Numb Meter Location

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GREC U3 STG Flow Calculations								
Tag Test Run								
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes	
HPS to CT Cooling Steam Flow							03-FE-035604	
Design Information								
Meter Type	-		Venturi	Venturi	Venturi	Venturi		
Тар Туре	-		Throat	Throat	Throat	Throat		
Inlet Diameter	in		4.9	4.9	4.9	4.9		
Throat Diameter	in		3.4	3.4	3.4	3.4		
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0		
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A		
Inlet Material	-		IAS	IAS	IAS	IAS		
Throat Material	-		IAS	IAS	IAS	IAS		
Fluid Type	-		Vapor	Vapor	Vapor	Vapor		
Measured Parameters								
Upstream Pressure	psia		1,700.0	1,768.0	1,772.1	1,774.2		
Downstream Temperature	Deg F		1,070.0	1,046.6	1,043.9	1,043.6		
DP	inH2O		0.5	0.0	0.0	0.0		
Calculated Parameters								
Fluid Density	lb/ft^3		1.99	2.12	2.13	2.13		
Fluid Viscosity	lbm/(ft*s)		0.000022	0.000021	0.000021	0.000021		
Calculated Flow	lb/h		4,685	0	0	0		
Calculated Flow	gpm		293	0	0	0		
							00.55.440505	
LP Steam Flow							03-FE-110636	
Design Information								
Meter Type	-		Venturi	Venturi	Venturi	Venturi		
Tap Type	-		Ihroat	Throat	Ihroat	Inroat		
Inlet Diameter	in		11.983	11.983	11.983	11.983		
Ihroat Diameter	in S		7.085	7.085	7.085	7.085		
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0		
Calibration Temperature	Deg F		45.5	45.5	45.5	45.5		
Iniet Material	-		CS	CS	CS CC2um	CS CC2vm		
Fluid Type	-		Vapor	Vapor	Vapor	Vapor		
Maggurad Daramatars								
Unctream Brossure	ncia		77.4	01.1	01 5	01.7		
Downstream Temperature	Dog E		//.1	51.1	51.5	51.7		
DP	inH2O		79.0	59.8	61.3	61.8		
C-11								
Culculated Parameters	16/6402		0.14	0.10	0.46	0.40		
Fluid Viscosity	ID/TC^3		0.000012	0.16	0.16	0.16		
Finite VISCOSILY	iDIII/(IC*S) Ib/b		0.000012	0.000013	0.000013	0.000013		
Calculated Flow	10/11 apm		02,310	28,496	39,324	39,643		
Calculated FIOW	SPIII		33,331	43,706	40,130	40,277		

Calibration Data
Meter Serial Numbe
Meter Location

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Meter Serial Number Meter Location Tap Set

er	17769-09									
		LP Steam	I Flow							
	1 2									
	Inlet Re	Cd	Inlet Re	Cd						
1	269,692	0.9889	269,692	0.9896						
2	327,975	0.9878	327,975	0.9895						
3	382,210	0.9881	382,210	0.9907						
4	439,548	0.9879	439,548	0.9905						
5	490,545	0.9882	490,545	0.9901						
6	551,391	0.9885	551,391	0.9905						
7	608,325	0.9884	608,325	0.9904						
8	666,877	0.9878	666,877	0.9898						
9	724,620	0.9883	724,620	0.9906						
10	776,966	0.9881	776,966	0.9897						
11	837,003	0.9887	837,003	0.9908						
12	893,532	0.9889	893,532	0.9907						
13	954,243	0.9891	954,243	0.9906						
14	1,003,891	0.9886	1,003,891	0.9903						
15	1,057,452	0.9893	1,057,452	0.9908						
16	1,114,520	0.9897	1,114,520	0.9911						
17	1,171,858	0.9895	1,171,858	0.9909						
18	1,229,736	0.9903	1,229,736	0.9914						
19	1,294,360	0.9899	1,294,360	0.9914						
20	1,343,603	0.9897	1,343,603	0.9914						

GREC U3 STG Flow Calculations									
		Tag		Test Run					
Description	Unit	Number	Design	1	Test Run 2	Test Run 3	Notes		
Condensate Flow (from STG)							03-FE-052610		
Design Information									
Meter Type	-		Orifice	Orifice	Orifice	Orifice			
Тар Туре	-		Flange	Flange	Flange	Flange			
Inlet Diameter	in		12.000	12.000	12.000	12.000			
Throat Diameter	in		7.204	7.204	7.204	7.204			
Diameter Measurement Temperature	Deg F		68.0	68.0	68.0	68.0			
Calibration Temperature	Deg F		N/A	N/A	N/A	N/A			
Inlet Material	-		CS	CS	CS	CS			
Throat Material	-		SS3xx	SS3xx	SS3xx	SS3xx			
Fluid Type	-		Liquid	Liquid	Liquid	Liquid			
Measured Parameters									
Upstream Pressure	psia		450.0	573.2	573.0	572.8			
Downstream Temperature	Deg F		100.5	108.9	107.8	107.9			
DP	inH2O		204.2	77.3	77.7	78.0			
Calculated Parameters									
Fluid Density	lb/ft^3		62.07	61.98	62.00	61.99			
Fluid Viscosity	lbm/(ft*s)		0.000455	0.000418	0.000422	0.000422			
Calculated Flow	lb/h		1,361,460	837,729	839,622	841,453			
Calculated Flow	gpm		2,735	1,685	1,689	1,692			

Calibration Data			
Meter Serial Number	Uncalibi	rated	
Meter Location			
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Description	Link	Design	Test Due 1	Test Due 2	Test Due 2	Natas
Innuts	Unit	Design	Test Run 1	Test Run 2	Test Run 3	Notes
Inputs Electrical Measurements						
STG gross power output	kW	151 333 00	142 949 10	143 816 67	143 994 02	
STG protation current		600.00	1 407 26	1 412 10	1 409 02	
STG generator power factor	<u> </u>	0.900	0.000	0.009	1,408.55	
STG Erequency	Hz	60.000	60.007	59,998	60.005	
staticqueity		00.000	00.007	55.550	00.005	
Temperature Measurements						
HP steam temp	Deg F	1.050.00	1.045.72	1.043.14	1.042.90	
CRH steam temp	Deg F	672.00	683.14	681.03	680.88	
HPH steam temp	Deg F	1 050 00	1 050 80	1 047 87	1 047 31	
I Disteam temp	Deg F	406.00	E12 20	E12 12	E12.00	
Hotwell temperature	Deg F	90.79	117.95	117.03	117.28	
notwen temperature	Degi	50.75	117.55	117.05	117.20	
Prossure Measurements						
HP steam pressure	nsia	1 729 30	1 764 39	1 768 31	1 770 61	
CRH steam pressure	psia	422.10	420.21	421.96	1,770.01	
HRH steam pressure	psia	308 50	406.31	407.95	402.45	
I B steam pressure	psia	91.40	90.92	90.24	400.40	
STG Exhaust Pressure	psia	0 722	1.099	1.061	1.062	
HP drum pressure	nsia	1 848 55	1 882 20	1 886 49	1 888 81	
IP drum pressure	nsia	530.12	554 35	557.13	558 17	
I P drum pressure	nsia	85.48	112 39	112.98	113.20	
Generator H2 Pressure	nsig	43.50	44 29	43.98	43.92	
Barometric pressure	nsia	14 37	14.25	14 38	14 38	
bulonicité pressure	psid	14.57	14.50	14.50	14.50	
level Measurements						
Starting HP Drum Level	in	20.00	14 27	14 43	14 48	
Ending HP Drum Level	in	20.00	14 70	14 48	14 49	
Starting IP Drum Level	in	20.00	19.85	19.68	19.66	
Ending IP Drum Level	in	20.00	19.97	19.66	19.74	
Starting LP Drum Level	in	20.00	54 31	54 32	53.63	
Ending LP Drum Level	in	20.00	53.95	53.63	53.95	
Starting Hotwell Level	in	20.00	3.55	3.52	2.88	
Ending Hotwell Level	in	20.00	1.88	2.88	0.81	
		20.00	1.00	2.00	0.01	
Other Measurements						
HPS to cooling steam DSH flow	lb/b	0.00	435.05	296.94	230.89	03-FIT-035601
STG Auviliary Power	kw/	928.00	74.10	74.10	74.10	1055001
N2 packing leakage flow	lb/b	11 680 00	50 022 24	50 072 24	50 022 24	
Mechanical Loss	kw/	1 100 00	1 100 00	1 100 00	1 100 00	
Design condensate entering HPSG enthalow	htu/lb	280.02	280.02	280.02	280.02	
besign condensate entering miso enthalpy	bcayib	200.02	200.02	200.02	200.02	
Desian Measurement Point to STG DP						
HP	nsi	0.00	0.77	0.77	0.77	
CRH	nsi	0.00	-0.35	-0.35	-0.35	
HRH	psi	0.00	0.45	0.45	0.45	
IP	nsi	0.00	0.45	0.45	0.45	
LP	psi	0.00	0.27	0.27	0.27	
Calculated Flows						
HP EW/ flow	lb/b	610 201	622,202	622.046	624 126	
HP FW to EGH flow	lb/h	72 202	110 720	117 576	117 957	
HP FW/ to TCA flow	lb/h	105 471	124.056	122 092	122,456	
HP DSH flow	lb/h	105,111	1 299	1 002	907	
HP to I P leakage 1 flow	lb/h	3 760	22 957	22,866	22 976	Error in instrument I light design value for HP to I P leakage flows
HP to LP leakage 2 flow	lb/h	3,769	2 969	3,000	3 033	Design value used
IP FW flow	lb/h	129 970	138 587	140 207	140 551	besign volde doed
CT cooling steam flow	lb/h	120,370	130,339	121 202	121 705	Not used
HPS to CT Cooling Steam Flow	lb/h	4 685	130,330	151,252	151,705	Valve was closed no flow
	lb/h	4,000		50 224	50 642	
Measured IP steam flow	10/11	62 310	58 496		59 04 5	
Measured LP steam flow	lh/h	62,310 1 261 460	58,496	830 622	59,043	
Measured LP steam flow Condensate flow HP steam flow (measured)	lb/h	62,310 1,361,460	58,496 837,729 656 925	839,622	59,043 841,453 659,712	Notured
Measured LP steam flow Condensate flow HP steam flow (measured) CPL steam flow (measured)	lb/h lb/h lb/b	62,310 1,361,460 1,060,028 607,840	58,496 837,729 656,925 565 401	839,622 659,237 566 659	59,643 841,453 659,713 567,516	Not used
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured)	lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840	58,496 837,729 656,925 565,401	839,622 659,237 566,659	59,643 841,453 659,713 567,516	Not used Not used
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured)	Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558	58,496 837,729 656,925 565,401 0	839,622 659,237 566,659 0	55,643 841,453 659,713 567,516 0	Not used Not used Not used
Measured LP Steam flow Condensate flow HP steam flow (measured) CRN steam flow (measured) LP steam flow (measured) Columbiance	lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558	58,496 837,729 656,925 565,401 0	839,622 659,237 566,659 0	39,643 841,453 659,713 567,516 0	Not used Not used Not used
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Lankman fondum	lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558	58,496 837,729, 656,925 565,401 0	839,622 659,237 566,659 0	39,043 841,453 659,713 567,516 0	Not used Not used Not used
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge lookups HP to IP leakage	lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558	58,496 837,729 656,925 565,401 0 7 724	839,622 659,237 566,659 0 7 744	59,043 841,453 659,713 567,516 0	Not used Not used Not used Design value from table (leakage 1)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leckage Iookups HP to LP leakage Gland LP leakage	lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41	33,622 659,237 566,659 0 7,744 3,519,63	55,043 841,453 659,713 567,516 0 7,764 3,530,35	Not used Not used Not used Design value from table (leakage 1) Design value from table (leakage 2)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge lookups HP to LP leakage Gland LP leakoff (HP side) Gland LP leakoff (HP side)	lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440.00 500.00	58,496 837,729 656,925 565,401 0 7,724 3,509.41 612,49	839,622 659,237 566,659 0 7,744 3,519,63 612,60	53,043 841,453 659,713 567,516 0 7,764 3,530.35	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 2)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokage lookups HP to LP leakage Gland LP leakoff (HP side) Calaud Leokaff (HP side)	lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,669,21	833,622 659,237 566,659 0 7,744 3,519.63 612.60 2.68 44	3,5,643 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668 56	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leakage lookups HP to LP leakage Gland LP leakoff (HP side) Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (IP side)	lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 3,440,00 590,00 2,680,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1023,64	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1023,77	5,9,643 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1023,89	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3)
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge lookups HP to LP leakage Gland LP leakaff (HP side) Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side)	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023.77	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leckage lookups HP to LP leakage Gland LP leakage Gland LP leakage Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Constant Onesures	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023.77	3,5,6,43 841,453 659,713 567,516 0 7,764 3,530.35 612,72 2,668.56 1,023.89	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge Lookups HP to LP leakage Gland LP Leakoff (HP side) LP gland sealing steam Gland subatmospheric Leakoff (HP side) LP gland sealing steam Gland subatmospheric Leakoff (LP side) Corrected HP Steam Perssure	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769 65	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokage lookups HP to LP leakage Gland LP leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected HP Steam Pressure	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,020,00 1,729,30 432,10	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69	839,622 659,37 566,659 0 7,744 3,519,63 612.60 2,668,44 1,023.77 1,767,55 432,25	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432 88	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge Lookups Giand LP leakoff (HP side) Giand subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected CRH Steam Pressure	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00 1,020,00 432,10 398,50	58,496 837,729 656,925 565,4011 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,023,64 430,69 450,69 450,69 40 40 40 40 40 40 40 40 40 40 40 40 40	839,622 659,237 566,659 0 7,744 3,519,63 612.60 2,668,44 1,023.77 1,767.55 432,25 432,25 432,27	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,023,89 1,023,89 1,069,85 432,88 432,88 432,88	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) CRH steam flow (measured) Calculations Lockage lookups HP to LP leakage Gland LP leakaff (HP side) UP gland sealing steam Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam Pressure	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 84,60	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023.77 1,767,55 432,25 407,35 432,25	35,043 841,453 659,713 567,516, 0 7,764 3,530,355 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 9,91	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leckage lookups HP to LP leakage Gland LP leakoff (HP side) Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected CRH Steam Pressure Corrected CRH Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 5,990,00 2,680,00 1,020,00 1,020,00 1,729,30 432,10 398,50 91,40	58,496 837,729 656,925 565,401, 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 89,60	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 432,25 432,25 407,35 90,01	35,643 841,453 659,713 567,516, 0 7,764 3,530,35 612.72 2,668.56 1,023.89 1,769,85 432,88 407,96 90,18	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokage lookups Gland LP leakage Gland LP leakolf (HP side) Calculations Leokage lookups HP to LP leakage Gland Subatmospheric leakolf (HP side) LP gland sealing steam Gland subatmospheric leakolf (LP side) Corrected AP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,023,64 1,023,64 1,063,63 430,69 400,86 89,60	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 1,767,55 432,25 407,35 90,01	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,028,85 432,88 407,96 90,18	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Measured LP steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Lackage lookups HP to LP leakage Gland LP leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected LP Steam Pressure	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 5,90,00 2,680,00 1,020,00 1,020,00 1,729,30 432,10 398,50 91,40	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 89,60 20195,20	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 1,767,55 432,25 407,35 90,01	35,643 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Lenkage clookups Gland LP leakage Gland LP leakaff (HP side) UP gland sealing steam Gland subatmospheric leakoff (HP side) DP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected Pressures Corrected Pressures Corrected VRH Steam Pressure Corrected LRH Steam Pressure Corrected LRH Steam Pressure Corrected LRH Steam Pressure Corrected LRH Steam Pressure Level Change How Calculations HP drum level change	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 3,440,00 5,90,00 2,680,00 1,020,00 1,729,30 432,10 3,98,50 91,40	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 430,586 89,60 20195,20 -7	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 432,25 407,35 432,25 407,35 90,01	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Ecology Ecology Calculations Ecology Ecology Gland Subatmospheric leakoff (HP side) LP gland sealing steam Gland Subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam Pressure Corrected LP Steam Pressure Corr	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 5,90,00 1,020,00 1,729,30 432,10 3,98,50 91,40	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 89,60 20195,20 -7 -2 -2	839,622 659,37 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 1,767,55 432,25 407,35 90,01	35,643 841,453 659,713 567,516 0 7,764 3,3503,5 612,72 2,668,56 1,022,89 1,769,85 432,88 407,96 90,18 0 -1	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge Lookups HP to LP leakage Gland LP leakoff (HP side) Calculations Leokoge Lookups Gland subatmospheric Leakoff (HP side) LP gland sealing steam Gland subatmospheric Leakoff (LP side) Corrected Pressure Corrected Pressure Corrected Christeam Pressure Corrected CHH Steam Pressure Level Change Flow Calculations HP drum level change LP drum level change	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 5,90,00 2,680,00 1,020,00 4,22,10 3,98,50 9,140 9,140 0 0 0	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 430,69 405,86 89,60 20195,20 -7 7 2 14	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 4,2225 407,35 90,01 -1 0 0,288	35,043 841,453 659,713 567,516 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 90,18	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3) Design value from table (leakage 5) Negative indicates water stored in drum
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) CRH steam flow (measured) Caludations Lookage lookups HP to LP leakage Gland LP leakaff (HP side) LP gland sealing steam Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected CH Steam Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam Pressure Corrected HRH Steam Pressure Corrected HRH Steam Pressure Corrected HRH Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure Level Change How Calculations HP drum level change LP drum level change LP drum level change	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40 0 0 0 0	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,023,64 430,69 405,86 89,60 20195,20 -7 -2 14 71 -2 2 14	839,622 659,37 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 4,767,55 432,25 407,35 90,01 -1 0 28 27 29,02	35,043 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 400,96 90,18 0 -1 1,33 87 0 200	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 4) Design value from table (leakage 5)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge Lookups HP to LP leakage Gland LP leakoff (HP side) Calculations Leokoge Lookups Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected CRH Steam Pressure Corrected CRH Steam Pressure Corrected CRH Steam Pressure Corrected HB Steam Pressure Corrected CRH Steam Pressure COR CH Steam Pressure CH Steam Pressure CH Steam Pressure CH Steam Pressure CH Steam Pressure CH Steam Pressure C	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00 1,020,00 432,10 398,50 91,40 0 0 0 0 0 0 0 0 0	58,496 837,729 656,925 565,401 7,724 3,509,41 612,48 2,668,31 1,023,64 430,69 405,86 89,60 20195,20 -7 7 -2 14 4 71 33,99	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 432,25 407,35 90,01 -1 0 0 28 8 27 39,8	35,643 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 0 -1 -1 -13 87 33,88	Not used Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3) Design value from table (leakage 5) Negative indicates water stored in drum
Mesarred LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) CRL steam flow (measured) Calculations Leokage lookups HP to LP leakage Gland LP leakolf (HP side) Calculations Leokage lookups HP to LP leakage Gland Subatmospheric leakolf (HP side) LP gland sealing steam Gland subatmospheric leakolf (LP side) Corrected AP Steam Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam Pressure Corrected LP Steam Pressure Corrected LP Steam Pressure LP of LP devel change LP drum level change LP drum level change Hotwell level change	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,023,64 405,86 89,60 20195,20 -7 -7 -2 2 14 71 39,9 50,1	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,022,77 1,767,55 432,25 407,35 90,01 -1 0 0 28 27 39,88 50,1	35,043 841,453 659,713 0 7,764 3,530,35 612,72 2,668,56 1,022,89 1,769,85 432,88 407,96 90,18 407,96 90,18 1,73 87 3,88 3,50,15 1,73 1,74 3,50,25 1,75 2,668,56 1,022,89 1,769,85 4,32,88 407,96 90,18 1,75 9,75 4,32,88 407,96 90,18 1,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 1,75 4,75 1,75 4,75 1,75 4,75 1,75 1,75 1,75 1,75 1,75 1,75 1,75 1	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5) Negative indicates water stored in drum 42'-11" x 11'-10" hotwell Saturated at pressure Saturated at pressure
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Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Calculations Calculations Calculations Leokage lookups Leokage lookups LP gland selland the steap Gland LP leakage Gland LP leakage Gland LP leakage Gland Subatmospheric leakoff (HP side) LP gland sellang steam Gland subatmospheric leakoff (LP side) LP gland sellang steam Gland Subatmospheric leakoff (LP side) Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HB Steam Pressure Corrected Steam Pressure Corrected Steam Pressure Corrected HB Ste	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 5,990,00 2,680,00 1,020,00 0,00	58,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 89,60 20195,20 7 7 2 14 71 39,9 50,1 561,1 561,1 51,7 2,284,4	839,622 659,37 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 1,767,55 432,25 407,35 90,01 0 2,88 407,35 90,01 0 2,88 90,01 0 2,88 90,01 0 2,88 90,01 0 2,88 90,01 0 0 2,88 90,01 0 0 2,88 90,01 0 0 2,88 90,01 0 0 2,88 90,01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	35,643 381,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 400,96 400,	Not used Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5) Negative indicates water stored in drum 42'-11" x 11'-10" hotwell Saturated at pressure Saturated at pressure Saturated at pressure Saturated at pressure
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokage (lookups HP to LP leakage Gland LP leakoft (HP side) LP gland sealing steam Gland Subatmospheric leakoft (HP side) LP gland sealing steam Gland Subatmospheric leakoft (LP side) Corrected Pressure Corrected Pressure Corrected Pressure Corrected RHS Steam Pressure Corrected RHS Steam Pressure Corrected HRS Steam Pressure Corrected HRS Steam Pressure Corrected HRS Steam Pressure Corrected IP Steam Pressure Corrected IP Steam Pressure LP drum level change LP drum level change Hotwell level change Hotwell level change Hotwell level change LP drum level change Hotwell level change Hotwell density HP drum level change flow Hotwell density HP drum level change flow Hotwell density HP drum level change flow P drum level change flow P drum level change flow	Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h Ib/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40 0 0 0 0 0 0 0 0 0 0 0 0 0	58,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 3,509,41 1,023,64 430,69 405,86 89,60 20195,20 -7 -2 20195,20 -7 -2 1,10 39,9 50,11 56,1 1,61,7 -298,4 -100,55 -208,4 -100,55 -208,4 -100,55 -208,4 -100,55 -208,4 -100,55 -208,4 -100,55 -208,4 -100,55 -208,45 -205,45 -20,	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 42,25 407,35 90,01 -1 0 28 8 90,01 -1 0 28 8 50,1 56,1 56,1 56,1 56,1 56,1 56,1 56,1 56	35,643 841,453 659,713 567,516 0 7,764 3,530.35 612,72 2,668,56 1,023,89 432,88 407,96 90,18 0 -1 -1 -1 -3 87 7 39,88 50,1 -1 -1 -3 85 -1 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3) Design value from table (leakage 5) Negative indicates water stored in drum 42'-11" x 11'-10" hotwell Saturated at pressure Saturated at pressure Saturated at pressure Saturated at pressure Saturated at pressure
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) CRH steam flow (measured) Calculations Leakoge lookups HP to LP leakage Gland LP leakage (Jand LP leakage (Jand Subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Curected CH Steam Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HBH Ste	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	38,496 837,729 656,925 565,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 1,763,63 430,69 405,86 89,60 20195,20 20195,20 7 7 2 2 14 7 1 39,99 50,11 56,11 61,7 7 2,284 4 ,100,55 81,2	839,622 659,37 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 5 432,25 407,35 90,01 -1 0 2,88 2,97 39,88 50,1 56,1 61,8 50,1 56,1 61,8 7,70,5 52,2 3,103,6 1,00 56,2 1,00 56,2 1,00 50,2 50,2 50,2 50,2 50,2 50,2 50,2 5	35,643 841,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 90,18 407,96 407,9	Not used Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3) Design value from table (leakage 5) Negative indicates water stored in drum 42 <sup>1</sup> ·11 <sup>*</sup> x 11 <sup>1</sup> ·10 <sup>*</sup> hotwell Saturated at pressure Saturated at pressure I hour test periods (except TR2) I hour test periods (except TR2)
Measured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) IP steam flow (measured) Calculations Leokoge lookups HP to LP leakage Gland LP leakoff (HP side) Calculations Leg Jand sealing steam Gland subatmospheric leakoff (HP side) LP gland sealing steam Gland subatmospheric leakoff (LP side) Corrected Pressures Corrected Pressures Corrected Pressures Corrected RHS Steam Pressure Corrected HRS Steam Pressure Corrected HRS Steam Pressure Corrected HRS Steam Pressure Corrected HRS Steam Pressure Corrected IP Steam Pressure Corrected IP Steam Pressure Corrected IP Steam Pressure Level Change How Calculations HP drum level change Hotwell level change Hotwell level change Hotwell density HP drum level change flow LP drum level change flow	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 590,00 2,680,00 1,020,00 432,10 398,50 91,40 0 0 0 0 0 0 0 40,11 50,33 56,88 62,11 0,000 0,000	58,496 837,729 656,925 565,401 0 7,724 3,509,41 1,023,64 1,763,63 430,69 405,86 89,60 20195,20 -7 -2 14 71 39,99 50,11 56,11 61,7 -298,4 -1005,51 812,55 812,5	839,622 659,237 566,659 0 7,744 3,519,63 612,60 2,668,44 1,023,77 1,767,55 432,25 407,35 90,01 -1 0 28 8 50,1 56,1 61,8 -70,7 39,8 50,1 56,1 61,8 -70,7 35,2 3,103,6 3,379,9	35,643 341,453 659,713 567,516 0 7,764 3,530,35 612,72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 0 0 -1 -13 3,87 398,8 5,011 5,611 611,8 -2,4 -68,77 -715,2 5,391,5	Not used Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 3) Design value from table (leakage 5) Regative indicates water stored in drum A2'-11" x 11'-10" hotwell Saturated at pressure Saturated at pressure Saturated at pressure Saturated at pressure 1 hour test periods (except TR2) 1 hour test periods (except TR2) 1 hour test periods (except TR2)
Mesured LP Steam flow Condensate flow HP steam flow (measured) CRH steam flow (measured) LP steam flow (measured) Calculations Leokage lookups Gland LP leokaft (HP side) Gland Subatmospheric leokoft (HP side) LP gland seiling steam Gland subatmospheric leokoft (LP side) Corrected Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HP Steam Pressure Corrected HRH Steam	lb/h lb/h lb/h lb/h lb/h lb/h lb/h lb/h	62,310 1,361,460 1,060,028 607,840 153,558 7,550 3,440,00 2,680,00 1,020,00 1,729,30 432,10 398,50 91,40 0 0 0 0 0 0 0 0 0 0 0 0 0	38,496 837,729 656,925 555,401 0 7,724 3,509,41 612,48 2,668,31 1,023,64 405,86 89,60 20195,20 7 7 2 2 14 71 39,9 50,1 56,1 61,7 7,-288,4 -7,248,4 71 39,9 50,1 56,1 61,7 7,248,4 71 56,1 61,7 7,248,4 7,1 8,105,5 812,5 5,4,362,5 7,244,4 7,105,5 812,5 7,244,4 7,105,5 812,5 7,244,4 7,105,5 812,5 7,244,4 7,105,5 812,5 7,244,5 7,105,5 7,1	839,622 659,37 566,659 0 7,744 3,519,63 612.60 2,668.44 1,023.77 1,767,55 432,25 407,35 90.01 -1 0 8 27 39,8 50.1 56.1 61.8 -70.7 39,8 50.1 56.1 61.8 -70.7 35,2 3,103.6 8,3,779,9	35,643 841,453 659,713 567,516 0 7,764 3,330,35 612.72 2,668,56 1,023,89 1,769,85 432,88 407,96 90,18 0 -1 -1 -1 -3 87 39,88 50,11 61,8 -2,44 -68,7 -7152 5,391,5 -7152 -7	Not used Not used Design value from table (leakage 1) Design value from table (leakage 2) Design value from table (leakage 3) Design value from table (leakage 4) Design value from table (leakage 5) Negative indicates water stored in drum 42'-11" x 11'-10" hotwell Saturated at pressure Saturated at pressure Saturated at pressure Saturated at pressure 1 hour test periods (except TR2) 1 hour test periods (except TR2) 1 hour test periods (except TR2)

Description	Unit	Design	GREC U3 STG Test Run 1	Calculation Test Run 2	Test Run 3	Notes
HP steam flow CRH steam flow	lb/h lb/h	631,100 607,840	647,509 575,740	650,374 578,575	650,630 578,799	HP FW + HP DSH + TCA - FGH Extraction + HP Drum Level - HPS to CT Cooling Steam HP Steam - STG leakages
IP steam flow	lb/h	139,600	138,486	140,242	140,482	IP FW + IP Drum Level
IP and CTG cooling steam	lb/h	139,600	138,921	140,539	140,713	IP Steam + HPS to CT cooling steam + HPS to CT cooling steam DSH
HRH steam flow	lb/h	747,430	714,661	719,114	719,512	CRH Steam + IP and CTG cooling steam
LP steam flow STG exhaust flow (calculated)	lb/h lb/h	55,420 823,740	58,496 842,449	59,324 847,749	59,643 848.487	LP Steam flow HRH Steam + IP steam + HP to IP - IP leakages
STG exhaust flow (condensate)	lb/h	823,740	837,729	839,622	841,453	
Leakage out of cycle Leakage out of cycle (% of condensate flow)	lb/h %	0 0.00%	4,776 0.57%	6,448 0.77%	4,605 0.55%	Should be less than 0.25%
Leakage adjusted flows		524.400	640.064		<b>C17</b> 440	Leakage subtracted on flow weighted basis as noted
HP steam flow (leakage adjusted) CRH steam flow (leakage adjusted)	lb/h lb/h	631,100 607,840	643,861 572.091	645,448 573,649	647,112	
IP steam flow	lb/h	139,600	138,486	140,242	140,482	
IP and CTG cooling steam (leakage adjusted)	lb/h lb/b	139,600	138,114	139,449	139,935	
LP steam flow	lb/h	55,420	58,496	59,324	59,643	
STG exhaust flow (calculated) STG exhaust flow (condensate)	lb/h lb/h	823,740 823,740	837,994 837,729	841,734 839,622	844,191 841,453	
Evolution Dower						
Generator MVA	MVA	168.1	143.2	144.1	144.2	
Excitation current	A	1,795	1,356	1,361	1,359	From V curve
Field Ioss Thyristor loss	kW kW	297	1/0	1/2	1/1	Design value
Excitation transformer Loss	kW	25	25	25	25	Design value
Total excitation loss	kW	338	211	213	212	Sum of losses
Enthalpy/Entropy			1 540 0	1 500 4	4 500.0	
HP steam entropy	btu/lb-F	1,514.4	1,510.8	1,509.1	1,508.8	
CRH steam enthalpy	btu/lb	1,345.5	1,351.8	1,350.5	1,350.4	
CRH steam entropy	btu/lb-F	1.6169	1.6227	1.6213	1.6210	
HRH steam entropy	btu/lb btu/lb-F	1,550.7	1,551.0	1,549.3	1,549.0	
LP steam enthalpy	btu/lb	1,278.6	1,287.0	1,286.9	1,286.7	
LP steam entropy	btu/lb-F	1.7178	1.7287	1.7281	1.7277	
Correction Parameters Reheater Pressure Drop	%	7.78%	5.77%	5.76%	5.76%	
HP steam specific volume	ft^3/lb	0.48	0.47	0.47	0.47	
Stodola's law of ellipse correction 'S' Change in flow capacity	- %	1.0000 0.00%	0.9983 -0.39%	0.9984 -0.48%	0.9984	Using IP Steam + CTG Cooling steam
UD Evidence Enthelmu on BU hast consumption parameters						
Test adjusted HRH pressure	psia	398.50	399.90	400.26	399.84	Using IP Steam + CTG Cooling steam
Test adjusted HRH enthalpy	btu/lb	1550.71	1550.68	1550.67	1550.68	
Change in test adjusted HRH enthalpy	btu/lb	0.00	-0.04	-0.05	-0.04	
HP section available energy at design conditions	psia btu/lb	432.10	433.62	434.01 185.5	433.55	
HP section available energy at test adjusted conditions	btu/lb	185.55	185.15	185.04	185.16	
HP turbine efficiency Change in HP exhaust enthalow	% htu/lb	91.02%	84.96%	85.01%	85.00%	
HP turbine leakage fraction	%	3.69%	11.15%	11.12%	11.10%	
Change in HP steam flow	lb/h	0.0	4,641.3	4,644.1	4,607.6	
Test adjusted HP steam flow	lb/h	631,100	626,459	626,456	626,492	Design - change
HP Exhaust Flow on RH heat consumption parameters Change in HP turbine leakage fraction	%	0.00%	7.46%	7.44%	7.41%	
Less than design leakage (HP steam flow)	16.76		6 072 0	C 050 0	C 020 2	
Test adjusted HP steam flow	lb/h	631,100	624,228	624,249	624,272	Design - change
Greater than design leakage (reheat spray flow) Change in RH DSH spray flow	lb/h	0.0	8,797.3	8,770.4	8,742.4	Not used as there's no RH DSH
Test adjusted IP steam flow	lb/h	139,600	130,803	130,830	130,858	Design - change
Unfired Corrections						
HP steam flow correction	kW	0.0	2,564.1	2,879.1	3,212.0	
HP steam temperature correction	kW	0.0	-166.5	-267.6	-277.9	
HP turbine flow capacity correction	kW	0.0	54.9	67.9	52.4	
Reheater pressure drop correction	kW kW	0.7	371.0	373.1	374.6	Using IP steam + CTG cooling steam
HP exhaust enthalpy effect on reheater heat consumption correction	kW	0.0	-978.9	-979.4	-971.7	
HP exhaust flow effect on reheater heat consumption correction	kW	0.0	-1,449.3	-1,444.9	-1,440.1	Always using HP steam flow correction. No RH DSH
HP steam flow correction Reheat spray flow correction	kW kW	0.0	-1,449.3 -1.203.6	-1,444.9 -1.200.0	-1,440.1 -1.196.1	Not used as there's no RH DSH
LP steam flow and enthalpy correction	kW	0.0	307.5	369.0	391.9	
Exhaust pressure correction	kW	0.0	-4,478.9	-4,096.8	-4,118.5	
H2 gas pressure correction	kW	0.0	42.1	42.5	42.8	
Deterioration	kW	0.0	0.0	0.0	0.0	
Sum of unfired corrections	kW	0.8	-3,880.3	-3,238.2	-2,892.8	
linfirad						
STG net power output	kW	150,066.5	142,663.6	143,530.0	143,707.7	Gross - Aux - Excitation
Corrected STG net power output	kW	150,065.8	146,543.9	146,768.2	146,600.5	Net - corrections

GREC U3 STG Unfired Results										
Description	Unit	Guarantee	Test Run 1	Test Run 2	Test Run 3	Average TR 1-3	Pass/Fail	Notes		
STG Net Output Corrected STG Net Output Margin	kW kW kW	- 150,330	142,664 146,544 -3,786	143,530 146,768 -3,562	143,708 146,600 -3,730	143,300 146,638 -3,692	Eail			
Margin	%		-2.52%	-2.37%	-2.48%	-2.46%	Tan			

**APPENDIX B** 

**UNIT STABILITY ANALYSIS**
						GRE	EC EPC Te	est Stabilit	y						
	Parameter	Inlet Tempe	t Air erature	Baror Pres	netric sure	Power	Output	Plant In Pres	ilet Gas sure	Fuel	Flow	Exh Backpr	aust ressure	Elect Frequ	rical ency
	Test Period 1	79.	3°F	14.43	PSIA	307,54	47 KW	695.8	PSIA	43976.9	9 SCFM	15.4 i	nH2O	3600.3	RPM
Averages	Test Period 2	75.4	4°F	14.42	PSIA	311,86	60 KW	695.2	PSIA	44410.3	3 SCFM	15.5 i	nH2O	3599.9	RPM
	Test Period 3	74.	1°F	14.42	PSIA	313,0 <sup>-</sup>	17 KW	695.2	PSIA	44567.3	3 SCFM	15.6 i	nH2O	3600.2	RPM
	Max Test Deviations	1.3	3°F	0.3	3%	1.3	3%	0.6	5%	1.3	3%	0.3	3%	0.6	5%
A shuel Test	Test Period 1	0.56	Pass	0.01%	Pass	0.00%	Pass	0.05%	Pass	0.26%	Pass	0.27%	Pass	0.00%	Pass
Actual Test Stability	Test Period 2	0.25	Pass	0.01%	Pass	0.00%	Pass	0.04%	Pass	0.30%	Pass	0.11%	Pass	0.00%	Pass
Otability	Test Period 3	0.88	Pass	0.01%	Pass	0.00%	Pass	0.04%	Pass	0.40%	Pass	0.32%	Pass	0.00%	Pass

**APPENDIX C** 

**TEST UNCERTAINTY ANALYSIS** 

bar         bar <th>Column</th> <th colspan="6">Plant Net Test Result Uncertainty TR 1</th> <th></th> <th></th> <th>Plant Net Outn</th> <th>ut (kW)</th> <th></th> <th>Plant</th> <th>Not Host Rate    </th> <th>W (Btu/kWb</th> <th>4</th>	Column	Plant Net Test Result Uncertainty TR 1								Plant Net Outn	ut (kW)		Plant	Not Host Rate	W (Btu/kWb	4	
bit         bit<	countri			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tiny	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	OB <sub>xbar</sub>	Θs <sub>sbar</sub>	450,543	θ	OB <sub>xbar</sub>	OS <sub>xbar</sub>	5,718
Horizon         Horizon <t< th=""><th>Description</th><th>Units</th><th>Mean</th><th>Instrument</th><th>Spatial</th><th>Total Systematic</th><th>Student T</th><th>Random</th><th>Total Random</th><th>Sensitivity</th><th>Systematic</th><th>Random</th><th>Total</th><th>Sensitivity</th><th>Systematic</th><th>Random</th><th>Total</th></t<>	Description	Units	Mean	Instrument	Spatial	Total Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total	Sensitivity	Systematic	Random	Total
Unit         Unit <th< th=""><th></th><th></th><th></th><th>Systematic</th><th>Systematic</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>.,</th><th></th><th></th></th<>				Systematic	Systematic										.,		
		T	units	units	units	units	units	units	units	units/units	units	units	units	units/units	units	units	units
	Power Measurements CTG generator gross power output	kW	307 546 52			1 340 564			157.939	1.052	1 410 227	166.147	1 419 981	-0.013	-17.888	-2.107	18.011
Changember bareP00.00	CTG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	3,932.031	17.244	0.388	17.249	-49.873	-0.219	-0.005	0.219
Signama proper warding       No.       Signama proper warding       No.       Signama proper warding	CTG generator frequency	HZ	60.00	0.000	0.000	0.000	1.980	0.001	0.002	-4,118.821	0.000	-10.132	10.132	-12.001	0.000	-0.030	0.030
Displayment burkImage: Displayment burkDisplayment burk <t< td=""><td>STG generator gross power output</td><td>kW</td><td>142 949 10</td><td></td><td></td><td>623 101</td><td></td><td></td><td>20.038</td><td>1.053</td><td>655 989</td><td>21.096</td><td>656.328</td><td>-0.013</td><td>-8.320</td><td>-0.268</td><td>8 325</td></t<>	STG generator gross power output	kW	142 949 10			623 101			20.038	1.053	655 989	21.096	656.328	-0.013	-8.320	-0.268	8 325
Mathemathemathemathemathemathemathemathem	STG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	1,484.745	6.523	0.162	6.525	-18.832	-0.083	-0.002	0.083
Non-book of the set of the																	
	UAT low side power UAT low side power factor	- KW	8,564.02	0.004	0.000	37.682	1.980	0.000	0.000	-1.054	-39.716	0.000	41.280	0.013	0.000	0.143	0.524
add m d and m d and         add	RAT low side power	kW	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Change weight point	KAT IOW side power factor	-	0.01	0.004	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NNLA23SA3<	CTG excitation current	А	2,020.46	101.023	0.000	101.023	1.980	0.752	1.489	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
And Andersensity         No.         And	STG excitation current	<u>^</u>	1 407 26	70 262	0.000	70 262	1 090	0 507	1.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
non-discussive discussive discusside discusside discusside discusside d	Sid excitation current	<u>^</u>	1,407.20	70.505	0.000	70.303	1.500	0.507	1.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
And sectorsAnd secto	Non-design auxiliary loads	kW	0.00	0.000	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
interpartment interpartment interpartment options and preserve with the preserve due to any options and preserve due to any options an	Pressure Mensurements																
not all properties understand understand under understand under und	Barometric pressure	psia	14.43	0.005	0.096	0.096	1.980	0.000	0.000	-33,110.093	-3,190.814	-6.038	3,190.820	0.032	0.003	0.000	0.003
Image Among <td>Fuel gas pressure upstream compressor suction</td> <td>psig</td> <td>695.78</td> <td>0.696</td> <td>0.000</td> <td>0.696</td> <td>1.967</td> <td>0.017</td> <td>0.034</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td>	Fuel gas pressure upstream compressor suction	psig	695.78	0.696	0.000	0.696	1.967	0.017	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
masses plating         masses	Temperature Measurements																
Addaming ACC         N         0.70         0.00         0.00         0.001 <th< td=""><td>Ambient dry bulb temperature at CTG</td><td>Deg F</td><td>79.31</td><td>0.250</td><td>0.060</td><td>0.257</td><td>1.980</td><td>0.016</td><td>0.032</td><td>1,104.827</td><td>284.000</td><td>35.360</td><td>286.193</td><td>-0.553</td><td>-0.142</td><td>-0.018</td><td>0.143</td></th<>	Ambient dry bulb temperature at CTG	Deg F	79.31	0.250	0.060	0.257	1.980	0.016	0.032	1,104.827	284.000	35.360	286.193	-0.553	-0.142	-0.018	0.143
Control while integration         Det F         77.9         10.00         6.02         6.030         6.030         6.00	Ambient RH at CTG	%	0.76	0.020	0.000	0.020	1.980	0.001	0.003	-4,820.311	-96.406	-12.811	97.254	-24.582	-0.492	-0.065	0.496
Desk         Part         Disk         Disk <thdisk< th="">         Disk         Disk         <thd< td=""><td>Cooling tower dry bulb temperature</td><td>Deg F</td><td>77.07</td><td>0.100</td><td>6.042</td><td>6.043</td><td>1.980</td><td>0.028</td><td>0.055</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></thd<></thdisk<>	Cooling tower dry bulb temperature	Deg F	77.07	0.100	6.042	6.043	1.980	0.028	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Car Labor         Car Labor <thcar labor<="" th=""> <thcar labor<="" th=""> <thc< td=""><td>Fuel gas temperature at outlet of regulating station</td><td>Deg F</td><td>68.72</td><td>0.730</td><td>0.001</td><td>0.730</td><td>1.967</td><td>0.014</td><td>0.019</td><td>-2.046</td><td>-1.494</td><td>-0.038</td><td>143.103</td><td>0.026</td><td>0.019</td><td>0.000</td><td>0.019</td></thc<></thcar></thcar>	Fuel gas temperature at outlet of regulating station	Deg F	68.72	0.730	0.001	0.730	1.967	0.014	0.019	-2.046	-1.494	-0.038	143.103	0.026	0.019	0.000	0.019
Control         W         Dist         Dist <thdis< th="">         Dist         Dist         D</thdis<>																	
Corrected (3) equations tangent (as (as (b)))         (a) (a) (b) (a) (b) (b) (b) (b) (b) (b) (b) (b) (b) (b	CTG Test Data	kw.	325 123 17	1 850 215	0.000	1 850 215			0.000	-1.008	-1 864 964	0.000	1 864 964	-0.005	-9.963	0.000	9 963
Corrected (15 shuft, theorem         h/h         (4,9,4,4,00)         (2,29) 3.79         0.00         (2,19) 3.19         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0	Corrected CTG equipment net heat rate (LHV)	btu/kWh	8,326.44	348.599	0.000	348.599			0.000	-0.483	-168.451	0.000	168.451	-0.690	-240.703	0.000	240.703
Corrected (16) bits interminant matrix mat	Corrected CTG exhaust flow	lb/h	4,943,461.00	82,309.379	0.000	82,309.379			0.000	-0.027	-2,192.383	0.000	2,192.383	0.000	27.808	0.000	27.808
Christer (12) config datem energy         methy         3.23         0.023         0.024         0.000         0.227         0.46.43         0.000         0.47.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.27.7         1.20         0.00         1.07         0.00	Corrected CTG exhaust temperature	Deg F	1,173.82	4.805	0.000	4.805			0.000	-209.015	-1,004.316	0.000	1,004.316	2.651	12.738	0.000	12.738
And back back back back back back back back	Corrected CTG cooling steam energy	mmbtu/h	28.98	0.625	0.000	0.625			0.000	-152.706	-95.415	0.000	95.415	1.937	1.210	0.000	1.210
MC influence         MC influence<																	
$ \begin{array}{c} \mbox{created} \mbox field \mbox f$	Corrected HRSG HP steam flow rate	lb/b	617 730 00	617 730	0.000	617 730			0.000	-0.075	-46 407	0.000	46 407	0.001	0 589	0.000	0 589
Corrected HisG I stam flow rate         h/h         146.738         0.00         16.738         0.00         1.05.73         0.00         0.00         0.000         <	Corrected HRSG HP steam temperature	Deg F	1,046.60	1.047	0.000	1.047			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrected HSG Pistem from importance         Def P         1573         0.000	Corrected HRSG IP steam flow rate	lb/h	146,738.00	146.738	0.000	146.738			0.000	-0.148	-21.657	0.000	21.657	0.002	0.275	0.000	0.275
corrected HigG LP stane flow rule         b/n         68.022 00         68.022 00         68.022 00         68.022 00         68.022 00         6.037         4.733 000         2.135 000         0.035 000 </td <td>Corrected HRSG IP steam flow temperature</td> <td>Deg F</td> <td>573.40</td> <td>0.573</td> <td>0.000</td> <td>0.573</td> <td></td> <td></td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td>	Corrected HRSG IP steam flow temperature	Deg F	573.40	0.573	0.000	0.573			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrected HIGG 2 heam temperature         Deg F         507.00         0.027         0.000         0.027         0.000         0.028         0.000	Corrected HRSG LP steam flow rate	lb/h	68,082.00	68.082	0.000	68.082			0.000	-0.070	-4.733	0.000	4.733	0.001	0.060	0.000	0.060
Corrected HIGS phase pressure drop         mirCo         1.1.44         0.0.03         0.0.01         1.1.44         0.0.03         1.1.59         4.0.20         0.0.00         0.0.	Corrected HRSG LP steam temperature	Deg F	507.00	0.507	0.000	0.507			0.000	-4.329	-2.195	0.000	2.195	0.055	0.028	0.000	0.028
Corrected HRSG Auxiliary Power output         W         386.70         0.389         0.000         0.000	Corrected HRSG gas side pressure drop Corrected HRSG reheater pressure drop	inH2O nsi	15.44	0.015	0.000	0.015			0.000	141.480 25.974	2.184	0.000	2.184	-1.795	-0.028	0.000	0.028
SP cet bair Corrected SF equipment net power output         W         146,544         146,544         146,544         146,544         146,544         146,544         146,544         146,544         0.00         146,544         0.00         147,57         0.00         147,57         0.01         147,57 <td>Corrected HRSG Auxiliary Power</td> <td>kW</td> <td>368.70</td> <td>0.369</td> <td>0.000</td> <td>0.369</td> <td></td> <td></td> <td>0.000</td> <td>1.000</td> <td>0.369</td> <td>0.000</td> <td>0.369</td> <td>-0.013</td> <td>-0.005</td> <td>0.000</td> <td>0.005</td>	Corrected HRSG Auxiliary Power	kW	368.70	0.369	0.000	0.369			0.000	1.000	0.369	0.000	0.369	-0.013	-0.005	0.000	0.005
She Hardman         WM         146,544.00         1465.44         0.00         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.544         0.000         16.554         0.000         16.758         0.000         16.758         0.000         0.058         0.000         <																	
Design Data         W         11.20         0.560         0.000         0.560         -         0.000         -         0.560         0.000         0.550         0.013         0.007         0.000         0.007           CfG Thyrister Losses         W         11.20         0.562         0.000         0.655         -         0.000         0.659         0.000         0.659         0.001         0.007         0.000         0.001         0.	Corrected STG equipment net power output	kW	146.544.00	146.544	0.000	146.544			0.000	-1.007	-147.587	0.000	147.587	0.013	1.872	0.000	1.872
Decign Date         Number of the set of the			,														
Sh G myntatr losses       VW       11.20       0.290       0.000       0.050       -       0.000       0.050       0.000	Design Data		44.20	0.550	0.000	0.550			0.000	4.054	0.500	0.000	0.500	0.010	0.007	0.000	0.007
Calculate Flows         Instruction	CTG Thyristor Losses	kW kW	11.20	0.560	0.000	0.625			0.000	-1.054	-0.590	0.000	0.590	0.013	0.007	0.000	0.007
Carbon         by/h         127,242.17         -         7,314.126         -         768.760         0.000																	
Prain Fund         ID/I         12/14/17         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         -         //21/112         0.000 <td>Calculated Flows</td> <td>the dis</td> <td>127 242 17</td> <td></td> <td></td> <td>7 314 136</td> <td></td> <td></td> <td>769 760</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.047</td> <td>244.046</td> <td>36.356</td> <td>246 846</td>	Calculated Flows	the dis	127 242 17			7 314 136			769 760	0.000	0.000	0.000	0.000	0.047	244.046	36.356	246 846
Fred Analysis (lab)         mole %         90.29%         0.002         0.000         0.000         4.303         0.001         0.006         0.512         0.001         0.003         30.137         0.450         1.865         1.918           Propanc, C3H8         mole %         0.33%         0.001         0.000         0.001         4.303         0.001         0.000         1.3648         1.31484         0.016         0.049         0.212         0.025         6.313         1.412.419         0.204         0.217         0.011         0.000         0.001         4.303         0.000         0.000         1.514.87         6.322         6.313         1.412.419         0.249         0.210         0.317         0.013         0.177         0.013         0.177         0.013         0.175         1.514.77         6.135         1.241         0.242         6.315         1.241         1.348         1.024         6.313         0.031         0.175         1.5147         1.544         1.348         1.021         1.212         1.324         1.343         0.312         0.124         1.344         1.348         1.337         1.433         0.321         1.214         1.343         0.321         1.214         1.344         1.3568         1.21	HRSG DB Fuel Gas	lb/h	0.00			0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Face A above         read A above<																	
Interner, CH         Index         Jobs         Loco         Loco <thloco< th="">         Loco         <thloco< th="">         Loco         Loco</thloco<></thloco<>	Fuel Analysis (lab)	molo %	00.20%	0.002	0.000	0.002	4 202	0.001	0.006	0.512	0.001	0.002	0.002	200 197	0.450	1 965	1 019
Propanci C3H8         mole %         0.33%         0.001         0.000         0.001         4.303         0.000         1.21,24.545         1.4.868         1.0.11         1.3.33         -1.2.819         0.2.10         0.3.37           Nebtane, C4H10         mole %         0.02%         0.000         0.000         4.303         0.000         0.000         3.7.02.746         6.345         1.2.04         6.453         1.2.24         5.02         0.2.13         0.2.13         0.013         0.2.15         1.3.13         4.2.12         9.2.10         0.3.17         1.0.17         0.0.13         0.0.17         6.3.45         1.2.04         6.453         1.2.24         5.0.23         0.0.27         1.2.63.11         1.3.23         0.2.12         0.0.13         0.2.12         0.2.12         0.1.21         0.2.12         0.2.12         0.1.21         0.2.12         0.2.12         0.1.21         0.2.12         0.2.12         0.1.21         0.2.12         0.2.12         0.2.12         0.0.21         0.2.11         0.3.21         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12         0.2.12	Ethane, C2H6	mole %	6.85%	0.001	0.000	0.002	4.303	0.001	0.004	10,751.879	12.902	38.932	41.014	-13.648	-0.016	-0.049	0.052
lss-Batane, IC4H10         mole %         0.01%         0.000         0.000         0.000         4.303         0.000         31,511.74         6.302         0.452         6.319         -88.267         4.117         0.013         0.107           NBatane, IC4H10         mole %         0.00%         0.000         0.000         0.000         0.000         4.303         0.000         0.000         4.303         0.000         4.312         1.218         8.502         1.212.43         4.233         0.001         0.000         0.000         0.000         0.000         4.003         0.000         4.213.86         8.413         1.049         8.508         1.212.43         4.234         0.014         0.224         0.000 <td>Propane, C3H8</td> <td>mole %</td> <td>0.33%</td> <td>0.001</td> <td>0.000</td> <td>0.001</td> <td>4.303</td> <td>0.000</td> <td>0.001</td> <td>21,240.545</td> <td>14.868</td> <td>10.811</td> <td>18.383</td> <td>-412.819</td> <td>-0.289</td> <td>-0.210</td> <td>0.357</td>	Propane, C3H8	mole %	0.33%	0.001	0.000	0.001	4.303	0.000	0.001	21,240.545	14.868	10.811	18.383	-412.819	-0.289	-0.210	0.357
Housing, PC-H121         Index #         Dock # <thdock #<="" th="">         &lt;</thdock>	Iso-Butane, i-C4H10	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	31,511.874	6.302	0.452	6.319	-882.607	-0.177	-0.013	0.177
N-Pertane, n-C5H12       mole %       0.00%       0.000       0.000       4.303       0.000       4.213.896       8.443       1.049       8.508       1.21.2433       0.242       0.124       0.33       0.000       0.000         Heptane, C7H16       mole %       0.00%       0.000	Iso-Pentane, i-C5H12	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	42,058.001	8.412	1.204	8.502	-1,263.113	-0.163	-0.031	0.165
NHexane, n. C6H14         mole %         0.01%         0.000         0.000         0.000         2.7.8.53         10.5.44         4.0.84         11.307         1.6.6.417         -0.124         0.330           Detrane, c7.H15         mole %         0.00%         0.000	N-Pentane, n-C5H12	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	42,213.986	8.443	1.049	8.508	-1,212.433	-0.242	-0.030	0.244
Impair         Index 6         Dood         Code	N-Hexane, n-C6H14 Hostane, C7H16	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	52,718.631	10.544	4.084	11.307	-1,606.417	-0.321	-0.124	0.345
Nonanc, CH20         mole %         0.00%         0.000	Octane, C8H18	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Decame_C10H22         mole %         0.00%         0.000	Nonane, C9H20	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Interact	Decane, C10H22 Nitrogen, N2	mole % mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide, CO2         mole %         0.63%         0.001         0.000         0.001         4.303         0.000         4.6553         -12.311         -19.860         37.927         -14.96.028         -10.488         -6.453         12.312           Water, H2D         mole %         0.006         0.000	Carbon Monoxide, CO	mole %	0.00%	0.001	0.000	0.001	4.303	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water, H2O         mole %         0.00%         0.00         0.000	Carbon Dioxide, CO2	mole %	0.63%	0.001	0.000	0.001	4.303	0.000	0.000	-46,158.553	-32.311	-19.860	37.927	-14,996.928	-10.498	-6.453	12.322
Interest         Underst         <	Water, H2O	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Helium, He         mole %         0.04%         0.000         0.000         4.303         0.000         4.308         0.000         4.303         0.000         0.000         4.303         0.000	Hydrogen, H2	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oxygen, 02         mole %         0.00%         0.000         0.000         4.303         0.000	Helium, He	mole %	0.04%	0.000	0.000	0.000	4.303	0.000	0.000	-4,198.053	-0.840	0.000	0.840	-1,363.949	-0.273	0.000	0.273
Argun, Al         Intere #         UUUU	Oxygen, O2	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R55 4078.95 183.80 4083.09 R55 113.00 13.30 93.65 120.04		more 76	0.01%	0.000	0.000	0.000	4.503	0.000	0.000	-41,030.723	-0.360	0.000	0.500	-13,012.308	-2.723	0.000	2.123
				-						RSS	4078.95	183.80	4083.09	RSS	113.30	39.65	120.04

Column	Plant Net Test Result Uncertainty TR 2							Plant Net Outn	aut (kW)		Plant	Not Hoat Rate	W (Btu/kWb	,		
countri			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	ΘB <sub>xbar</sub>	θs <sub>sbar</sub>	450,389	θ	ΘB <sub>xbar</sub>	θs <sub>sbar</sub>	, 5,714
Description	Units	Mean	Instrument	Spatial Systematic	Total Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total	Sensitivity	Systematic	Random	Total
		units	units	units	units	units	units	units	units/units	units	units	units	units/units	units	units	units
Power Measurements		units	units	units	unto	units	units	units	units) units	units	units	units	units) units	units	units	units
CTG generator gross power output	kW	311,859.98			1,359.366			130.354	1.041	1,414.492	135.640	1,420.980	-0.013	-17.936	-1.720	18.018
CTG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	4,005.109	17.555	0.365	17.559	-50.783	-0.223	-0.005	0.223
Cid generator frequency	n2	80.00	0.000	0.000	0.000	1.960	0.001	0.002	-4,001.004	0.000	-11.050	11.050	-0.621	0.000	-0.016	0.016
STG generator gross power output	kW	143,925.25			627.356			26.417	1.041	653.316	27.510	653.895	-0.013	-8.284	-0.349	8.291
STG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	1,487.443	6.533	0.159	6.535	-18.860	-0.083	-0.002	0.083
UAT low side power	kW	8,579.31	37.749	0.000	37.749	1.980	5.920	11.721	-1.043	-39.357	-12.220	41.210	0.013	0.499	0.155	0.523
UAT low side power factor	-	0.81	0.004	0.000	0.004	1.980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BAT low side power	kW	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RAT low side power factor	-	0.81	0.004	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CTG excitation surrout		2 045 25	102 267	0.000	102.267	1 090	0.545	1.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
cro excitation current	<u>^</u>	2,045.55	102.207	0.000	102.207	1.500	0.545	1.078	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
STG excitation current	A	1,416.03	70.801	0.000	70.801	1.980	0.382	0.757	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Non-design auxiliany loads	kw.	0.00	0.000	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Non design downed y loads		0.00	0.000	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pressure Measurements																
Barometric pressure	psia	14.42	0.005	0.053	0.054	1.980	0.000	0.000	-33,146.582	-1,///./36	-5.015	1,777.743	9.873	0.530	0.001	0.530
8 F	PB															
Temperature Measurements	D	75.00	0.350	0.000	0.200	4 000	0.000	0.010	4 437 054		24 200		4 300	0.503	0.004	0.500
Ambient RH at CTG	Deg F %	/5.38	0.250	0.300	0.390	1.980	0.009	0.019	-4.077.394	-81.548	-5.283	444.520 81.719	-1.288 -23.942	-0.503	-0.024	0.503
Cooling tower dry bulb temperature	Deg F	73.07	0.100	9.463	9.464	1.980	0.010	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cooling tower wet bulb temperature	Deg F	70.66	0.100	0.539	0.548	1.980	0.002	0.004	193.964	106.297	0.865	106.300	-2.459	-1.348	-0.011	1.348
Fuel gas temperature at outlet of regulating station	Degr	67.94	0.750	0.000	0.750	1.967	0.015	0.029	-2.046	-1.495	-0.080	1.490	0.028	0.019	0.001	0.019
CTG Test Data																
Corrected CTG equipment net power output	kW htu/kW/h	325,603.42	1,852.948	0.000	1,852.948	-		0.000	-1.008	-1,867.692	0.000	1,867.692	-0.005	-9.960	0.000	9.960
Corrected CTG exhaust flow	lb/h	4,930,019.00	82,085.567	0.000	82,085.567			0.000	-0.027	-2,186.422	0.000	2,186.422	0.000	27.723	0.000	27.723
Corrected CTG exhaust temperature	Deg F	1,174.22	4.807	0.000	4.807			0.000	-209.072	-1,004.935	0.000	1,004.935	2.651	12.742	0.000	12.742
Corrected CTG rotor air cooler energy Corrected CTG cooling steam energy	mmbtu/h mmbtu/h	37.97	0.924	0.000	0.924			0.000	-129.072 -152.706	-119.266	0.000	119.266 94.526	1.637	1.512	0.000	1.512
concerca end cooming accumentary	initioca, ii	20.71	0.015	0.000	0.015			0.000	152.700	54.520	0.000	54.520	1.550	1.1.55	0.000	1.155
HRSG Test Data	the dis	632 631 00	632 631	0.000	632 631			0.000	0.075	46.009	0.000	46.008	0.001	0.505	0.000	0.505
Corrected HRSG HP steam temperature	Deg F	1,045.20	1.045	0.000	1.045			0.000	-0.075	-46.908	0.000	46.908	0.001	0.000	0.000	0.000
Corrected HRSG IP steam flow rate	lb/h	147,736.00	147.736	0.000	147.736			0.000	-0.148	-21.805	0.000	21.805	0.002	0.276	0.000	0.276
Corrected HRSG IP steam flow temperature	Deg F	573.49	0.573	0.000	0.573	-		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrected HRSG LP steam flow rate	lb/h	68,169.00	68.169	0.000	68.169			0.000	-0.069	-4.714	0.000	4.714	0.001	0.060	0.000	0.060
Corrected HRSG LP steam temperature	Deg F	507.70	0.508	0.000	0.508			0.000	-4.373	-2.220	0.000	2.220	0.055	0.028	0.000	0.028
Corrected HRSG gas side pressure drop Corrected HRSG reheater pressure drop	inH2O nsi	15.58	0.016	0.000	0.016			0.000	141.480 25.974	2.204	0.000	2.204	-1.794	-0.028	0.000	0.028
Corrected HRSG Auxiliary Power	kW	368.90	0.369	0.000	0.369			0.000	1.000	0.369	0.000	0.369	-0.013	-0.005	0.000	0.005
STG Test Data																
Corrected STG equipment net power output	kW	146,768.00	146.768	0.000	146.768			0.000	-1.007	-147.813	0.000	147.813	0.013	1.874	0.000	1.874
Decian Deta																
STG Thyristor loss	kW	11.20	0.560	0.000	0.560			0.000	-1.043	-0.584	0.000	0.584	0.013	0.007	0.000	0.007
CTG Thyristor Losses	kW	12.50	0.625	0.000	0.625			0.000	-1.043	-0.652	0.000	0.652	0.013	0.008	0.000	0.008
Calculated Flows																
Plant Fuel Gas Flow	lb/h	125,776.18			1,686.858			226.952	0.000	0.000	0.000	0.000	0.047	78.635	10.580	79.343
HRSG DB Fuel Gas	lb/h	0.00			0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuel Analysis (lab)																
Methane, CH4	mole %	90.00%	0.002	0.000	0.002	4.303	0.000	0.002	-8.315	-0.012	-0.013	0.018	301.771	0.453	0.473	0.654
Ethane, C2H6 Propage, C3H8	mole %	7.02%	0.001	0.000	0.001	4.303	0.000	0.000	10,770.897	12.925	1 908	13.962	-0.174	0.000	0.000	0.000
Iso-Butane, i-C4H10	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	31,588.860	6.318	0.785	6.366	-839.284	-0.168	-0.021	0.169
N-Butane, n-C4H10	mole %	0.03%	0.000	0.000	0.000	4.303	0.000	0.000	31,803.071	6.361	1.825	6.617	-771.223	-0.154	-0.044	0.160
Iso-Pentane, I-C5H12 N-Pentane, n-C5H12	mole % mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	42,163.461 42.318.967	8.433	0.605	8.454	-1,206.219	-0.241	-0.017	0.242
N-Hexane, n-C6H14	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	52,852.214	10.570	0.461	10.580	-1,536.885	-0.307	-0.013	0.308
Heptane, C7H16	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nonane, C9H20	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Decane, C10H22	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen, N2	mole %	1.86%	0.001	0.000	0.001	4.303	0.000	0.001	-29,243.120	-29.243	-29.058	41.225	-9,291.360	-9.291	-9.232	13.098
Carbon Dioxide, CO Carbon Dioxide, CO2	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	-45,941.406	-32.159	0.000	32.159	-14,596.874	-10.218	0.000	10.218
Water, H2O	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulphide, H2S	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Helium, He	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	-4,178.304	-0.836	0.000	0.000	-1,327.564	-0.266	0.000	0.266
Oxygen, O2	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Argon, Ar	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	-41,701.616	-8.340	0.000	8.340	-13,249.774	-2.650	0.000	2.650
	1	1 1							RSS	3113.06	144.32	3116.40	RSS	162.37	14.16	162.99
										0.69%	0.03%	0.69%		2.84%	0.25%	2.85%

Plant Net Test Result Uncertainty TR 3									Plant Net Outn	ut (kW)		Plant N	let Heat Rate LH	V (Btu/kWh)		
			Binst	B <sub>spataial</sub>	B <sub>stbar</sub>	T <sub>inv</sub>	S <sub>xbar</sub>	TinvSxbar	θ	ΘB <sub>xbar</sub>	Θs <sub>xbar</sub>	450,630	θ	ΘB <sub>xbar</sub>	θs <sub>sbar</sub>	5,711
Description	Units	Mean	Instrument	Spatial	Total Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total	Sensitivity	Systematic	Random	Total
			Systematic	Systematic					1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1							
Denne Maneurante		units	units	units	units	units	units	units	units/units	units	Units	units	units/units	units	units	units
CTG generator gross power output	kW	313,016.51			1,364.407		-	194.586	1.037	1,414.355	201.709	1,428.667	-0.013	-17.931	-2.557	18.113
CTG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	3,983.611	17.475	0.092	17.475	-50.503	-0.222	-0.001	0.222
CTG generator frequency	HZ	60.00	0.000	0.000	0.000	1.980	0.001	0.003	-4,134.469	0.000	-11.416	11.416	-10.508	0.000	-0.029	0.029
STG generator gross power output	kW	143,994.02			627.655		-	22.603	1.037	651.147	23.449	651.569	-0.013	-8.255	-0.297	8.260
STG generator gross power factor	-	1.00	0.004	0.000	0.004	1.980	0.000	0.000	1,477.054	6.490	0.135	6.492	-18.726	-0.082	-0.002	0.082
UAT low side power	kW	8,568.83	37.703	0.000	37.703	1.980	6.518	12.905	-1.039	-39.159	-13.404	41.390	0.013	0.496	0.170	0.525
UAT low side power factor	-	0.81	0.004	0.000	0.004	1.980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RAT low side power	LW.	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RAT low side power factor	-	0.81	0.004	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		2.040.05	402.002	0.000	402.002	4 000		0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CIG excitation current	А	2,040.06	102.003	0.000	102.003	1.980	0.443	0.878	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
STG excitation current	А	1,408.93	70.447	0.000	70.447	1.980	0.204	0.404	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Non-decign auxiliance loade	LW.	0.00	0.000	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Non-design advinary loads	~**	0.00	0.000	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pressure Measurements																
Barometric pressure	psia	14.42	0.005	0.055	0.056	1.980	0.000	0.000	-33,110.854	-1,843.339	-5.591	1,843.347	9.129	0.508	0.002	0.508
Temperature Measurements	Deg F	74.00	0.350	0.354	0 250	1 090	0.034	0.049	1 147 634	110 001	55 646	414 553	1 477	0 511	-0.050	0.51/
Ambient RH at CTG	%	0.84	0.020	0.000	0.020	1.980	0.0024	0.004	-3,825.609	-76.512	-15.403	78.047	-24.424	-0.488	-0.098	0.498
Cooling tower dry bulb temperature	Deg F	71.99	0.100	7.068	7.068	1.980	0.040	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cooling tower wet bulb temperature	Deg F	70.16	0.100	0.522	0.531	1.980	0.009	0.018	187.737	99.776	3.317	99.831	-2.380	-1.265	-0.042	1.266
The Bastemperature of outlet of regulating station	DCP 1	07.70	0.750	0.000	0.750	1.507	0.010	0.020	2.040	1.434	0.041	1.434	0.020	0.015	0.001	0.015
CTG Test Data	LAN	225 412 70	1 951 960	0.000	1 951 960			0.000	1.008	1 866 607	0.000	1 866 607	0.005	0.063	0.000	0.053
Corrected CTG equipment net power output Corrected CTG equipment net heat rate (LHV)	kw btu/kWh	325,413.70 8.138.81	1,851.869	0.000	1,851.869	-	-	0.000	-1.008	-1,866.607	0.000	1,866.607	-0.005	-9.962	0.000	9.962 235.135
Corrected CTG exhaust flow	lb/h	4,915,961.00	81,851.500	0.000	81,851.500		-	0.000	-0.027	-2,180.454	0.000	2,180.454	0.000	27.643	0.000	27.643
Corrected CTG exhaust temperature	Deg F	1,174.37	4.807	0.000	4.807	-	-	0.000	-209.136	-1,005.369	0.000	1,005.369	2.651	12.746	0.000	12.746
Corrected CTG cooling steam energy	mmbtu/n mmbtu/h	28.62	0.927	0.000	0.927		-	0.000	-129.072	-119.615 -94.227	0.000	94.227	1.636	1.516	0.000	1.516
HRSG Test Data	lh/h	672 001 00	672 001	0.000	622.001			0.000	0.075	46 920	0.000	46 970	0.001	0 504	0.000	0 594
Corrected HRSG HP steam temperature	Deg F	1,045.30	1.045	0.000	1.045		_	0.000	0.000	-40.829	0.000	40.829	0.001	0.000	0.000	0.000
Corrected HRSG IP steam flow rate	lb/h	148,224.00	148.224	0.000	148.224		-	0.000	-0.148	-21.877	0.000	21.877	0.002	0.277	0.000	0.277
Corrected HRSG IP steam flow temperature	Deg F	573.53	0.574	0.000	0.574	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrected HRSG LP steam flow rate	lb/h	68,493.00	68.493	0.000	68.493		-	0.000	-0.069	-4.719	0.000	4.719	0.001	0.060	0.000	0.060
Corrected HRSG LP steam temperature	Deg F	507.20	0.507	0.000	0.507		-	0.000	-4.399	-2.231	0.000	2.231	0.056	0.028	0.000	0.028
Corrected HRSG gas side pressure drop	inH2O nsi	15.73	0.016	0.000	0.016			0.000	141.480	2.225	0.000	2.225	-1.794	-0.028	0.000	0.028
Corrected HRSG Auxiliary Power	kW	367.30	0.367	0.000	0.367		-	0.000	1.000	0.367	0.000	0.367	-0.013	-0.005	0.000	0.005
CTC Test Date																
Corrected STG equipment net power output	kW	146,600.00	146.600	0.000	146.600		-	0.000	-1.007	-147.643	0.000	147.643	0.013	1.872	0.000	1.872
Design Data STG Thyristor loss	kW	11.20	0.560	0.000	0.560			0.000	-1.039	-0.582	0.000	0.582	0.013	0.007	0.000	0.007
CTG Thyristor Losses	kW	12.50	0.625	0.000	0.625		-	0.000	-1.039	-0.649	0.000	0.649	0.013	0.008	0.000	0.008
Calculated Flower																
Plant Fuel Gas Flow	lb/h	126,377.53			1,717.051		-	570.112	0.000	0.000	0.000	0.000	0.046	79.702	26.464	83.981
HRSG DB Fuel Gas	lb/h	0.00			0.000		-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuel Analysis (lab)																
Methane, CH4	mole %	89.93%	0.002	0.000	0.002	4.303	0.000	0.001	4.012	0.006	0.005	0.008	307.220	0.461	0.393	0.605
Ethane, C2H6	mole %	7.03%	0.001	0.000	0.001	4.303	0.000	0.000	10,798.724	12.958	1.761	13.078	9.663	0.012	0.002	0.012
Iso-Butane, i-C4H10	mole % mole %	0.35%	0.001	0.000	0.001	4.303	0.000	0.000	21,331.966 31.648.893	6.330	4.216	6,395	-371.164	-0.260	-0.073	0.270
N-Butane, n-C4H10	mole %	0.03%	0.000	0.000	0.000	4.303	0.000	0.000	31,862.756	6.373	1.371	6.518	-752.775	-0.151	-0.032	0.154
Iso-Pentane, i-C5H12	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	42,239.328	8.448	0.545	8.465	-1,183.515	-0.237	-0.015	0.237
N-Pentane, n-C6H14	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	42,394.380	10.589	0.622	10.607	-1,154.057	-0.227	-0.018	0.227
Heptane, C7H16	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Octane, C8H18	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Decane, C10H22	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen, N2	mole %	1.90%	0.001	0.000	0.001	4.303	0.000	0.001	-29,167.266	-29.167	-39.905	49.428	-9,291.589	-9.292	-12.712	15.746
Carbon Monoxide, CO Carbon Dioxide, CO2	mole % mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	-45.822.239	-32.076	0.000	0.000	0.000	0.000	0.000	0.000
Water, H2O	mole %	0.00%	0.001	0.000	0.001	4.303	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulphide, H2S	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen, H2 Helium, He	mole % mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000 -4,167.466	0.000	0.000	0.000	0.000	0.000	0.000	0.000 0.266
Oxygen, O2	mole %	0.00%	0.000	0.000	0.000	4.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Argon, Ar	mole %	0.01%	0.000	0.000	0.000	4.303	0.000	0.000	-41,593.446	-8.319	-5.965	10.237	-13,250.101	-2.650	-1.900	3.261
	ı	L							pse	3141.67	216.21	3149.10	psc	161.59	29.83	164.32
								L	ccn	0.70%	0.05%	0.70%	ccn	2.83%	0.52%	2.87%

GREC U3 EPC	Multip	le Test Uncertai	nty			
			$\mathbf{B}_{xbar}$	T <sub>inv</sub>	S <sub>xbar</sub>	$\mathbf{T}_{inv}\mathbf{S}_{xbar}$
			Total			
			Systematic			Total
Description	Units	Mean	(Absolute)	Student T	Random	Random
Corrected Plant Net Power Output						
Test Run 1	kW	450,542.770	4,078.953			
Test Run 2	kW	450,388.986	3,113.057	4.303	86.236	371.042
Test Run 3	kW	450,629.836	3,141.674			
Average	kW	450,520.530		Systematic	Random	Total
Total Uncertainty (units)				3,473.67	371.04	3,493.43
Total Uncertainty (%)				0.77%	0.08%	0.78%
Corrected Plant Net Heat Rate						
Test Run 1	kW	5,717.876	113.304			
Test Run 2	kW	5,714.246	162.370	4.303	2.392	10.293
Test Run 3	kW	5,711.116	161.588			
Average	kW	5,714.413		Systematic	Random	Total
Total Uncertainty (units)				147.55	10.29	147.91
Total Uncertainty (%)				2.58%	0.18%	2.59%

			СТ	G Measured	Power Uncerta	inty TR 1						
Column		F	Q	w		AI	AO			Power Uncerta	inty (kW)	
			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	ΘB <sub>xbar</sub>	$\Theta s_{xbar}$	307,547
			Instrument	Spatial	Total							
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
CTG Measured Power	kW	307,546.52	307.55	0.00	0.10%	1.98	79.77	0.05%	100.00%	0.10%	0.05%	0.11%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
									DCC	0.44%	0.05%	0.44%
									n35	1,340.6	157.9	1,349.8

		1	ST	G Measured I	Power Uncerta	inty TR 1		1				
Column		F	Q	w		AI	AO			Power Uncerta	ainty (kW)	
			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	ΘB <sub>xbar</sub>	$\Theta s_{xbar}$	142,949
			Instrument	Spatial	Total							
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
STG Measured Power	kW	142,949.10	142.95	0.00	0.10%	1.98	10.12	0.01%	100.00%	0.10%	0.01%	6 0.10%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	6 0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	6 0.30%
									DCC	0.44%	0.01%	6 0.44%
									55	623.1	20 (	623.4

	Plant Fuel Flow Uncertainty TR 1 (enable meter)												
Column		F	Q	w		AI	AO			Flow Uncertain	nty (lb/h)		
			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	TinvSxbar	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	127,242	
			Instrument	Spatial	Total								
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total	
		units	units	units	%	units	units	%	%/%	%	%	%	
Meter Type	-	Ultrasonic											
Тар Туре	-	N/A											
Inlet Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Throat Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Diameter Measurement Temperature	Deg F	72.00	4.00	0.00	5.56%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Calibration Temperature	Deg F	48.40	4.00	0.00	8.26%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Inlet Material	-	SS3xx											
Throat Material	-	SS3xx											
Fluid Type	-	Vapor											
Upstream Pressure	psia	806.88	1.00	0.00	0.12%	1.97	1.08	0.26%	112.01%	0.14%	0.30%	0.33%	
Downstream Temperature	Deg F	68.72	0.73	0.00	1.06%	1.97	0.01	0.03%	-19.66%	-0.21%	-0.01%	0.21%	
Meter Reported Flow Rate	KACF/h	45.23	0.15	0.00	0.33%	1.97	0.08	0.36%	100.00%	0.33%	0.36%	0.49%	
Fuel Analysis													
Methane, CH4	mole %	90.29%	0.00	0.00	0.17%	4.30	0.00	0.69%	-16.83%	-0.03%	-0.12%	0.12%	
Ethane, C2H6	mole %	6.85%	0.00	0.00	1.75%	4.30	0.00	5.29%	2.22%	0.04%	0.12%	0.12%	
Propane, C3H8	mole %	0.33%	0.00	0.00	21.48%	4.30	0.00	15.62%	0.49%	0.11%	0.08%	0.13%	
Iso-Butane, i-C4H10	mole %	0.01%	0.00	0.00	176.47%	4.30	0.00	12.65%	0.03%	0.05%	0.00%	0.05%	
N-Butane, n-C4H10	mole %	0.02%	0.00	0.00	92.31%	4.30	0.00	17.51%	0.05%	0.05%	0.01%	0.05%	
Iso-Pentane, i-C5H12	mole %	0.00%	0.00	0.00	495.87%	4.30	0.00	72.96%	0.01%	0.06%	0.01%	0.06%	
N-Pentane, n-C5H12	mole %	0.00%	0.00	0.00	500.00%	4.30	0.00	62.10%	0.01%	0.06%	0.01%	0.06%	
N-Hexane, n-C6H14	mole %	0.01%	0.00	0.00	182.37%	4.30	0.00	70.63%	0.04%	0.08%	0.03%	0.08%	
Heptane, C7H16	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Octane, C8H18	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Nonane, C9H20	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Decane, C10H22	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Nitrogen, N2	mole %	1.80%	0.00	0.00	5.56%	4.30	0.00	8.39%	-3.97%	-0.22%	-0.33%	0.40%	
Carbon Monoxide, CO	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Carbon Dioxide, CO2	mole %	0.63%	0.00	0.00	11.11%	4.30	0.00	6.83%	0.95%	0.11%	0.07%	0.12%	
Water, H2O	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Hydrogen Sulphide, H2S	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Hydrogen, H2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Helium, He	mole %	0.04%	0.00	0.00	50.00%	4.30	0.00	0.00%	-11.45%	-5.73%	0.00%	5.73%	
Oxygen, O2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	
Argon, Ar	mole %	0.01%	0.00	0.00	200.00%	4.30	0.00	0.00%	0.01%	0.03%	0.00%	0.03%	
	1									5 75%	0.60%	5 78%	
									RSS	7 314 1	768.8	7 354 4	

			GSL	J 5 Measured	Power Uncer	tainty TR 2						
Column		G	R	х		AJ	AP			Power Uncerta	inty (kW)	
			Binst	B <sub>spatalal</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	311,860
			Instrument	Spatial	Total							
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
UAT Measured Power	kW	311,859.98	311.86	0.00	0.10%	1.98	65.84	0.04%	100.00%	0.10%	0.04%	0.11%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
									DCC	0.44%	0.04%	0.44%
									n35	1.359.4	130.4	1.365.6

			GSL	J 6 Measured	Power Uncer	tainty TR 2						
Column		G	R	х		AJ	AP			Power Uncerta	inty (kW)	
			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	143,925
			Instrument	Spatial								
Description	Units	Mean	Systemtaic	Systematic	Total Spatial	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
UAT Measured Power	kW	143,925.25	143.93	0.00	0.10%	1.98	13.34	0.02%	100.00%	0.10%	0.02%	0.10%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
									DCC	0.44%	0.02%	0.44%
									1.33	627.4	26.4	627.9

Plant Fuel Flow Uncertainty TR 2 (enable meter)												
Column		G	R	х		AJ	AP			Flow Uncertain	nty (lb/h)	
			B <sub>inst</sub> Instrument	B <sub>spataial</sub> Spatial	B <sub>xbar</sub>	T <sub>inv</sub>	$S_{xbar}$	$T_{inv}S_{xbar}$	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	125,776
Description	Units	Mean	Systemtaic	Systematic	Total Spatial	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
Meter Type	-	Ultrasonic										
Тар Туре	-	N/A										
Inlet Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Throat Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Diameter Measurement Temperature	Deg F	72.00	4.00	0.00	5.56%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Calibration Temperature	Deg F	48.40	4.00	0.00	8.26%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Inlet Material	-	SS3xx										
Throat Material	-	SS3xx										
Fluid Type	-	Vapor										
Upstream Pressure	psia	840.84	1.00	0.00	0.12%	1.97	0.09	0.02%	112.72%	0.13%	0.02%	0.14%
Downstream Temperature	Deg F	67.94	0.73	0.00	1.07%	1.97	0.01	0.04%	-19.92%	-0.21%	-0.01%	0.21%
Meter Reported Flow Rate	KACF/h	42.43	0.14	0.00	0.33%	1.97	0.01	0.03%	100.00%	0.33%	0.03%	0.33%
Fuel Analysis												
Methane, CH4	mole %	90.00%	0.00	0.00	0.17%	4.30	0.00	0.17%	-9.82%	-0.02%	-0.02%	0.02%
Ethane, C2H6	mole %	7.02%	0.00	0.00	1.71%	4.30	0.00	0.70%	7.07%	0.12%	0.05%	0.13%
Propane, C3H8	mole %	0.36%	0.00	0.00	19.56%	4.30	0.00	2.50%	6.42%	1.26%	0.16%	1.27%
Iso-Butane, i-C4H10	mole %	0.01%	0.00	0.00	142.86%	4.30	0.00	17.74%	0.03%	0.05%	0.01%	0.05%
N-Butane, n-C4H10	mole %	0.03%	0.00	0.00	73.17%	4.30	0.00	20.99%	0.06%	0.05%	0.01%	0.05%
Iso-Pentane, i-C5H12	mole %	0.01%	0.00	0.00	348.84%	4.30	0.00	25.02%	0.02%	0.06%	0.00%	0.06%
N-Pentane, n-C5H12	mole %	0.01%	0.00	0.00	400.00%	4.30	0.00	49.68%	0.02%	0.06%	0.01%	0.06%
N-Hexane, n-C6H14	mole %	0.01%	0.00	0.00	164.84%	4.30	0.00	7.19%	0.05%	0.08%	0.00%	0.08%
Heptane, C7H16	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Octane, C8H18	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Nonane, C9H20	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Decane, C10H22	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Nitrogen, N2	mole %	1.86%	0.00	0.00	5.38%	4.30	0.00	5.34%	0.81%	0.04%	0.04%	0.06%
Carbon Monoxide, CO	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Carbon Dioxide, CO2	mole %	0.65%	0.00	0.00	10.77%	4.30	0.00	0.00%	0.98%	0.11%	0.00%	0.11%
Water, H2O	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Hydrogen Sulphide, H2S	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Hydrogen, H2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Helium, He	mole %	0.04%	0.00	0.00	50.00%	4.30	0.00	0.00%	-0.03%	-0.02%	0.00%	0.02%
Oxygen, O2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Argon, Ar	mole %	0.01%	0.00	0.00	200.00%	4.30	0.00	0.00%	0.01%	0.03%	0.00%	0.03%
	1									1 34%	0 18%	1 35%
									RSS	1.686.9	227.0	1.702.1

			GS	U 5 Measured	Power Uncert	ainty TR 3						
Column		н	S	Y		AK	AQ			Power Uncerta	inty (kW)	
			Binst	B <sub>spatalal</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	θB <sub>xbar</sub>	$\Theta s_{xbar}$	313,017
			Instrument	Spatial	Total							
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
	-	units	units	units	%	units	units	%	%/%	%	%	%
UAT Measured Power	kW	313,016.51	313.02	0.00	0.10%	1.98	98.28	0.06%	100.00%	0.10%	0.06%	0.12%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
									DCC	0.44%	0.06%	0.44%
									n35	1,364.4	194.6	1,378.2

			GS	U 6 Measured	Power Uncert	ainty TR 3						
Column		н	S	Y		AK	AQ			Power Uncerta	inty (kW)	
			Binst	B <sub>spatalal</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	143,994
			Instrument	Spatial	Total							
Description	Units	Mean	Systemtaic	Systematic	Systematic	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
UAT Measured Power	kW	143,994.02	143.99	0.00	0.10%	1.98	11.42	0.02%	100.00%	0.10%	0.02%	0.10%
PT Ratio	Deg F	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
CT Ratio	%	0.00	0.00	0.00	0.30%	0.00	0.00	0.00%	100.00%	0.30%	0.00%	0.30%
									DCC	0.44%	0.02%	0.44%
									N33	627.7	22.6	628.1

			GSU 7	Measured Po	wer Result Und	ertainty TR	3					
Column		н	S	Y		AK	AQ			Flow Uncertain	nty (lb/h)	
			Binst	B <sub>spataial</sub>	B <sub>xbar</sub>	Tinv	S <sub>xbar</sub>	T <sub>inv</sub> S <sub>xbar</sub>	θ	$\Theta B_{xbar}$	$\Theta s_{xbar}$	126,378
			Instrument	Spatial								
Description	Units	Mean	Systemtaic	Systematic	Total Spatial	Student T	Random	Total Random	Sensitivity	Systematic	Random	Total
		units	units	units	%	units	units	%	%/%	%	%	%
Meter Type	-	Ultrasonic										
Тар Туре	-	N/A										
Inlet Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Throat Diameter	in	10.02	0.00	0.00	0.01%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Diameter Measurement Temperature	Deg F	72.00	4.00	0.00	5.56%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Calibration Temperature	Deg F	48.40	4.00	0.00	8.26%	0.00	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Inlet Material	-	SS3xx										
Throat Material	-	SS3xx										
Fluid Type	-	Vapor										
Upstream Pressure	psia	841.92	1.00	0.00	0.12%	1.97	0.05	0.01%	112.75%	0.13%	0.01%	0.13%
Downstream Temperature	Deg F	67.78	0.73	0.00	1.08%	1.97	0.01	0.03%	-19.89%	-0.21%	-0.01%	0.21%
Meter Reported Flow Rate	KACF/h	42.53	0.14	0.00	0.33%	1.97	0.01	0.04%	100.00%	0.33%	0.04%	0.33%
Fuel Analysis												
Methane, CH4	mole %	89.93%	0.00	0.00	0.17%	4.30	0.00	0.14%	-9.85%	-0.02%	-0.01%	0.02%
Ethane, C2H6	mole %	7.03%	0.00	0.00	1.71%	4.30	0.00	0.23%	7.08%	0.12%	0.02%	0.12%
Propane, C3H8	mole %	0.35%	0.00	0.00	19.85%	4.30	0.00	5.61%	6.35%	1.26%	0.36%	1.31%
Iso-Butane, i-C4H10	mole %	0.01%	0.00	0.00	146.34%	4.30	0.00	20.99%	0.03%	0.05%	0.01%	0.05%
N-Butane, n-C4H10	mole %	0.03%	0.00	0.00	71.43%	4.30	0.00	15.37%	0.06%	0.05%	0.01%	0.05%
Iso-Pentane, i-C5H12	mole %	0.01%	0.00	0.00	327.87%	4.30	0.00	21.16%	0.02%	0.06%	0.00%	0.06%
N-Pentane, n-C5H12	mole %	0.01%	0.00	0.00	333.33%	4.30	0.00	0.00%	0.02%	0.06%	0.00%	0.06%
N-Hexane, n-C6H14	mole %	0.01%	0.00	0.00	160.43%	4.30	0.00	9.42%	0.05%	0.08%	0.00%	0.08%
Heptane, C7H16	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Octane, C8H18	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Nonane, C9H20	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Decane, C10H22	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Nitrogen, N2	mole %	1.90%	0.00	0.00	5.25%	4.30	0.00	7.19%	3.73%	0.20%	0.27%	0.33%
Carbon Monoxide, CO	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Carbon Dioxide, CO2	mole %	0.66%	0.00	0.00	10.66%	4.30	0.00	4.37%	0.99%	0.11%	0.04%	0.11%
Water, H2O	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Hydrogen Sulphide, H2S	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Hydrogen, H2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Helium, He	mole %	0.04%	0.00	0.00	50.00%	4.30	0.00	0.00%	-0.03%	-0.02%	0.00%	0.02%
Oxygen, O2	mole %	0.00%	0.00	0.00	0.00%	4.30	0.00	0.00%	0.00%	0.00%	0.00%	0.00%
Argon, Ar	mole %	0.01%	0.00	0.00	150.00%	4.30	0.00	107.57%	0.02%	0.03%	0.02%	0.03%
										1 36%	0.45%	1 //3%
									RSS	1.717 1	570 1	1.809.2

**APPENDIX D** 

**TEST EQUIPMENT INFORMATION** 

			G	REC U3 EPC Instrument Li	ist		
Measurement Description	Number of Instruments	Source	Expected Accuracy	Drawing	Location	Tag Number	Notes
Ambient dry bulb temperature at CTG	12	Temporary	0.25 Deg F	N/A	CTG filter house	-	3x4 grid at the inlet face
Ambient RH at CTG	9	Temporary	2.00%	N/A	CTG filter house	-	3x3 grid at the inlet face
Barometric pressure	2	Temporary	0.25% of span	N/A	Centerline of CTG	-	
Cooling tower inlet dry bulb temperature	2	Temporary	0.25 Deg F	N/A	Cooling tower face	-	
Cooling tower inlet wet bulb temperature	12	Temporary	0.1 Deg F	N/A	Cooling tower face	-	
Fuel temperature at metering station outlet	1	Station	0.25% of span	1255-102-02	Gas Yard	TIT-200	
Fuel pressure upstream compressor suction	1	Station	0.25% of span	2014-071-PS-650	Fuel gas separator	03-PIT-650617	
Fuel composition	N/A	Grab Samples	ASTM D1945	2014-071-PS-652	03-V652604	N/A	At inlet to calorimeter pressure reduction unit
Plant fuel flow	1	Station	0.33%	1255-102-02	Gas Yard	FE-200	ACF flow signal
Plant fuel flow pressure	1	Station	0.25%	1255-102-02	Gas Yard	PIT-200	
Plant fuel flow temperature	1	Station	0.73 Deg F	1255-102-02	Gas Yard	TIT-200	
Duct burner fuel flow pressure	1	Temporary	0.25% of span	DB-9155553-151	03-FE-980840	-	
Duct burner fuel flow temperature	1	Station	4 Deg F	DB-9155553-151	HRSG DB FE	03-TE-980840	
Duct burner fuel flow DP	1	Temporary	0.25% of span	DB-9155553-151	03-FE-980840	-	
CTG Generator Gross Electrical Output	1	Temporary	0.44%	2014-071-EO-001	CTG Generator	-	
STG Generator Gross Electrical Output	1	Temporary	0.44%	2014-071-EO-001	STG Generator	-	
CTG Generator Power Factor	1	Temporary	0.44%	2014-071-EO-001	CTG Generator	-	
STG Generator Power Factor	1	Temporary	0.44%	2014-071-EO-001	STG Generator	-	
RAT Input	2	Station	0.44%	2014-071-EO-001	RAT	-	Backup only. Off during testing
UAT Power	2	Temporary	0.44%	2014-071-EO-001	UAT	-	
CTG Excitation Current	1	Calculation	-	2014-071-EO-001	CTG Excitation Transformer		Calculated from generator V curve
STG Excitation Current	1	Calculation	-	2014-071-EO-001	STG Excitation Transformer		Calculated from generator V curve
CTG GSU Power Factor	1	Station	0.50%	S120S011	Switchyard	TBD	From revenue metering
STG GSU Power Factor	1	Station	0.50%	S120S011	Switchyard	TBD	From revenue metering
UAT Power Factor	2	Temporary	0.44%	2014-071-EO-001	UAT	-	
RAT Power Factor	2	Station	0.44%	2014-071-EO-001	RAT	-	Backup only. Off during testing

## **APPENDIX E**

## **EQUIPMENT CALIBRATIONS**

BFW 3.1

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7

## **Rosemount Production Flow Facility Calibration Data** 12001 Technology Drive, Eden Prairie, MN 55344 USA

Model number: 8800DF010SA8N1D1E5M5Q4Q8 Serial Number: 0285524 Sales Order: 4495472 Customer Tag: 03-FIT-035601

19.8%

12.1%

10.0%

5.0

3.0

2.5

Calibration Date: Mar 22, 2016 Trace Number: 270719 Computed mean K-factor: 301.51 

3.0

1.8

1.5

-0.06%

0.21%

0.28%

		Pa	ass/Fail:	PASS			
Run #	Flow rate % FS <sup>1</sup>	Velocity ft/s	Velocity m/s	Reynolds number	Flow rate US gpm	Flow rate m³/hr	Deviation % rate
1	88.6%	22.1	6.75	174,273	60	13.6	-0.21%
2	60.0%	15.0	4.57	118,038	40	9.2	-0.21%
3	39.9%	10.0	3.04	78,460	27	6.1	-0.17%
4	23.9%	6.0	1.82	46,980	16	3.7	-0.15%

1.51

0.92

0.76

39,019

23,790

19,639

13

8

7



## Calibration conditions:

Water temperature = 65.9 °F ( 18.9 °C ), water density = 62.329 lb/ft3 ( 998.41 kg/m3 ) 1100% flow rate = 25 ft/sec (7.62 m/s) in schedule 40 pipe.

Measuring and test equipment used in the manufacture and inspection of the above flowmeter are directly traceable to the National Institute of Standards and Technology. The calibration system was designed to meet the intent of ANSI Z540.3-2006.

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-11-16 sina Wistalicz RECORDER CALIBRATION. Grand River Energy Center Unit 3 Project Name: Project #: 102739 System #: SFW 3.1 Work Package #: WP-INST-004 ERACK Location: Area; DSE 94.03.14.100.03 Drawing #: 2014.071.1A.08042B Specification: Description (Type): VORTEX FlowmETER INSTRUMENT TAG OPAY PRINTED ATA SERET # P&ID SERVICE 5-034 ANDRACTURER 5601 14 MODEL NUMBER TOLERANCE KOS EMOUA SSOODFO LOOP DIAGRAM NUMBER UNE / VESSEL # LINE SIZE / SCHEDULE 23-14-402-1FAA CALIBRATION DATA BENCH METHOD: ART ADDITIONAL INSTRUMENT INFORMATION · Configuration ATTACHED 5 TÊST EQUIPMENT. MODEL# SERTAL # CALDATE 1.tek  $\Delta$ 334 266200 14 6 ster! OUTPUT-NODEL# TEST EQUIPMENT DESIRED AS LEFT DEVIATION AS FOUND : . ASLEET N 4 NI E YES D NO INSTRUMENT'IS IN TOLERANCE: COMMENT 16/1 1 CATTERATED BY ACCEPTED BY DATE 11-11-16 TREMAN (SIG DATE OPERATIONS REC RESENTATIVE (SIGN) DATE THE QUALITY CONTROL (SHEN IF APPLICABLE) TATIVE (SIGN IF APPLICABLE) RESE

TIC-SD-KEG-FRM-INST-8.02.12

03/2013 .

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BF623, EMERSON Process Management			١	/ortex Factor	8800 Flo y Config	owme gurati	eter ion
PL: MVS Serial Nu	mber: <i>0285524</i>	Configuration	n Date:22	-Mar-2016	Time:	11:21	
Transmitter Order	Information		Sale	s Order:	4495472		
Model:	8800DF010SA8N1D1E5M5Q4Q8				4		
Name Tag: Short Tag:	03-FIT-035601 03-FIT-0		D	Unit: Line: evice ID:	<b>4</b> 205689		
Message:				8			
Descriptor:				Address	000		
Configuration Info	rmation		SW F	Revision:	5.2.5		1995
K-Factor: Process Fluid: Pipe ID: Fixed Process Temp: Fixed Process Density: Fixed Density Ratio: Flow Damping:	301.51 pulses/US gal Liquid 0.815 in 330.000000 °F 56.564 lb/ft3 N/A 2 Second(s)	(4-20mA) PV: Totalizer:	0 Mass	to	29250	lb/hr	
Velocity Flow Based On:	Mating Pipe ID						
LFC Response Type:	Stepped						
Installation Effects: Pulse Output Mode: Pulse Output Factor:	0 N/A N/A						
Security: Alarm:	Off RMT High	LCD Disp:	PV, % R	ange			
Meter Body Meter Body S/N: Flange Type: Wetted Material:	0285524B A8 S				2		

	I Ipa	TRANSI	RANSMITTE DUCER, IND	CR, ICATOR, DA	TE: 1-02-17
Samilleon	m District	I RECOR	UEK CALIBI	KAIION	· · · ·
Project Name:	Grand R	iver Energy Center	r Unit 3	Project #:	102739
System #:	CDN 3.1	in a second second	Work Pacl	rage #: INST	F-8120-INST-003
Location: STEA	M TURBINE GEN	GRATOR	Area:	OHA-STG1	
Drawing #: PS	- 050	Specificati	88.	15.02.002D	
Description (Type):	COND HOTWELL	LVL A. L	EVEL IND. TH	ANSMITTEL (PL	ESSURE TYPE)
INSTRUMENT TAG #	P&ID		SERVICE		INSTRUMENT DATA SHBET #
03-117-050	610A MODEL NI	5-050	INSTRUMENT SI	SA ERIAL NUMBER ·	TOLERANCE
Rosemount	3051	LZAG	2509	454	NIA
HOOK UP DRAWING NUMBER	3	UNCTION BOX	IA	LOOP DIAGRAM	NUMBER N//A
LINE/VESSEL#	10		LINE SIZE / SCHI	EDULE #	
	*	CALI	BRATION DATA	,	
METHOD: P	Sench	Hart	475 Used		
	Low psi h	and pum	P		
	ĂÏ	DITIONAL INS	TRUMEN'T INF	ORMATION ·	
			VIA	1.	
() <del>                                    </del>					
TËST EQUIPM	ENT.	MODEL#		SERIAL #	CALDATE
Amerek	XP	21300	3678	24	313/2016
ALLEK	ADDLIGA	54A	TPUT .	DESIRED	AS LEFT DEVIATION
	T. Pressure	COUND :	· ? · AS LEAST		N//A
. N/A	- 59.315 H20	4.01ma	H.Olma	7 mt	.19//1
· · ·					
	-20.8425" HzD	12.01ma	12.01ma	12m.t	20
					l
N/A	17.63" 420	20.01 mg	20.01ma	20mA	M/A
	INSTR	UMENT IS IN TO	LERANCE: Y	ės 🗆 no .	
MENIS	C	-121			
Kange: -	59.315 -	11.6311	H20		NR I
11 0		1. 1			
Stanley	Varcent	9/23/16	0 •	·	
BRATEDBY	11	ATE	ACCEPTED BY	2 	DATE
Chan La	las To	1-02-17	e		· ·
MAN (SIGN)	Di Di	VIE VIE	OPERATIONS REPRESE	ENTATIVE (SIGN)	TATE
ARO		1-10-17	ND>		2/20/16
TALITY CONTROL (SIGN IF APPI	licable) Da	TE	CLISIN REPRESENTAT	IVE (SIGN IF APPLICABLE)	DATE
	·				

1.00

guilden Souther	l ja m District	TRANSD RECORD	ANSMI'I'I'E UCER, INDI ÞER CALIBR	R, ICATOR, DAT ATION	E: <u>1-02-17</u>
Project Name:	Grand R	iver Energy Center I	Unit 3	Project #:	102739
System #: (	CON 3.1		Work Pack	age#: <u>INST-8</u>	8120-INST-003
Location: STEAM	M TURBINE GE	NERATOR.	Area:	OYA - STGI	
Drawing #:	PS-DSD	Specificatio	n: <u>4</u> 4	8. 15.02.00215	
Description (Type):	COND HOTWELL	LVL A. LEV	EL IND. TRA	NSMITTER ( PRE	SORG TYPE)
INSTRUMENT TAG #	P&D	27	SERVICE		INSTRUMENT DATA SHEET #
03-LIT-05	D610B MODEL NU	MBER	INSTRUMENT SE	J/A RIAL NUMBER -	TOLERANCE
Rosemount	3051	LZAG	25094	155 ILOOP DIAGRAM NU	
N/A		μl/			NIA
LINE/VESSEL#	JIA		LINE SIZE / SCHR	DULK#  2//4-	
•		CALIB	RATION DATA	· · · ·	
METHOD:	Bench	Hart und pump	475 Used	<b>1</b>	
· · · · · · · · · · · · · · · · · · ·	w psi n	DITIONAL INST		SRW241CKI	
		N//	1	,	
TËST EQU.PM	ÊNT.	MODEL #	E	SERIAL #	CALDATE
Ametek		P7: 300	3678	174	3/3/2016
	~	101 040			Distant
Altek	3	3HA OUT	2667	1001	3412016
ALLEK	Appenso	34A OUT	PUT ASLEET	DESIRED	31412016 AS LEFT DEVIATION
ALLEK TEST EQUIPMENT	-59.315"H2D	AS FOUND : .	2667	DESIRED 4 mA	31412016 ASTEFT DEVIATION
ALLEK TEST EQUIPMENT	-59.315"H2D	34A OUT AS FOUND : . 4.01 ma	2667 ASLEFT H.DIMQ	DESIRED 4 mA	3/4/2016 AS LEFT DEVIATION
ALLEK TEST EQUIPMENT	-20.8425" H20	۵۳۲ ۵۳۲ ۵۶ FOUND : - ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰۰۰ ۲۰	2667 PETE: ASLEFT 4.01mg	DESTREP 4 mA 12 mA	3/4/2016 AS LEFT DEVIATION
ALLEK TEST BOUIPMENT	-20.8425" H20	34Α 	2667 PDT ASLEFT 4.01ma 12ma	DESTRED 4 mA 12 mA	3/4/2016 AS LEFT DEVIATION
ALLEK TEST EQUIPMENT	-59.315"H2D -20.8425" H2D	20ma	2667 PETE::: ::::ASLERT 4.01ma 12ma 20ma	DESTREP 4 mA 12 mA 20 mA	3/4/2016 AS LEFT DEVIATION
ALLEK TEST EQUIPMENT N/A	Apos 25 -59.315"H2D -20.8425" H2D 17.63" H2D INSTR	20  ma	ZOMA	DESTRED 4mA 12mA 20mA 30mA 30mA	3/4/2016 AS LEFT DEVIATION
ALLEK TEST EQUIPMENT N/A N/A	-59.315"H20 -20.8425" H20 17.63" H20 INSTR	20ma	Z667 PETE ASLERT H.DIMQ 12mq 12mq Z0mq SRANCE: YYE	DESTRED 4mA 12mA 20mA 30mA 30mA	3/4/2016 ASTEFT DEVIATION
Altek TEST EQUIPMENT N/A N/A N/A	Apos 200 -59.315"H2D -20.8425" H2D 17.63" H2D INSTR 1.315-17.631	34A 34A 34A 0000 4.0000 1200 1200 2000a 2000a 2000a 1200 1200a 1	2667 PETE ASLEET H.DIMQ 12ma 20ma ERANCE: LY YE	1001 DESTRED 4 mA 12 mA 12 mA 20mA	3/4/2016 AS LEFT DEVIATION
Altek TEST EQUIPMENT N/A N/A NENTS Range: -50	Appendix -59.315"H2D -20.8425" H2D 17.63" H2D INSTR 1.315-17.631	34A 34A 0000 4.0000 12ma 12ma 20ma 20ma 000000000000000000000000000000000000	2667 PETE ASLERT 4.01mq 12ma 12ma 20ma ERANCE: YE	DESTRED	3/4/2016 AS LEFT DEVIATION
Altek TEST EQUIPMENT N/A N/A N/A MENTS Range: -50	Aposition -59.315"H2D -20.8425" H2D 17.63" H2D INSTR 1.315-17.631 unent	$\frac{344}{1.00}$ 4.00 4.00 12 ma 12 ma 20 ma 20 ma 12 ma 20 ma 20 ma 12 ma 20 ma 20 ma 12 ma 20 ma 20 ma 12 ma 20 ma 12 ma 20 ma 12 ma 12 ma 20 ma 12 ma	2667 PETE: ASILEET 4.01mq 12mq 12mq 20mq ERANCE: Vye	DESTRED 4/mA 12mA 20mA SS □ NO	BIHI 2016 AS LEFT DEVIATION NI/A
Altek TEST EQUIPMENT N/A N/A N/A MENTS Range: -50	-20.8425" H20 -20.8425" H20 17.63" H20 INSTR 1.315-17.631	$\frac{344}{200}$ $\frac{344}{200}$ 4.000 12 ma 12 ma 20 ma 20 ma 0 MENT IS IN TOLE $n Hzd\frac{9/23/16}{400}$	Z667 PETE: ASILENT H.DIMQ IZMQ IZMQ ZOMQ ERANCE: YE	DESTRED 4 mA 12 mA 20 mA SOMA SOMA	BIHIZOID ASTEFT DEVIATION
Altek TEST EQUIPMENT N/A N/A MENTS Range: -50 Stanley L Ranley L Ranley L Ranley L	-20.8425" H20 -20.8425" H20 17.63" H20 INSTR 1.315-17.631 INSTR	34A 34A 34A 0000 4.0000 12ma 12ma 20ma 20ma 000000000000000000000000000000000000	Z667 PETE: ASLERT H.DIMQ IZMQ IZMQ ZOMQ ERANCE: YYE	DESTRED 4mA 12mA 20mA 30mA 30mA 30mA	3/4/2016 AS LEFT DEVIATION N/A N/A DATE
Altek TEST EQUIPMENT NA NA NA NA MENTS Range: -50 Stanley Manley L RATEDBY	-20.8425" H20 -20.8425" H20 17.63" H20 INSTR 1.315-17.631 INSTR	3HA AS FOUND: H.01ma 12ma 12ma 20ma 20ma 0MENT IS IN TOLE $NHzD9/23/16ATE1-02-17TE$	266 T PUTF ASILENT 4.01mq 12mq 12mq 20mq BRANCE: YF ACCEPTED BY OPERATIONS REPRESENT	NTATIVE (SIGN)	BIHI 2016 AS LEFT DEVIATION NI/A N/A DATE
Altek TEST EQUIPMENT N/A N/A N/A MENTS Range: -50 Stanley Manley Man (SIGN) Man (SIGN)	Apage 2017 -59.315"H2D -20.8425" H2D 17.63" H2D INSTRI 1.315-17.631 Lacet D	$\frac{344}{1.00}$ 4.00 4.00 12 ma 12 ma 20 ma 20 ma 20 ma 20 ma 12 ma 20 ma 20 ma 12 ma 20 ma 12 ma 20 ma 12 ma 12 ma 20 ma 12 ma	266 T PUTP ASILENT 4.01mq 12mq 12mq 20mq ERANCE: VYE ACCEPTED BY OPERATIONS REPRESENTATION	$\frac{1001}{\text{DESIRED}}$ $\frac{1}{2} \text{ mA}$ $\frac{12}{3} \text{ mA}$ $\frac{20}{3} \text{ mA}$ $\frac{20}{3} \text{ mA}$ $\frac{20}{3} \text{ mA}$ $\frac{20}{3} \text{ mA}$ $\frac{10}{3} \text{ mA}$ $\frac{10}{3} \text{ mA}$	BILLIZOND AS LEFT DEVIATION NI/A N/A DATE DATE

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		' TRANSI	DUCER, INDI	CATOR, DA	TE: 12-20-	16
Sanunilhes	rn District	RECOR	RDER CALIBR	ATION	1	
Project Name:	Gra	nd River Energy Cente	r Unit 3	. Project #:	102739	
System #:	N3.1		Work Pack	age #: _ <u>INST-8</u>	5170-1NST-003	
Location: STEF	IM TURBINE	GENERATOR	Area:	0419- STUI		
Drawing #: P	5-050	Specificat	ion: 88	15,02.0020		1.000
Description (Type):	COND HOTW	IELL LVL C. LEI	JEL IND. TRANS	SMITTER (PRESSI	DRE TYPE)	
INSTRUMENT TAG#	DLIDC	DS-150	SERVICE	/A	INSTRUMENT DATA SHEET #	
MANUFACTURER	MOD	ELNUMBER	INSTRUMENT SE	RIALNUMBER -	TOLERANCE	
HOOK UP DRAWING NUMBER	7 0	JUNCTION BOX	1 2 309	LOOP DIAGRAM	NUMBER	
LINE/VESSEL#	A		LINE SIZE / SCHE	DULE #	N/A .	
N/A	,	CALI	BRATION DATA	NA		
METHOD:	Bench	Hart 47	5 used			
	LOW PSi	hand pump	0.02.0			
		ADDITIONAL INS	STRUMENT INFO	RMATION		
			MA			
		terre	these second		and the second secon	-
TRET POTTON		· MODEL #				
TEST ROOTEM	ENT.	MODEL#	S	ERIAL #	CAL DATE	1
Ametek	ENT. X	P2:300	3678	erial #	CALDATE 3/3/2016	1
Ametek Altek		P21300 334A	3678	ERIAL# 124 1001	CAL DATE 3/3/2016 3/4/2016	ľ,
Ametek Altek Test bourpment	Appenton Piceso	морн.# <u>P2:300</u> <u>334A</u> //e, <u>AS FOUND</u>	3678 3678 2667	erial # 24 100   Desirep	CAL DATE 3/3/2016 3/4/2016 As left deviate	ÓN
Ametek Altek Test bouipment	APAGE 50 -59.315"H	R21300 334A re:, AS FOUND: 20 4.01ma	ASLEET H.OMA	ERIAL# 24 1001 DESIRED 4mA	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE	ÓN
Ametek Altek Test bouipment N/A	APALIER -59.315"H	MODEL# PZ:300 334A re:, AS FOUND: 20 4.01ma	ASLEET H.OMA	ERIAL # 24 1001 DESIRED 4 mA	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATO	ÓN
Ametek Altek Test bouipment N/A	-59.315"H	120 17.01ma	3678 3678 2667 777907 2667 777907 2667 77907 2667 77907 2667 700700 4.01000	1001 DESIRED 4mA 12mA	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATO	ÓN
Ametek Altek TEST EQUIPMENT	-59.315"H	PZi300 334A re:, ASFOUND: 20 4.01ma 420 17.01ma	3678 2667 2667 2667 2667 2667 2667 2667 2	ERIAL # 124 1001 DESIRED 4/mA 12mA	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A	ÓN 
Ametek Altek TEST BOUIPMENT N/A	Apres 22 -59.315" H- -20.8425" H 17.63" H20	20 17.01ma	3678 266 77797 266 77797 266 77797 266 4.0100 a 12.01ma 12.01ma 12.01ma	$\frac{1001}{1001}$ $\frac{1}{2}mA$ $\frac{1}{2}mA$ $\frac{1}{2}mA$ $\frac{1}{2}mA$	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A	ÓN
Ametek Altek TEST BQUIPMENT N/A	AAM 2000 -59.315"H- -20.8425"H 17.63" H20	RODEL# P2:300 334A re As FOUND: 20 4.01ma 420 17.01ma 20 12.01ma STRUMENT IS IN TOI	3678 3678 266 7TPUT 266 7TPUT 266 4.0100 a 12.0100 a 12.0100 a 12.0100 a 12.0100 a	$\frac{1001}{1001}$ $\frac{1}{1001}$	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATION N/A	ÓN
Ametek Altek TEST EQUIPMENT N/A	APRO 250 -59.315"H- -20.8425"H 17.63" H20 INS .315-17.6	ADDEL# PZi300 334A re:, AS FOUND: z0 4.01ma A20 17.01ma 20 17.01ma STRUMENT IS IN TOI 3 in Hz0	3678 3678 266 7TPDT 266 7TPDT 4.0100 4.0100 12.0000 12.0000 12.0000 12.0000 12.0000 12.00000 12.0000000000	ERIAL # 124 1001 DESIRED 4/mA 12mA 12mA 12mA 320mA	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A	ÓN
Ametek Altek TEST BOUIPMENT N/A N/A N/A Range: -59	Apres 23 -59.315"H -20.8425"H 17.63" H20 INS .315 - 17.6	$\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{12.01}$ $\frac{10000}{12.01}$ $\frac{10000}{12.01}$ $\frac{10000}{12.01}$ $\frac{10000}{12.01}$ $\frac{10000}{12.01}$ $\frac{10000}{12.01}$	26678 2667 2667 2667 2667 2667 2667 2667	ERIAL # 124 1001 DESTREP 4/mA 12mA 12mA 20mA 3 □ NO	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A	ón 
Ametek Altek TEST BOUIPMENT N/A N/A Bange: -59	елт -59.315" н- -20.8425" н- 17.63" н20 INE .315 - 17.6	$\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$	3678 3678 266 7TPDT 266 7TPDT 266 4.0100 a 12.0100 a 12.0100 a 12.0100 a 12.0100 a	$\frac{1001}{1001}$ $\frac{1}{1001}$	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A	ÓN
Ametek Altek TEST BOUIPMENT N/A N/A N/A Range: -59	April 20 -59.315"H -20.8425"H 17.63" H20 INS .315-17.6	$\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$ $\frac{10000}{12.0100}$	2667 2667 2667 TTPLET 4.0100 a 12.01 ma 12.01 ma LERANCE: VE	ERIAL # 124 1001 DESIRED <i>4 mA</i> <i>12mA</i> <i>12mA</i> <i>20mA</i> <i>3</i> □ NO	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A N/A	
Ametek Altek TEST BOUIPMENT N/A N/A BENIS Range: -59	ENT Арилор -59.315" н. -20.8425" н. 17.63" H20 INE .315-17.6 /mg.0	P2i300 334A re AS FOUND: z0 4.01ma Az0 17.01ma Az0 17.01ma STRUMENT IS IN TOI 3 in Hz0 $-\frac{e_{f}}{23/ll}$	20ma 12.01ma 2.01ma 2.01ma 2.01ma 2.01ma	$\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$ $\frac{1001}{1001}$	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A N/A	
Ametek Altek TEST BOUIPMENT N/A N/A BATED BY MOC Jocks	ENT April 62 -59.315"H -20.8425"H 17.63" H20 INE 315-17.6 Imageo	$\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{12.0100}$ $\frac{120}{12.0100}$ $\frac{120}{12.0100}$ $\frac{12.0000}{12.0100}$ $\frac{12.0000}{12.0100}$	ACCEPTED BX	TATIVE (SIGN)	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A DATE DATE	ÓN
Ametek Altek TEST BOUIPMENT N/A N/A BENTS Range: -59	ЕЛТ -59.315" H -20.8425" H 17.63" H20 INS 315-17.6 Magoo	$\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{334A}$ $\frac{P2i300}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$ $\frac{P20}{12.0100}$	3678 3678 266 7TPLUT 266 7TPLUT 4.0100 a 12.01 ma 12.01 ma 20ma LERANCE: V YES	TATIVE (SIGN)	CAL DATE 3/3/2016 3/4/2016 AS LEFT DEVIATE N/A N/A N/A DATE DATE 1 2 2016	

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TRANSMITTER, 9-30-16 TRANSDUCER, INDICATOR, DATE: RECORDER CALIBRATION sailhern District 102739 Grand River Energy Center Unit 3 Project #: Project Name: 1NST-8120-14ST-002 Work Package #: System #: HR. G. 3.1 03A-HRSOIL Area: Location: 100 -PD -0003-001 02.00ZD Specification: 88. 15. Drawing #: Description (Type): INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # P&ID NIA 03-4T-102635A 100-PD-0003-001 MODEL NUMBER NA TOLERANCE INSTRUMENT SERIAL NUMBER MANUFACTURES 3051CDZA 2758709 Rosemount HOOK UP DRAWING NUMBER LOOP DIAGRAM NUMBER NIA MA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NA CALIBRATION DATA Hart 475. Bench METHOD: LOW pressure hand pump ADDITIONAL INSTRUMENT INFORMATION NIA CALDATE MODEL # SERTAL # TEST EQUIPMENT. 3365061 \$ 20/2016 724 FINKE 367824 31312016 XP21300 Ametek OUTPUT AS LEFT DEVIATION 1.50 DESIRED TEST EQUIPMENT AS FOUND : 12 ASLEFT 4mA O in H20 4.00ma 4.00ma 12mA 33,75in H20 12.02mg 12.02 md 67.5 in Hzo ZOMA 20.02mg 20.02mg INSTRUMENT IS IN TOLERANCE: I YES D NO COMMENTS 67.Sin Hzo DATE CALIBRATED BY OPERATIONS REPRESENTATIVE (SIGN) DATE PREPRESENTATIVE (SIGN IF APPLICABLE) TICQUALITY CONTROL (SIGN IF APPLICABLE) DATE DAT

03/2013 .

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 9-30-16 1 RECORDER CALIBRATION Alhern Wishrict 102739 Grand River Energy Center Unit 3 Project #: Project Name: INST-8120-INST-002 ÷ HRGI 3.1 Work Package #: System #: MA Area: 1 03A - HP-SG 3. Location: 88.15.02.0020 100-PD-0003-001 Specification: Drawing #: Description (Type): LEVEL IND TRANS 2-WIRE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # P&ID NIA NA 100-PD-0003-001 03-LIT-102635B INSTRUMENT SERIAL NUMBER TOLERANCE MODEL NUMBER MANUFACTURER 305100ZA Rosemount NA 2,758710 LOOP DIAGRAM NUMBER HOOK UP DRAWING NUMBER NIA NA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NIA CALIBRATION DATA Hart 475 used METHOD: sench pressure hand pump LOW ADDITIONAL INSTRUMENT INFORMATION N/A . CALDATE MODEL # SERTAL # TÊST EQUIPMENT. 724 3365061 \$ 20/2016 FINKE 367824 3/3/2016 XPZ1300 Ametek OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT ase a sag · AS FOUND : · ASLEFT 4mA 4.01ma 4.0lma n HzO 12mA 33.75 inHz0 12.01ma 12.01ma ٩. 20.0200 67.5 in H20 20.0200 ROMA A N INSTRUMENT IS IN TOLERANCE: WYS D NO COMMENTS 67.5in Hzp Range NA an DATE ACCEPTED BY CATTERATED B OPERATIONS REPRESENTATIVE (SIGN) DATE AN (SIGN INTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 9-30-16: RECORDER CALIBRATION Sauddhern District Grand River Energy Center Unit 3 Project #: 102739 Project Name: INST-8120-11NST-002 HRG1 3.1 Work Package #: System #: HRSG 3A NA Area: Location: 100-PD-0006-001 Specification: 02.002D Drawing #: Description (Type): LEVEL IND. TRANS. 2-WIZE INSTRUMENT DATA SHEET # P&ID SERVICE INSTRUMENT TAG # 03-LIT- 102635C 100-PD-006-00 NIA NIA INSTRUMENT SERIAL NUMBER MODEL NUMBER TOLERANCE 762408 NIA Rose mount HOOK UP DRAWING NUMBER 3051COZA LOOP DIAGRAM NUMBER NIA NA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NIA CALIBRATION DATA Bench Hart 475 Used METHOD: SW pressure hand pump ADDITIONAL INSTRUMENT INFORMATION NIA MODEL # SERTAL # CAL DATE TEST EQUIPMENT. 7/20/2016 24 336 5061 -liske 81312016 367824 XP 21300 Ametek OUTPUT ALLOA Dicess AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : ASLEET 4 mA 4.000 4.0 ma O in HzO 12mA 33.75 in 420 12,02ma 12.02mg 20m A 20.01mg 67.Sin HzD 20.01mg V YES INSTRUMENT IS IN TOLERANCE: D NO OMMENTS 67.5 in HzO Ranae: NA an ACCEPTED BY DATE (TATTERATED) BY OPERATIONS REPRESENTATIVE (SIGN) DATE E (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) D/

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Б.,	in a second frame	I Ha 11 District		TRANSE RECOR	RANSMITTE DUCER, INDI DER CALIBR	R, (CATOR, DAT ATION	E. <u>9-30516</u>
	Project Name:		Grand R	iver Energy Center	: Unit 3	. Project #:	102739
	System #:	HRG1 3.1	×.		Work Pack	age #: 1157-8	120- INST-002
	Location:	MA			Area:	03A - HIRSG	
	Drawing #: 10/	)-PD-0006-	-001	Specificati	on: 88.19	5,02.0020	
	Description (Type):	LEVEL .IN	VD	TRANS. 2-M	NRE		
	INCEPTIMENTPEAD #	, , , , , , , , , , , , , , , , , , ,	P&TD		SERVICE	18 18	INSTRUMENT DATA SHEET #
	03-111-105	665A	100-FT	0006-001	1	A/4	N/A
	MANUFACTURER	JV.	2AS	MBER	INSTRUMENT SE	RIAL NUMBER .	TOLERANCE
10	HOOK UP DRAWING NUMBER	1	<u>а03</u>	INCTION BOX	N/A	LOOP DIAGRAM N	DMBER MA
	LINE/VESSEL #	4	1	×	LINE SIZE / SCHE	DULE #	
		. NI	A	CATI	BRATION DATA		PTA
		Davodia	-	chin	Hast L	175 Used	· · ·
	METHOD:	W Dress	STG	hand Pu	MAP	10 100	
	<b></b>	1.4-2	· 'Aïn	DITTONAL	TRUMENT INF	TRMATION	2
	<u> </u>	16) 	. <del>,</del> , , , ,		1	,	
				A	hr		
а 1	TÊST ROTTÊM	ĖŃT .		MODEĹ#	1 5	SERIAL #	CALDATE
.	FWKE		789	<u>.</u>	263600	58	3/4/2016
t	Ameters		XPI	1300	36782	4	3/3/2016
		1 A	2	CU	TPUT ASTREE	DESIRED	AS LEFT DEVIATION
	TEST EQUIPMENT	Append	sure	TODIAD .	F		
	TEST EQUIPMENT	Oin H	sure 120	4.02ma	L.OZMA	4mA	NA
-	TEST EQUIPMENT	Oin H	sure 120	4.02ma	H.OZMA	4mA	NA
	TEST EQUIPMENT	Oin H	sure 120	4.02mg	4.02mg	4 mA	N/A
	TEST BOUIPMENT	Oin H 20in H	20	4.02ma	4.02mg	4 mA 12 mA	N/A
	TEST BOUIPMENT	20 in H	20 20	4.02ma	4.02mg	4 mA 12 mA	
	TEST EQUIPMENT	20 in H 40in H	20 20	4.02ma 12.02ma 20.01ma	12.02mg 20.01mg	4 mA 12mA 20mA	N/A N/A
	TEST EQUIPMENT	20 in H 20 in H	20 20 1NSTR	12.02ma 20.01ma	L.02mg 2.0.01mg ERANCE: MY	4mA 12mA 20mA	N/A N/A
·	N/H Range: O-	20 in H 20 in H 40 in H	20 20 1NSTRI 120	4.02ma 12.02ma 20.01ma	L.02mg 20.01mg ERANCE: TYP	4 mA 12 mA 20 mA	N/A N/A
	M/A N/K Range: 0-	20 in H 20 in H 40 in H 40 in H	20 20 1NSTRU 120	4.02ma 12.02ma 20.01ma MENTIS IN TOI	4.02mg 12.02mg 20.01mg ERANCE: My	4mA 12mA 20mA is □ NO	N/A N/A
	MARENIS Range: O	April 20 O in H 20 in H 40 in H 40 in H 40 in H	20 20 1NSTRI 120	4.02ma 12.02ma 20.01ma IMENTIS IN TOI	LI.OZMA LZ.OZMA ZO.O LMA ERANCE: MY ACCEPTED BY	4mA 12mA ZomA s □ NO	
	MARINENTS Range: O-	April 20 O in H 20 in H 40 in H 40 in H 40 in H	20 20 1NSTRI 120	4.02ma 12.02ma 20.01ma JMENTIS IN TOI	LI.OZMA LI.OZMA LZ.OZMA ZO.O IMA ERANCE: YE	4mA 12mA 20mA is INO	
	MARTENTS Range: O MARTENTS Range: O MARTENTS Range: O	April 20 Oin H 20 in H 40 in H 40 in H	20 20 1NSTRI 420	4.02ma 12.02ma 20.01ma 20.01ma JMENTIS IN TOI -30-16 13	LIDIANIA LIDZMA IZ.OZMA ZO.OIMA ZO.OIMA ERANCE: MY MA ACCEPTED BY MA OPERATIONS REPRESENT	4 mA 12 mA 20mA 30mA 30mA 35 □ NO	N/A
CO CAL	MARCENTS N/K N/K MARCENTS Range: O- That I Instance Instance Instance I Instance I Instance I Instance I Insta	April 20 in H 20 in H 20 in H 40 in H 40 in H	20 20 20 1NSTRI 420	4.02ma 12.02ma 20.01ma 20.01ma 1000000000000000000000000000000000000	IZ.02mq IZ.02mq IZ.02mq ZO.0 Imq ERANCE: YE MA ACCEPTED BY MA OPERATIONS REPRESENT OPERATIONS REPRESE	4 mA 12 mA 20mA 30mA 35 □ NO	NA NA NA DATE DATE DATE DATE

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	Project Name:	Grand R	iver Energy Center	: Unit 3	Project #:	102739
	System #: HR(	51 3.1 ·		Work Packa	ge#: <u>_INST-1</u>	8120-1NST-002
	Location:	NB		Area: _(	)3A-HRSGI	
	Drawing #: 10	1- PD-0006-0	)) Specificati	on: 88	15.02.002	D
	Description (Type):	LEVEL IND. TRI	INS. 2-WIRE			
	INSTRUMENT TAG #	P&ID		SERVICE		INSTRUMENT DATA SHEET #
	03-LIT-105	SUSB 100-1	D-0000-00	N	)/A	N/A
	MANUFACTURER	MODEL NU		7.76	LALO	NIA
l.	HOOK UP DRAWING NUMBER		UNCTION BOX	NA	LOOP DIAGRAM N	UMBER
	INR/VESSEL#			LINE SIZE / SCHED	ULE #	10//1
	N/A	1				N/A
		*	CALI	BRATION DATA		
	METHOD:	Bench	H	art 475 use	d	
	Low pr	ressure hand	bowb			· · · · · · · · · · · · · · · · · · ·
		ÂÏ	DITIONAL INS	TRUMENT INFO	RMATION	
3			N	I/A ···	1207	
		tistur · · · ·	MODEL #	8	RÊTAL #	CALDATE
	TEST EQUIPM	ENT	MODEL#	32650h		7/20/2016
	Amelek	XP	21300	36782	4	3/3/2016
	TEST EQUIPMENT	Appendia	AS FOUND	TPUT ASLEET	DESIREP	AS LEFT DEVIATION
	Alla	Dig HaD	4.0000	4.0ma	4mA	NA
k I			LEI .			
	('	20:011 0:	10 02	12 12 22 2	12m A	
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Project Name:		Grand R	iver Energy Center	r Unit 3	Project #:	102739
System #:	HRG	3.1		Work Packa	age #: <u>INST</u> -	8120-1NST-002
Location:	NA			Area:	03A - HRSO	11
Drawing #: VCC	-PD-000	e-001	Specificat	ion: 58.	15:02.0020	
Description (Type):	LEVEL I	NP. T	RANS 2-14	VIDE		
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TËST EQUIPM Fluk &	ĖNT.	7	MODEL#	N/A:	FERIAL #	CAL DATE 7 20 2016
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TEST EQUIPM Fluk & Amete K TEST EQUIPMENT N/A	ENT Apost O in 20 in	7 Xpz Source HzO HzO	MODEL# 24 1300 AS FOUND : 4.01mg	N/A: 33650 3678 TTPUT: ASLEET 4.01 Ma 12.02 Ma	ERIAL # 61 24 DESIRED 4/mA 12mA	CAL DATE 7[20   2016 3 3  2016 AS LEFT DEVIATION
TEST EQUIPM Fluk & Amete K Test equipment N/A	ent Apost O in 20 in	7 Xpz Essure HzO HzO	MODEL# 24 1300 As Found: 4.01ma 12.02ma	N/A 33650 3678 TIPUT ASLEET 4.01 Ma 12.02 Ma	ERIAL # 61 24 DESIRED 4/mA 12mA	CAL DATE 7[20]2016 3[3] 2016 AS LEFT DEVIATION
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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 9-:30-16: RECORDER CALIBRATION Athern District Project #: 102739 Grand River Energy Center Unit 3 Project Name: INST-8120-INST-102 ±: HRG 3.1 Work Package #: System #: D3A-HRSGI NA Area: Location: 02.002D. Specification: 88. 15. Drawing #: Description (Type): LP DIZM LVL INSTRUMENT DATA SHEET # SERVICE P&ID INSTRUMENT TAG # NIA 665 NIA 03-LIT-MANUFACTURER 100-PD-0010-001 INSTRUMENT SERIAL NUMBER TOLERANCE MODEL NUMBER 1.0 NIA 3051CDZA 2775648 Rose mount LOOP DIAGRAM NUMBER JUNCTION BOX NIA N/A NA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NIA CALIBRATION DATA Hart 475 used METHOD: Bench PRESURE hand gmvg LOW ADDITIONAL INSTRUMENT INFORMATION N/A SERIAL # CALDATE MODEL # TEST EQUIPMENT. 26360063 34/2016 789 rluke 3131201.6 367824 XPZ1300 Ametek OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT ance and ASLEET AS FOUND : . 4 mA 4.02ma 4.02mg HZU 12mA 35.75 in H20 12.01 ma 12.01ma 71.Sin Hzo ZOM 210.02ma 20.02ma INSTRUMENT IS IN TOLERANCE: YES 1 NO COMMENTS 71. Sin HzO · del DATE CALIBRATED B NA OPERATIONS REPRESENTATIVE (SIGN) DATE FOREMAN SEMITATIVE (SIGN IF APPLICABLE) DAT TICQUALITY CONTROL (SIGN IF APPLICABLE) DAT

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 9-30-16 RECORDER CALIBRATION ailhearm District 102739 Grand River Energy Center Unit 3 Project #: Project Name: INST- 8120-INST-002 ÷ Work Package #: HRG 3.1 System #: AИ 03A-HESGIL Area: Location: 38.15.02.002D 100-PD-0010-001 Specification: Drawing #: Description (Type): LEVEL , IND. TRANS. 2-WIRE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # N/A N/A 03-LIT-109665B 100-PD-0010-001 INSTRUMENT SERIAL NUMBER TOLERANCE MODEL NUMBER 2758711 3051CDZA NIA Rosemount LOOP DIAGRAM NUMBER HOOK UP DRAWING NUMBER NIA N/A NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NIA CALIBRATION DATA Hart 475 Used Bench METHOD: pressure hand pump LUW ADDITIONAL INSTRUMENT INFORMATION NIA . SERIAL # CALDATE MODEL # TEST EQUIPMENT. 789 26360053 314/2016 FUKE 3/3/2016 367 924 X021300 Ametek OUTPUT AS LEFT DEVIATION anersia DESIRED TEST EQUIPMENT AS FOUND : · ASLEFT 4mA 4.02ma 4.02ma 420 12mA 35.75 in HzO 12.02mg 12.02mg ۰. 71.5 in H20 20.02ma 20.02ma ROMA N INSTRUMENT IS IN TOLERANCE: WYES D NO COMMENTS 1.S in Hzo DATE CALIBRATED B 9-30-1 OPERATIONS REPRESENTATIVE (SIGN) DATE FORRMAN (SIGN) ESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) DATE

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 9-30-16 RECORDER CALIBRATION authern District Grand River Energy Center Unit 3 Project #: 102739 Project Name: INST-8120-11UST- 002 Work Package #: HEGI 31 System #: OBA-HIRSGI Location: Area: Specification: 88. 15,02.0070 100-90-0010-00 Drawing #: Description (Type): LEVEL IND. D-WIRE TR INSTRUMENT DATA SHEET # P&ID SERVICE INSTRUMENT TAG # 100-PD-0010-001 NA 03-LIT-L09 MANUFACTURER NA 665 C INSTRUMENT SERIAL NUMBER MODEL NUMBER TOLERANCE N/A Rosemount HOOK UP DRAWING NUMBER 3051 CDZA 2775649 LOOP DIAGRAM NUMBER N/A NA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NIA CALIBRATION DATA 425 U.SED METHOD: Rench Low pressure hand PUMP ADDITIONAL INSTRUMENT INFORMATION -\* ... NIA MODEL # SERTAL # CAL DATE TEST EQUIPMENT. 2667001 3/4/ 16 334A LTEK 367824 16 XP WETER 300 3 OUTPUT Pressure AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : 12 ASLEFT 4.0 ma 4 mA OinHzD ma 12mA 12.02 ma 12.02ma 35.75inHzD 20m A NI A 20.07ma 20.07ma 71.Sin Hap INSTRUMENT IS IN TOLERANCE: YES D NO N R OMMENTS .Sin Hzo Range: NA an ACCEPTED BY DATE TRRATED B OPERATIONS REPRESENTATIVE (SIGN) DATE Ex 2 0 ESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) CLIENT REP DAT

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-13-16 RECORDER CALIBRATION and District Grand River Energy Center Unit 3 Project #: 102739 Project Name: WP-INST-00 Work Package #: CSS 3.1 System #: Pipenall Area: Location: Drawing #: 2014-071.1A. 08042A Specification: 94.03.14.100.00 Diff Low TRANSMITTER fressure Description (Type): SERVICE GT STIM INL INSTRUMENT DATA SHRET # INSTRUMENT TAG # co 03 PD IT 035625A 105-035 PRESS 6 TOLERANC MODEL NUMBER 3051CA4A Ose Moo DP DIAGRAM NUMBER ATATING NITING BE LINESIZE / SCHEDULE LINE / VESSEL # 3" HRH 6518 CALIBRATION DATA BENCH METHOD: low Vino ADDITIONAL INSTRUMENT INFORMATION 1.0 \*\*\* CAT: DATE SERTAL # MODEL# TEST EQUIPMENT. 266 7001 14 16 334A Altek 367824 116 NETEK DISTRED AS LEFT DEVIATION OUTPUT TEST EQUIPMENT AS FOUND : . ASLERT 4 mA mst 12mA 12md psid ROS INSTRUMENT'IS IN TOLERANCE: XYES D NO COMMEN 150 psid ANGE 1/11/16 DATE ACCEPTEDBY 11-13-16 DATE XI OPERATIONS REPRESENTATIVE (SIGN) DATE MANTISTON VTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (HIGHTIF APPLICABLE)

REV. 0

TRANSMITTER, DATE: 11-13-16 . TRANSDUCER, INDICATOR, RECORDER CALIBRATION na District Grand River Energy Center Unit 3 Project #: 102739 Project Name: NP-INST-004 Work Package #: 353.1 System #: Piperael OSE Area: Location: Drawing #: 7014.071. 1A. 08042A Specification: 94.03 .. 141.100.00 Description (Type): fressure DiFF IND Trensmitter INSTRUMENT DATA SHEET # INSTRUMENTTAG # PS-035 03 POIT TYNT WE AND MODEL NUMBER 3051C04A OSE MOUN OP DIAGRAM NUMBER LINE SIZE / SCHEDULE # LINE / VESSEL # HRH 6518 CALIBRATION DATA BEWCH HART METHOD: rump ised ADDITIONAL INSTRUMENT INFORMATION 2.2 \*\*\* r SERTAL # CAL DATE MODEL# TËST EQUIPMENT. 2667001 33 tell 367824 ETEK OUTPUT AS LEFT DEVIATION DESTRED TEST EQUIPMENT ASLEEP in A 4 mA 12mA 12mt Rosand 20ml INSTRUMENT IS IN TOLERANCE: DAYES D NO KANGE PSID 0-150 11/11/16 ACCEPTED BY DATE 11-13-16 IV M. DATE OFERATIONS REPRESENTATIVE (SIGN) east DATE ENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-13-16 RECORDER CALIBRATION sing District Project #: 102739 Grand River Energy Center Unit 3 Project Name: WP-INST-004 CSS 3.1 Work Package #: System #: OSE Piperack Area: Location: Specification: 94.03.14.100.00) Drawing #: 201.4.071.19.08042A Description (Type): Pressure Dist lup Transmitter SERVICE GT COMB COOM ANTRUMENT DATA SHEET # INSTRUMENTTAG# 0 3 PO PS-035 STIN INC OUTLDIFF PEIC CODRT NUMBER 3051CA4A 13 LOOP DIAGRAM NUMBER OSE MOULA NA LINE SIZE / SCHEDULE # LINE / VESSEL # 8=HRH6518 CALIBRATION DATA BENCH HAPT METHOD: Pump Used PSI HAND ADDITIONAL INSTRUMENT INFORMATION CALDATE SERTAL # MODEL# TÊST EQUIPMENT. 2667001 314 16 334A Altek 7824 21300 116 AMETEK OUTPUT AS LEFT DEVIATION DISTRED TEST EQUIPMENT AS FOUND : IS ASLEET YmA 4 mA NIA 12mA 12mA 12mA 20ml 20put 20mA 15.0 INSTRUMENT IS IN TOLERANCE: Dis D NO 0-150 psid ANGE ACCEPTED B DATE 11-13-16 OPERATIONS REPRESENTATIVE (SIGN) DATE REPRESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-11-16 RECORDER CALIBRATION sem District Grand River Energy Center Unit 3 102739 Project #: Project Name: WP-INST- 004 Work Package #: System #: Area: Location: Drawing #: 2011 Specification: ZA Description (Type): RANSMITT INSTRUMENT DATA SHEET # INSTRUMENT TAG # P&ID : OBL TOLERANCE MODELNUMBER MANUFACTURE 3 51 TGUA HOOK UP DRAWING NUMBER LOOP DIAGRAM NUMBER INE SIZE / SCHEDULE # LINE / VESSEL # CALIBRATION DATA 2 METHOD: ADDITIONAL INSTRUMENT INFORMATION ۰. SERTAL # CAL DATE MODEL # TÊST EQUIPMENT. 3 10 METER 4/16 101 OUTPUT. AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : 1 ASLEEF 4 mA 12mA RossA TYES D NO INSTRUMENT IS IN TOLERANCE: COMMENTS DATE ACCEPTEDE CALIBRATED BY 11-16-DATE OPERATIONS REP. SENTATIVE (SIGN) TIC QUALTTY CONTROL (SIGN IF APPLICABLE) TIVE (SIGN IF APPLICABLE)

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TRANSMITTER, DATE: 11-11-16 TRANSDUCER, INDICATOR, RECORDER CALIBRATION Ahern District Grand River Energy Center Unit 3 Project Name: Project #: 102739 Work Package #: WE-INST-004 System #: CSS secal Area: Location: 2A Specification: 9 Drawing #: 2014.071. T.R ANSMITT Description (Type): INSTRUMENT DATA SHEET # INSTRUMENT TAG # P&ID Stm Cool P INSTRUMENT SERIAL NUMBER 51 TOLERANCI MODEL NUMBER MANUFACTURE 3051TG4A emo HOOK UP DRAWING NUMBER LOOP DIAGRAM NUMBER NI A LINE SIZE / SCHEDULE # LINE / VESSEL # CALIBRATION DATA 11 METHOD: DSG ADDITIONAL INSTRUMENT INFORMATION ... SERTAL # CALDATE MODEL # TËST EQUIPMENT. XP21315 461540 3/3/16 METER 2007 14/16 Fe K OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : . ASLEFT 4 mA 12mA Rosa INSTRUMENT'IS IN TOLERANCE: X YES D NO COMMENTS ACCEPTED BY DATE CALIBRATED BY OPERATIONS RAPRESENTATIVE (SIGN) DATE AN (SIGN) BENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

TRANSMITTER, DATE: 11-13-16. TRANSDUCER, INDICATOR, RECORDER CALIBRATION and Wissbridge Grand River Energy Center Unit 3 102739 Project #: Project Name: WP-INST-004 Work Package #: 55 3.1 System #: Piperack Area: Location: Drawing #: 2014.071.1A,08047A Specification: 94.03.14,102.00 WO Transmitter Description (Type): Pressure OMS TRANSINSTRUMENT DATA SHBET # NSTRUMENTTAG# P5-034 MODEL NUMBER 03 PIT 0346020 TOLERANCE 3051T64A COSCINCULA R UP DRAWING NUMBER 1A N LINE SIZE / SCHEDULE LINE / VESSEL # 03-10"- HRH 6405 CALIBRATION DATA Beneut METHOD: SOTTI ADDITIONAL INSTRUMENT INFORMATION 1 . CAT, DA'EE SERTAL # TËST EQUIPMENT. MODEL# 2667001 Le R 334A 16 3K 61540 OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT FOUND ASLEEF 4 mA 12mt 12m 12mA ROMAN X YES D NO INSTRUMENT IS IN TOLERANCE: ANGE DATE ACCEPTED BY 11-13-16 DATE gl THE OPERATIONS REPRESENTATIVE (SIGN) DATE PRESENTATIVE (SIGN IF APPLICABLE) THE QUALITY CONTROL (SIGN IF APPLICABLE)

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-11-16 RECORDER CALIBRATION art District Grand River Energy Center Unit 3 Project #: 102739 Project Name: 553.1 WP-INST-002 Work Package #: System #: RSG 03A Area: Location: 94.03, 14.100.00 Drawing #: 3014-071,14.08042A Specification: Description (Type): VICSS 2ANSMITTE Cooling STM INSTRUMENTI INSTRUMENT TAG # PAID PS. MODEL NUMBER 03PIT 03 5616 SUPPLY TOLERANCE 30517644 JUNCTION BOX 2599 MOUN HOD LINE / VESSEL # LINE SIZE / SCHEDULE # HRH 651 13-CALIBRATION DATA 475 BENCH 4025 11 Sec METHOD: ADDITIONAL INSTRUMENT INFORMATION θ. CALDATE MODEL # SERTAL # TËST EQUIPMENT. Alte 2667001 334A 3K 461540 AMETER OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : . ASLEFT 4 mA in 12mb ROA YES D NO INSTRUMENT IS IN TOLERANCE: COMMENTS 830psig DATE CALIBRATED 11-11-16 OPERATIONS REPRESENTATIVE (SIGN) DATE NTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-02-16 RECORDER CALIBRATION ern District Grand River Energy Center Unit 3 Project #: 102739 Project Name: WP-INST-DOZ Work Package #: ND3. System #: 03A-HR36-1 IRSG Area: Location: Drawing #: 2014.071.1A.08041. Specification: 94.03 14,100.00 Description (Type): Pressure INDICATING TRAN MITER 15 INSTRUMENT DATA SHEET # P&TD INSTRUMENT TAG # 03 PIT 061 TOLERANCE MODEL NUMBER 305 TT 64A KOS CALL OOP DIAGRAM NUMBER LINE SIZE / SCHEDULE # LINE / VESSEL # FW6217 CALIBRATION DATA 0 Sed RENCH METHOD: ADDITIONAL INSTRUMENT INFORMATION CALDATE SERTAL # MODEL# TEST EQUIPMENT. 416(540 6 XP213K AMETER 2667001 16 4A OUTPUT AS LEFT DEVIATION DESIREP ABEI GA TEST EQUIPMENT AS FOUND : . ASLEET 4mA 12mA 1500 min ROMA D NO INSTRUMENT IS IN TOLERANCE: X YES COMMENTS 000 160 01 ACCEPTED BY DATE CALIBRATED BY 1.1-02 OPERATIONS REPRESENTATIVE (SIGN) DATE CLIENT REPRESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 11-02-16 RECORDER CALIBRATION thern Disbriet Grand River Energy Center Unit 3 Project #: 102739 Project Name: WP-INST-004 Work Package #: System #: OSE-PIPE RACK KACK Area: Location: 94.03.14,100.00 Drawing #: J014. 071.1A.08042B Specification: Tressure IN DICATING IPANSMI. Description (Type): HER INSTRUMENT DATA SHEET # INSTRUMENT TAG# P&ID OZP 065606 TOLERANCE MODEL NUMBER 305TTG 34 KOSE MA OOP DIAGRAM NUMBER LINE SIZE / SCHEDULE # LINE / VESSEL # CALIBRATION DATA 475 METHOD: SENCH FART 560 ADDITIONAL INSTRUMENT INFORMATION CALDATE SERTAL # MODEL# TEST EQUIPMENT. XP213K AMETCE 6154 200 66 OUTPUT. AS LEFT DEVIATION DESIRED TEST EQUIPMENT AS FOUND : ASLERT 4 mA 1.99ml 12mA 11.99 SASIC Rocat D NO INSTRUMENT IS IN TOLERANCE: YES COMMENTS 0.516 GAUGE ON lun DATE ACCEPTED B CALIBRATED B 11-02-16 OPERATIONS REPRESENTATIVE (SIGN) DATE AN (SIGN 16-14-TIC QUALITY CONTROL (SIGN IF APPLICABLE) NTATIVE (SIGN IF APPLICABLE)

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Project Name:	G.	rand River Energy Cente	er Unit 3	Project #:	102739
System #: HR	613.1	4	Work Pack	tage #: <u>INST</u>	- SIZO - TX41- 002
Location: UN	IT 03 H	IRSG	Area:	03A - HRSG	
Drawing #: 20	14-071-74-070	944B Specificat	tion: 88,	15,07,002P	
Description (Type):	HPFWP	R-ESS.			
INSTRUMENT TAG #	På	m.	SERVICE	VIA	INSTRUMENT DATA SHEET #
MANUFACTURER	blb MC	DDELNUMBER	INSTRUMENT SE	RIAL NUMBER .	TOLERANCE
Rosemoun	F 3	BOSITGHA	2758	721	N/A
NIA		N/A			N/A .
LINE/VESSEL#		2	LINE SIZE / SCHE	DULE #	)
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	£.	ADDITIONALIN	STRUMENT INF	DRWATION	
		, <u>112,11,12,11,12,11,1</u>	///		
TÊST EQUIPM Fluke	ÈNT.	MODEL#	33650	serial #	CALDATE 7/20/2016
Ametek	AAAIIGI	101 OI	TPUT	DISTRIPTO	ASTRET DEVIATION
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<u>}</u>	1671.30	519 12,0210	12.02000	15m15	
N/A	3395 psi	6 20.01mg	20.01ma	ROMA	NA
N/A	3395 psi	6 20.01mg	20.01ma	20mA	NA
MA MENTS Range: C	3395 psi 3395 psi 3395 psi	G 20.01mg NSTRUMENT IS IN TO 25 psi G	20.01ma LERANCE: My	ROMA ROMA	N/A
MA EMENTS Range: C Canony BRATED BY	3395 psi	$\frac{1}{16} \frac{120.01mq}{20.01mq}$ $\frac{1}{15} \frac{1}{15} \frac{1}{10} \frac{1}{$	LERANCE: WYA	ROMA ROMA	DATE
MAN (SIGN)	3395 psi 3395 psi 11 2 - 339 11 11 11 11 11 11 11 11 11 11 11 11 11	$\frac{G}{20.01mq}$ $\frac{G}{20.01mq}$ $\frac{20.01mq}{15 \text{ ps: }G}$ $\frac{9/20/16}{DATE}$ $\frac{9/20/16}{DATE}$	LERANCE: VE	ROM A	DATE

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 10-11-16 RECORDER CALIBRATION rn District Grand River Energy Center Unit 3 102739 Project #: Project Name: HR01 3.1 Work Package #: INST-8/20-1NST-002 System #: 03A - HESGIL Area: Location: 100-PD-0003-001 Specification: Drawing #: 88.15.02.00ZD Description (Type): HD DEM PRESS A. PRESSURE IND TRANS. 2-WIRE. INSTRUMENT DATA SHEET # INSTRUMENT TAG # RRVIN NIA 03 PIT 100-PD-0003-001 NIA 102670A INSTRUMENT SERIAL NUMBER TOLERANCE MANUFACTURER 3051T64A NIA 24 OOP DIAGRAM NUMBER ROSEMOU HOOK UP DRAWING NUMBER NIA NIA N/A LINE SIZE / SCHEDULE # LINE / VESSEL # NLA NIA CALIBRATION DATA BENCH TART USED METHOD: ADDITIONAL INSTRUMENT INFORMATION . . NIA SERIAL # CAL DATE MODEL # TEST EQUIPMENT. 0 METER Du OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT ASLEFT A'S FOUND : 4 mA 1 cer 12mA Romk INSTRUMENT IS IN TOLERANCE: YES YES I NO COMMENTS ANGE NA ACCEPTED BY DATE CALIBRATED BY 10-11-16 OPTRATIONS BE RESENTATIVE (SIGN) DATE DATE TIC QUALITY CONTROL (SIGN IF APPLICABLE) (SIGN TRAPPTICABLE

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 10-11-16 RECORDER CALIBRATION නෙමහට කමන්වේ. Grand River Energy Center Unit 3 Project #: 102739 Project Name: INST-8120-INST-002 Work Package #: HRG 3.1 System #: 03A-HESGI Area: Location: 100-PD-0003-001 88.15.02.02pD Specification: Drawing #: Description (Type): HP DEM PRESS B. PRESSURE IND. TRANS. 2-WIRE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # NIA NIA 100-PD-0003-001 1005 10. TOLERANCE INSTRUMENT SERIAL NUMBER MANUFACTURER NIA 3051 T6 4A SEMIC LOOP DIAGRAM NUMBER UP DRAWING NUMBI NIA N/A NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NLA CALIBRATION DATA APT 475 1.500 FUCH METHOD: ADDITIONAL INSTRUMENT INFORMATION N/A. SERIAL # CALDATE MODEL # TEST EQUIPMENT. T-150 95536 METER. DU OUTPUT AS LEFT DEVIATION DESIRED Appendia TEST EQUIPMENT AS FOUND : AS LEFT 4mA Ind NA 12mA 20mA D YES D NO INSTRUMENT IS IN TOLERANCE: COMMENTS -2965 PS16 NB 6 DATE 10-11-16 REPRESENTATIVE (SIGN) DATE DATE AN (SIGN CATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) 03/2013 .

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TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 12-20-16 RECORDER CALIBRATION arm Mistriet Project #: 102739 Grand River Energy Center Unit 3 Project Name: INST-8170-1NST-002 HEG 3.1 Work Package #: System #: 03A - HESCIL HRSG Area: Location: 88.15.02.0020 100-10-0003-001 Specification: Drawing #: Description (Type): HP DRM. PRESS C. PRESSURE IND. TRANS. 2-WIRE. INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # P&ID 03 PIT 102 670C 100 - PD-0003-001 MODEL NUMBER NIA NIA INSTRUMENT SERIAL NUMBER TOLERANCE 275 8722 ILOOP DIAGRAM NUMBER NIA 3051T64A KOSEMOUL HOOK UP DRAWING NUMBER NA NIA N/A LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NIA CALIBRATION DATA PUMP USED HAUN BENCH METHOD: AART 475 0500 ADDITIONAL INSTRUMENT INFORMATION NA SERIAL # CALDATE MODEL # TEST EQUIPMENT. 2667001 334A 3/4 ALTER 3K 461540 116 IETEK OUTPUT AS LEFT DEVIATION Appenson DESIRED TEST EQUIPMENT ASLEFT AS FOUND : 1 4mA NA 3.99 N/A 2516 12mA ZOMA 19.99m A 19.99 NIA NIA INSTRUMENT IS IN TOLERANCE: VES D NO 1 COMMENTS ANGE 0-2965 PSIG 116 ACCEPTED BY DATE CALIBRATED BY 12-20-16 DATE AP2 OPERATIONS REPRESENTATIVE (SIGN) DATE TATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

03/2013 .

TRANSMITTER, DATE: 9-30-16 TRANSDUCER, INDICATOR, RECORDER CALIBRATION wilhern Wistrict Grand River Energy Center Unit 3 Project #: 102739 Project Name: JNST-8120-INST-002 3.1 Work Package #: System #: NB Area: 03A-HRSON 1 Location: 100 - PD - 0004 -001 Specification: 88.15.02.0020 Drawing #: Description (Type): HP SH, STM OUTL PRESS INSTRUMENT DATA SHEET # SERVICE P&ID INSTRUMENT TAG # NIA NIA 100-PP-0004-001 03 PIT MANUFACTURER 104604 INSTRUMENT SERIAL NUMBER TOLERANCE MODEL NUMBER N/A JUNCTION BOX 205 OOP DIAGRAM NUMBER HOOK UP DRAWING NUMBER NIA NIA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NIA CALIBRATION DATA OSEN 475 UCH METHOD: Rec USED ADDITIONAL INSTRUMENT INFORMATION ž a N/A. SERTAL # CAL DATE TËST EQUIPMENT. MODEL # 266700 e C 334 540 MATER OUTPUT Appendia DESIRED AS LEFT DEVIATION TEST EQUIPMENT AS FOUND : 12 ASLEET 4 mA 151G 12mA ZomA KYES INSTRUMENT IS IN TOLERANCE: D NO COMMENTS NA ACCEPTED BY DATE NA OPERATIONS REPRESENTATIVE (SIGN) DATE Cel TIC OPALITY CONTROL (SIGN IF APPLICABLE) WTATIVE (SIGN IF APPLICABLE) DATE REPH

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 8 RECORDER CALIBRATION milhorn District 102739 Project #: Grand River Energy Center Unit 3 Project Name: INST-8120-INST-002 Work Package #: HRGI 31 System #: O3A-HRSGI HRSG Area: Location: Specification: 204-071-1A-07044E 88.15.02.0020 Drawing #: Description (Type): PRESURE IND. TRANS. Z-WIRE INSTRUMENT DATA SHEET # SERVICE P&ID INSTRUMENT TAG # 23 PIT TANUPACTURER N/A TOLERANCE IP DEM PRESS INSTRUMENT SERIAL NUMBER 94.03.32.100-PD-0006-001 MODEL NUMBER 229 NI LOOP DIAGRAM NUMBER NIA JUNCTION BOX HOCK UP DRAWING NUMBER NIA N/A LINE/VESSEL# MA LINE SIZE / SCHEDULE # NIA N/A CALIBRATION DATA Xm Used METHOD: ADDITIONAL INSTRUMENT INFORMATION NA CALDATE SERIAL # MODEL # TEST EQUIPMENT 266 2001 14/16 Altek 334A 461540 16 FMETER OUTPUT AS LEFT DEVIATION Appendia DESIRED TEST EQUIPMENT AS FOUND ASLEFT 4 m 4 mA NIA N/A 3.97 PSIL 12mA 11.97 mit 415 PS16 NIA 20m A NIA 19.99mA 200 PSIL 830 INSTRUMENT IS IN TOLERANCE: TYPE D NO COMMENTS Zen - 830 DATE ACCEPTED BY CALIBRATED BY en Al OPERATIONS REPRESENTATIVE (SIGN) DATE 0 PRESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

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TRANSMITTER, DATE: 12/15/14 TRANSDUCER, INDICATOR, RECORDER CALIBRATION adharn District Project #: 102739 Grand River Energy Center Unit 3 Project Name: INST-8120-INST-002 HRGI 3.1 Work Package #: System #: HESGI Area: HIZSON Location: 2014-071-1A-07044F 88 15.02.0021 Specification: Drawing #: Description (Type): PRESSURE IND. TRAINS. 2-WIRE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # P&TD 94,03.32.100-PD-0006-001 NIA 3 P11 P DEM PRESS NOTDIMENT SEPTAL NITMERI ANDEACTURER 30517644 NIA HOOK UP DRAWING NUMBER JUNCTION BOX LOOP DIAGRAM NUMBER NIA N/A NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NIA CALIBRATION DATA es Jace XMIR tous METHOD: 10 ADDITIONAL INSTRUMENT INFORMATION NA CAL DATE SERÍAL # MODEL # TEST EQUIPMENT 266 9001 334 A Altek 116 461540 3 Amete 3K 2 OUTPUT AS LEFT DEVIATION DESIRED Appensis TEST EQUIPMENT AS FOUND : ASLEFT 4mA NA NIA 12mA 200 20mA NIA INSTRUMENT IS IN TOLERANCE: Dives D NO COMMENTS 51 en ACCEPTED BY DATE CALIBRATED BY 12-15-1 OPERATIONS REPRESENTATIVE (SIGN) DATE SIGN C RESEMPATIVE (SIGN IF APPLICABLE) DATE TIC QUALITY CONTROL (SIGN IF APPLICABLE)

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TRANSMITTER, TRANSDUCER, INDICATOR, 1 DATE: 9-30-16 . RECORDER CALIBRATION Solitica District Grand River Energy Center Unit 3 Project #: 102739 Project Name: INST-8120-1NST-002 HRGI 3.1 ÷, Work Package #: System #: 03A - HRSG NA Area: Location: 100-PD-0009-001 88.15.02.002D Specification: Drawing #: Description (Type): CONDENSATE INL PRESS PRESSURE IND. TRANS. 2-WIRE INSTRUMENT DATA SHEET # SERVICE P&ID INSTRUMENT TAG # 03 PIT 100-PD-0009-001 N/A 108609 TOLERANCE INSTRUMENT SERIAL NUMBER MODELNUMBER NA JUNCTION BOX 8733 HOOK UP DRAWING NUMBER LOOP DIAGRAM NUMBER NIA N/A NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NA CALIBRATION DATA METHOD: 1)SEO ADDITIONAL INSTRUMENT INFORMATION 1 3 NIA CAL DATE SERTAL # TËŚT EQUIPMENT. MODEL # 3 U 2001 215 METER OUTPUT AS LEFT DEVIATION Applien DESIRED TEST EQUIPMENT ASLEET AS FOUND : 12 4 mA 12mA Le ZomA X YES INSTRUMENT'IS IN TOLERANCE: D NO COMMENTS 1516 NA as ACCEPTED BY DATE CALIBRATED BY ONS REPRESENTATIVE (SIGN) DATE TIC QUALITY CONTROL (SIGN IF APPLICABLE) CUTENCEREPRI ATTVE (SIGN IF APPLICABLE)

03/2013 .

TRANSMITTER, DATE: 12-15-16 TRANSDUCER, INDICATOR, RECORDER CALIBRATION harn District Project #: 102739 Grand River Energy Center Unit 3 Project Name: INST-8120-1145T-002 HEG 3.1 Work Package #: System #: 03A-HRSGI 1 HISG. Area: Location: B.15.02.002D 2014-071-1A-07044E Specification: Drawing #: Description (Type): Pressure IND. Trans. 2-WIVE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # O3 PIT 94 03 32.100-PD-1000-001 LP DRM NIA 1096701 TOLERANCE ANUEACTURER 3051 T63 016 N/A HOOK UP DRAWING NUMBER UNCTION BOX N/A LINE/VESSEL# NIA NIA LINE SIZE / SCHEDULE # NIA NIA CALIBRATION DATA XMIT 42 USEO Benel 1st METHOD: L le ADDITIONAL INSTRUMENT INFORMATION ÷. . MA CAL DATE MODEL # SERIAL # TEST EQUIPMENT 266 7001 Ite Ic 334A 116 16 (340 AMETEIL 7021 OUTPUT AS LEFT DEVIATION Appener DESIRED TEST EQUIPMENT ASLEFT AS FOUND : NIA 4. 114A 4mA NIA 516 12mA 12-014 DSIA 20mA NIA 20.01 65 INSTRUMENT IS IN TOLERANCE: KYES D NO COMMENTS 165 ACCEPTED BY DATE CATTER ATED BY 12-15-16 DATE OPERATIONS REPRESENTATIVE (SIGN) DATE CLIENT REPRESENTATIVE (SIGN IF APPLICABLE) DATE TIC QUALITY CONTROL (SIGN IF APPLICABLE)

03/2013

TRANSMITTER, DATE: 12-15-16 TRANSDUCER, INDICATOR, **RECORDER CALIBRATION** Unorn District Project #: 102739 Grand River Energy Center Unit 3 Project Name: INST-8120-1115T-002 HRGI Work Package #: 3. System #: HRSG 1 O3A HRSON Area: Location: 2014-071-1A-07044E 15.02.0020 Specification: Drawing #: Description (Type): PRESSURE IND. TRANS. 2-WIRE INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # 94.03.32.100-PD-0010-001 LP DRM PRESS B NIA Pil 03 6 INSTRUMENT SERIAL NUMBER FOLERANCE ODEL NUMBER MANUFACTURER 3051T63A JIA OOP DIAGRAM NUMBER no HOOK UP DRAWING NUMBER NIA N/A NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NIA NIA CALIBRATION DATA 425 USe XUTTA METHOD: 210 ADDITIONAL INSTRUMENT INFORMATION CAL DATE SERIAL # MODEL # TEST EQUIPMENT. 14 3344 2667001 Alter 13/16 461540 3 HMETER 3K OUTPUT Appener DESIRED AS LEFT DEVIATION TEST EQUIPMENT ASLEFT AS FOUND : 4mA A N/A 12mA 99 k.A ZOMA NIA NA 9. 9 9m INSTRUMENT IS IN TOLERANCE: X YES D NO COMMENTS 65 DATE ACCEPTED BY CALTBRATED BY 12-15-1 OPERATIONS REPRESENTATIVE (SIGN) DATE SENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) DATT

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: 1 RECORDER CALIBRATION Sauthorn District Grand River Energy Center Unit 3 Project #: 102739 Project Name: INST-8120-1WST-002 Work Package #: FUS 3.) System #: OJA-HESG Area: 03A-HRSGI Location: 88, 15, 02,0020 PS-160 Specification: Drawing #: FINS SEP OUTL PRESS FIT Description (Type): INSTRUMENT DATA SHEET # SERVICE INSTRUMENT TAG # P&ID NIA PS-650 MODEL NUMBER NIA 650617 <u>23 P1</u> MANUFACTURER INSTRUMENT SERIAL NUMBER TOLERANCE NA 305/TG 4A HOOK UP DRAWING NUMBER LOOP DIAGRAM NUMBER NA NIA NIA LINE SIZE / SCHEDULE # LINE / VESSEL # NA NIA CALIBRATION DATA METHOD: ADDITIONAL INSTRUMENT INFORMATION + + NIA SERIAL # CAL DATE MODEL# TEST EQUIPMENT. 266900 Altek 116 6154 021 MATER OUTPUT AS LEFT DEVIATION Appendia DESIRED TEST EQUIPMENT ASLEFT AS FOUND : 17 4 mA N/A /A N 12mA 430 20m A NIA N/A \$60 INSTRUMENT IS IN TOLERANCE: YES D NO COMMENTS Inn Zer ACCEPTED BY DATE CALIBRATED BY DATE OPERATIONS REPRESENTATIVE (SIGN) DATE NISTON CLIENT REPRESENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE)

Part Spillie Southern D	īstrīct	TRAN TRANSDUC RECORDE	NSMITTER, CER, INDICA R CALIBRA	ATOR, DAI	E: 12-15-16
Project Name:	Grand I	River Energy Center Unit	t 3	Project #:	102739
System #:	3.1	2 24 23/22 - 12 - 12 - 12 - 12 - 12 - 12 - 12 -	Work Package	#: INST-7	8120-INST-003
Location: STEAM	TURBINE	GENERATOR .	Area:	04A-STGI	
Drawing #: 2014-0	071-1A-08042E	Specification:	88.1	5.02.002D	
Description (Type): H	RH STM	TEMP.			•
INSTRUMENT TAG #	P&D		SERVICE		INSTRUMENT DATA SHEET #
03-TE-03562	23 PS-	185	INSTRUMENT SERIAL	NUMBER	TOLERANCE
JMS SOUTH	EAST BEK	BNMT	NIA		N/A .
HOOK UP DRAWING NUMBER		JUNCTION BOX		LOOP DIAGRAM N	UMBER
LINE/VESSEL#		N/A	LINE SIZE / SCHEDUI	B#/	
NA	· · · · · · · · · · · · · · · · · · ·	CALIBRA	TION DATA		
		· · · · · · · · · · · · · · · · · · ·	M. M	<u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u>	
PTD	, , , , , , , , , , , , , , , , , , ,	DDITTONAL INSTRI	DMENT INFOR	MATION	· · · · · · · · · · · · · · · · · · ·
ETD TEST EQUIPMEN Fluke	T	DDITIONAL INSTRI MODEL# 724	UMENT INFOR	MATION RIAL # 5001	CALDATE 7/20/16
ETD TEST EQUIPMEN Fluke TEST EQUIPMENT	Ť MCDEL#	MODEL # 724 OUTPL	MENT INFOR	mation rial # 5001 desired	CAL DATE 7/20/16 AS LEFT DEVIATION
ETD TEST EQUIPMEN Fluke TEST EQUIPMENT	T MODELL AMBI	MODEL # 724 OUTPL	UMENT INFOR	MATION RIAL # 5001 DESTRED	CAL DATE 7/20/16 AS LEFT DEVIATION
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A	T MODELL AMBI	DDITIONAL INSTRI MODEL # 724 ASTOUND ENT	UMENT INFOR	MATION RIAL # 5001 DESIRED	CALDATE 7/20/16 ASIEFTDEVIATION
ETD TEST EQUIPMEN Fluke TEST EQUIPMENT N/A	T MODELLA AMBI	DDITIONAL INSTRI MODEL # 724 ASTOUND ENT	UMENT INFOR	MATION RIAL # 5001 DESIRED	CAL DATE 7/20/16 AS LEFT DEVIATION
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A	T MODELLE MARTINE	DDITIONAL INSTRI MODEL # 724 ASTOUND ENT	DMENT INFOR	MATION RIAL # 5001 DESIRED	CAL DATE 7/20/16 AS LEFT DEVIATION
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A	T MODELL AMBI	MODEL # 724 OUTPL	UMENT INFOR	MATION RIAL # 5001 DESTRED	CALDATE 7/20/16 ASLEFT DEVIATION
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A	T MODERA AMBI	MODEL # 724 OUTPL ASTOUND ENT TRUMENT IS IN TOLER	ASTERT 70.) °F	MATION RIAL # 5001 DESTRED	CALDATE 7/20/16 ASLEFT DEVIATION N/A
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A N/A	T MOTORIA AMBI AMBI INST	DDITIONAL INSTRI	Ambient	MATION RIAL # 5001 DESTRED	CALDATE 7/20/16 ASTEPT DEVIATION N/A
ETD TEST EQUIPMENT Fluke ITEST EQUIPMENT N/A N/A N/A N/A N/A SMMENTS RANGE: -328	T Marine Marine AMBI AMBI INST -032°F	MODEL # 724 COUTPL ASTOUND ENT FRUMENT IS IN TOLER	Ambient	MATION RIAL # 5001 DESIRED	CALDATE 7/20/16 ASLEPT DEVIATION N/A
ETD TEST EQUIPMENT Fluke TEST EQUIPMENT N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A	T Marine Marine AMBI AMBI INST -032°F	MODEL # 724 COUTPL ASTOUND ENT ENT TRUMENT IS IN TOLER	ACCEPTED BY	MATION RIAL # 5001 DESIRED	CALDATE 7/20/16 ASLEPT DEVIATION N/A

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Southern District	TRAN TRANSDUC RECORDER	SMITTER, ¢ ER, INDICATOR, DA R CALIBRATION	TE: <u>12-69-16</u>
Project Name: Grand	River Energy Center Unit	3 Project #:	102739
System #: CDN 3.1	8	Work Package #:	-8120-INST-003
Location: STEAM TURBINE (	HEN.	Area: 04A-STG1	
Drawing #: 2014-071-1A-080	51 Specification:	88.15.02.0020	)
Description (Type): COND HO	TWELL TEMP.		а 
INSTRUMENT TAG # P&ID	x-050	SERVICE	INSTRUMENT DATA SHEET #
MANUFACTURER MODELL	NUMBER	INSTRUMENT SERIAL NUMBER	TOLERANCE
HOOK UP DRAWING NUMBER	JUNCTION BOX	LOOP DIAGRAM	NUMBER
LINE/VESSEL#	P*//\	LINE SIZE / SCHEDULE #	1.1/1.
	CALIBRA	LION DATA	and the second
METHOD: BENCH.			
	ADDITIONAL INSTRU	MENT INFORMATION	*********
T/C TYPE E.			<u>24 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</u>
TEST FOUTDMENT	a total a star and a total a star a		and the second sec
	MODEL#	SERIAL #	7/20/10
FIVE	MODEL #	SERIAL # 3365061	CAL DATE 7/20/16
TEST EQUIPMENT MODELCE	MODEL # 724 	SERIAL # 3365061 	CAL DATE 7/20/16 ASLEFT DEVIATION
TEST EQUIPMENT MODERCE N/A Aw	MODEL # 724 	SERIAL # 3365061 	CAL DATE 7/20/10 ASLEFT DEVIATION N/A
TEST EQUIPMENT MODERCE N/A AW	MODEL # 724 <u>ASTOUND</u>	SERIAL # 3365061 	CAL DATE 7/20/10 AS LEFT DEVIATION N/A
TEST EQUIPMENT MODERCE	MODEL # 724 	SERIAL # 3365061 T- ASTERT DESTRED	CAL DATE 7/20/10 AS LEFT DEVIATION N/A
TEST EQUIPMENT	MODEL # 724 	SERIAL # 3365061 T. DESIRED 67.8°F	CAL DATE 7/20/10 AS LEFT DEVIATION N/A
TEST EQUIPMENT MODERCE N/A AW	MODEL # 724 	SERIAL # 3365061 T ASTERT 0ESTRED 07.8°F	CAL DATE 7/20/10 AS LEFT DEVIATION N/A N/A
TEST EQUIPMENT MODERCE TEST EQUIPMENT MODERCE N/A AW	MODEL # 724 	SERIAL # 3365061 T astert 07.8°F 07.8°F ANCE: $7es$ Yes $\Box$ NO	CAL DATE 7/20/16 AS LEFT DEVIATION N/A
TEST EQUIPMENT TEST EQUIPMENT N/A AW N/A INS COMMENTS RANGE: 0-1200'F	MODEL # 724 	SERIAL # 3365061 T ASTERT 07.8°F 07.8°F 07.8°F 07.8°F NO Ambient + Function	Check ONWT.
FIVE       TEST EQUIPMENT       N/A	MODEL # 724 	SERIAL # 3365061 T ASLERT DESTRED 07.8°F 07.8°F COT 8°F COT 8°F NO Ambient & Function	Check ONly.
RANGE: 0-1200 F	MODEL # 724 	SERIAL # 3365061 T ASLERT DESTRED $67.8^{\circ}F$ Construction Ambient $+$ Function Ambient $+$ Function	Check ONWS.
RANGE: 0-1200°F	MODEL # 724 	SERIAL # 3365061 T ASTERT DESTRED $47.8^{\circ}F$ $67.8^{\circ}F$ Amplent $4Function$ Amplent $4Function$ MA ACCEPTED BY	CNECK ONWY.
RANGE: 0-1200 F Stanty Unent CALIBRATED BY FOREMAN (SIGN)	MODEL # 724 	SERIAL # 3365061 TDESIRED ASTERT DESIRED 078°F	CAL DATE 7/20/10 AS LEFT DEVIATION N/A N/A N/A CNECK ONWY. DATE
TEST EQUIPMENT TEST EQUIPMENT N/A N/A N/A N/A INI COMMENTS RANGE: 0-1200°F Stanty Unent CALIBRATED BY FOREMAN (SIGN) ACD	MODEL # 724 	SERIAL # 3365061 T DESIRED ASLERT DESIRED $478^{+}$ $678^{+}$ $678^{+}$ Ance: Yes no Ambient + Function Ambient + Function Ambient + Gunchion	CAL DATE 7/20/10 AS LEFT DEVIATION N/A N/A N/A N/A DATE DATE 12/1/16

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Southern D	istrict	TRA TRANSDU RECORDE	NSMITTER, CER, INDICAT ER CALIBRATIO	OR, DATI	E: <u>12-02-16</u>
Project Name:	Grand Riv	er Energy Center Un	it 3	Project #:	102739
System #: BFW	3.1		Work Package #:	INST-	8120-INST-004
Location: BOILE	z feed wat	er.	Area: 05	E- PIPERA	
Drawing #: <u>2014</u> Description (Type):	-071-1A-07042 3FP 01A SU	Specification:	88.15	5.02.002	D
INSTRUMENT TAG #	P&ID	160	SERVICE		INSTRUMENT DATA SHEET #
JMS SOUTH EAS	MODEL NUM	BER UT.ESHUPZZZM	INSTRUMENT SERIAL NU	MBER	TOLERANCE M/A
100K UP DRAWING NUMBER	4	NCTION BOX		LOOP DIAGRAM N	JMBER N/A
INE / VESSEL * N/A		0.2020	LINE SIZE / SCHEDULE #	N/A	
		CALIBR	ATION DATA		
METHOD: BEN	CH.				
	AD	DITIONAL INST	RUMENT INFORM	ATION	
T/C TYP	ΈE				
TEST EQUIPMEN	TT	MODEL #	SERI	<b>\L</b> #	CAL DATE
FIUKE	7	124	336 50 Cel		7/20/16
TEST EQUIPMENT	INPUT	OUT AS FOUND	PUT AS LEFT	DESIRED	AS LEFT DEVIATION
N/A	AME	SIENT	67.7 F		NIA
N/A					NA
MMENTS	INSTI	RUMENT IS IN TOL	ERANCE: XYES	□ NO	
PANGE: 18	0 - 420 F	AM	BIENT+ FUN	JUTION	CHECK ONLY.
Stanley (	1 mast	8/9/1C	NA- ACCEPTED BY		DATE
Sme like		17-07-16	NA		
REMAN (SIGN)	CIP	DATE	OPERATIONS REPRESENTA	TIVE (SIGN)	DATE /

BFW3.1

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	Sound hourse ables	TRANSD RECORI	RANSMITTER, DUCER, INDICATOR, DER CALIBRATION.	DATE: 12-02-16
	Project Name:	Grand River Energy Center	Unit 3 Project	t#: 102739
	System #: BFW	3.	Work Package #:	5T-8120-INST-004
	Location: BOILER	FEED WATER	Area: 05E - PIP	PE RACK
	Drawing #: 2014-0	II-IA-07042 Specification	88.15.02.002	.D
	Description (Type): BE	POID SUCT TEMP	т	
	INSTRUMENT TAG #	P&D	SERVICE	INSTRUMENT DATA SHEET#
8	03-TE-060615 MANUFACTURER	PS-060. MODEL NUMBER	INSTRUMENT SERIAL NUMBER	TOLERANCE .
5	JMS SOUTHER	IST IFH BKU 7.55 HUP222	N/A	AM NUMBER
	N/A	NA	TINE SIZE / SCHEDULE =	N/A .
	N/A		N/A	
	METHOD BENG	CALIBR	ATION DATA	
		ADDITIONAL INSTE	RUMENT INFORMATION	
	T/C TYPE E		*	· · · · · · · · · · · · · · · · · · ·
-		· MODEÌ #'	SERTAT. # '*	CAT:DATE
f	FLUKE	724	3365061	7/20/10
•  -	TEST BOTTPMENT	ASPER OFTPI	DESIRED	ASLEFT DEVIATION
t		ANRIENT	TASLER T	N/A
F		Mapigat		
F		2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		. :
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F	1	INSTRUMENT IS IN TOLERA	ANCE: Kyes I NO .	,
COM	DANGE . LAN'F-47	0'F	MRIENT + GILVTIONS	CHECK ANIN
-	RANCETO	<u> </u>	TEIGHT + TONOTIONS	UNECIE DIVEY
	4111	+ elalu	NA	
CALIR	MATED BY	DATE 8/8/16 AC	CEPTED BY	DATE
K	Any habias	10-0211	NA	
OREM.	IAN (SLIGN)	DATE OPE	STATIONS REPRESENTATIVE (SIGN)	DATE 1 1
7). 1	ych	12/7/14	J.	12/2/16
IC QUA	LITY CONTROL (SIGN IF APPLICABLE)	DATE CSUE	RTREPRESENTATIVE (SIGN IF APPLICABLE)	DATE
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. I	Smethern Distri	TRANSDI RECORD	ANSMITTER, JCER, INDICATOR, ER CALIBRATION	DATE: 12-52-16
	Project Name:	Grand River Energy Center U	hit 3 Project	#: 102739
34 1941	System #: BFW 3	1	Work Package #:	ST-8120-INST-004
	Location: BOILER F	EED WATER	Area: OSE-PIP	E RACK.
	Drawing #: 2014-011-	1A-07044B Specification	88.15.02.002	D
	Description (Type): BFW	I HP ECON INL TER	NP.	1 (b) (b)
	03-TE-061023	PS-001	SERVICE N/A	
	JMS SOUTHEAS	T. 1E4BKUJSH6PZZZMIX	INSTRUMENT SERIAL NUMBER	TOLERANCE .
	HOOK UP DRAWINGNUMBER	JUNCTION BOX	LOOP DIAGRA	N/A .
	LINE/VESSEL#		LINE SIZE/SCHEDULE # N/A	8 g
ž	BGINI	CALIBRA	TION DATA	· · · ·
		<b>L</b> •	· · · · · · · · · · · · · · · · · · ·	
	· · · · · · · · · · · · · · · · · · ·	ADDITIONAL INSTRI	MENT INFORMATION	
	T/C TYPE	E BA		
	TËST EQUIPMENT.	MODEL#	SEŔŤAL#	CALIDATE
-	FINKE	724	3365061	7/20/10
	TEST EQUIPMENT	OUTPUT	P DESIRED	AS LEFT DEVIATION
T	NIA	AMBIENT	UA.8 F	N/A
			•	
·.[				
	N/A	<u> </u>	·	NIA
€ COM	I IMENTS	' INSTRUMENT IS IN TOLERAN	NCE: K YES D NO	<u>.</u>
	PANGE: 180 F-4	20°F Ame	BLENT + FUNCTION CL	LECK ONLY.
<	Tonly Vinent	+ 8/9/16 A	PTED BY	DATE
K	ine Jackine of	2 12-02-16 OFFE	ATIONS REPRESENTATIVE (SIGN)	DATE
TICQUA	AUTY CONTROL (SIGN IF APPLICABLE)	- 12/7/14 D	DEFRESENTATIVE (SIGN IF APPLICABLE)	- D/2/16.
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Southern Di	istrict	TRAN TRANSDUC RECORDE	NSMITTER CER, INDIC R CALIBRA	, ATOR, DAT ATION	E: <u>12-02-16</u>
Project Name:	Grand Rive	r Energy Center Uni	t 3	Project #:	102739
System #: BFW	3.1		Work Packag	ge #: INST	-8120-1NST-004
Location: BOILER	L FEED WAT	FR	Area:	OSE-PIPE	RACK
Drawing #: 2014	-071-11A-07043	Specification:	88.	15.02.0020	
Description (Type):	G PERF HT	ir fw ini	- TEMP.		
INSTRUMENT TAG #	ST PRID C-	NIA7	SERVICE	A	INSTRUMENT DATA SHEET #
MANUFACTURER	MODEL NUMB		INSTRUMENT SERI	AL NUMBER	TOLERANCE
HOOK UP DRAWING NUMBER	JUN	CTION BOX	A NI	LOOP DIAGRAM N	
LINE / VESSEL #	/1	14//	LINE SIZE / SCHED	ULE # () / A	MA
IM/M		CALIBR	ATION DATA	PIM	
METHOD: BE	NCH				
TK TYPE	ADL E	DITIONAL INSTR		RMATION	
TEST EQUIPMEN	T	MODEL #	S	ERIAL #	CAL DATE
FLUKE		724 3365061		5061	7/20/16
TEST EQUIPMENT	MARCIERTON	OUTP AS FOUND	UT AS LEFT	DESIRED	AS LEFT DEVIATION
N/A	AME	IENT	69.	7 °F	N/A
N/A					N/A
DMMENTS	INSTR	UMENT IS IN TOLE	TRANCE: 🗌 Y	es 🗌 no	
PANGE:	180°F-1	010°F	AMBIENT	F + FUNCTION	CHECK ONLY.
Stanley L JIBRATED BY	ment .	5/8/16 DATE 12-02-14 DATE		SENTATIVE (SIGN)	DATE
CQUALITY CONTROL (SIGN IF APPL	ICABLE) E	12/7/14	CHEN REPRESENT	ATTVE (SIGN IF APPLICABLE)	12/2/16

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	Alasia attheana District	Y TRANS RECO	TRANSMIT' SDUCER, IN RDER CALD	ter, dicator, bration	date: <u>12-29-</u> 1	'le :
Project Name:		Grand River Energy Cent	ter Unit 3	Project	#:	39
. System #:	CND 3.1		Work Pr	ickage #: <u>IN</u>	ST-81:20-11NST-	003
Location:	STERM TURBI	NE .	Area:	OHA-STG		
Drawing #:	2014-071-1A-	08041 Specifica	tion: <u>48</u>	. 15. 02,0020		
Description (Ty	pe): F(1 PER	OF HTR FW ON	TL TEMP.			
, /	* ****	P&D :	SERVICE	·	. INSTRUMENT DATA SHEE	T#
: U3-TE-01	026.15	P5-062	1	V/A	N/A	
MANURACIURER	OUTHEAST	MODELNUMBER 1E4BKUIUSHUP2ZZ	INSTRUMENT	SERIAL NUMBER	TOLERANCE	
HOOK UP DRAWINGNUM	ABER	JUNCTION BOX		LOOP DIAGRA	MNUMBER	
LINE/VESSEL#		<u> ~/R</u>	LINE SIZE/SCH	HEDULE #	14/A .	
MIA		CATT	N/	<u>A</u>		
AUTUTOD	DENICH	لبلغي	BRALION DAL	<u>.</u>		
MELHOD: -	BENCH.			· · · · · · · · · · · · · · · · · · ·		······
·		· ADDPTTOATAT		Oph/Wittow		
	TVDE E	. Apprint Mar 1145	TWOMMANT	ONNALION.		
1					· · · · · · · · · · · · · · · · · · ·	
wikit kottu	Dutonin · I	MODRÍ #'		SUDTAT # ''	CAT.DARR	
Flux C	FDIGNT.	7211	231	ofolol	7.120/14	2
I IVEC	cret i	<u>- 100</u>		Lanav.	1 1/00/10	•
TEST EQUIPMEN	T	₩	PUT ASLEEF	DESIREP	AS LEFT DEVIAT	IÓN
		NAME IN	in			
NIA	L. A	MATENI	01	8'1	N/A	
. N/A	A	MRIENI	(A	8' .	N/A	
. N/A	A	MBIENI		8'1	N/A	
. N/A	A			814	N/A	:
. N/A	A			8'1-	N/A	· ·
. N/A 				8'1-	N/A	
N/A		M BIENI	RANCE: X YE	З <sup>ГР</sup>		:
COMMENTS RANGE:		M BIENI NSTRUMENT IS IN TOLE	RANCE: X YE	$s \square xo$ n bient + FVi	N/A Nation check on	: :
COMMENTS RANGE:		MBIENI NSTRUMENT IS IN TOLE )°F	RANCE: X VE	s D Moi nbient + FU	N/A N/A NOtion Check on	Light I
N/A N/A N/A COMMENTS RANGE: Stanley	180°F- 610	MBIENT NSTRUMENT IS IN TOLE S'F - B/u/16	RANCE: X VE Ar	s □ NO i nbient + FV	N/A N/A Nation check on	: Mg
COMMENTE RANGE: Stanley	180°F- Cell	MENTIS IN TOLE $\gamma^{e}F$ $= \frac{g/n/l}{DATE}$	RANCE: X YE Ar ACCRETED BY	$g^{r}$ $g \square xro i$ h bient + Fui	N/A NA NA NA	i.
N/A N/A N/A COMMENTS PANGE: Stanley ATTERATED BY	180°F- WIC	IN BIENI NSTRUMENT IS IN TOLE $5^{\circ}F$ $= \frac{g/n/l/6}{DATE}$ $12 - D9 - 14$	RANCE: X YE Ar ACCEPTED BY	s □ xro; nbient + Fu	N/A NCTION CNOCK ON DATE	i Mg
N/A N/A N/A N/A COMMENTES RANGE: Stanley Stanley Mus Judy	180°F- Cell	MULLENT NSTRUMENT IS IN TOLE $\gamma^{e}F$ $\frac{g/\mu/l/6}{DATE}$	RANCE: X YE RANCE: X YE Ar ACCREPTED BY MA OPERATIONS REPRESENT	s □ NO i nbient + FU	N/A N/A NCTION CNEOLON DATE	μξ Ξ
INTA NTA NTA COMMENTIS RANGE: Stanley Stanley Muss Jack	180°F- Will	METENT METENT NSTRUMENT IS IN TOLE $5^{\circ}F$ $\frac{B/n/l/6}{DATE}$ $\frac{12-59-16}{12 \sqrt{2}/l/6}$	TRANCE: X YE	S I NO i n <u>Dient + Fu</u>	NA NA NA NA DATE	Lig
COMMENTS RANGE: RANGE: Stanley ALIBRATED BY	180°F- (ell Vinent Vinent	IN BIENT NSTRUMENT IS IN TOLE f $\frac{B/n/l}{}$ $\frac{DATE}{DATE}$ $\frac{2-54-16}{C}$ $\frac{12}{DATE}$	CAL RANCE: X YE AT ACCRETED BY MA OPERATIONS REPRESENT MA OPERATIONS REPRESENT AT DESCRIPTIONS REPRESENT AT ACCRETED BY MA OPERATIONS REPRESENT AT ACCRETED BY MA OPERATIONS REPRESENT ACCRETED BY MA OPERATIONS REPRESENT ACCRETED BY MA	S I NO ; h Dient + FV ATTVE (SIGN) (SIGNIFAPPTICABLE)	N/A N/A NATE DATE DATE	Lugy

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TCA 3.1

TRANSMITTER, TRANSDUCER, INDICATOR, DATE: AUG 8, 2010 RECORDER CALIBRATION. Stalkate in Grand River Energy Center Unit 3 Project Name: Project #: 102739 TCA 3.1 Work Package #: System #: INST-8120-INST-006 Area: TCA/ROTOR AIR COOLER. 087A - BOP Location: 88.15.02.002D 2014-071-1A-07044B Specification: Drawing #: Description (I'ype): BFW TCA PMP 03A SUCT TEMP. INSTRUMENT TAG # SERVICE INSTRUMENT DATA SHEET# P&ID 03-TE-063609 PS-064 N/A N/A MODEL INSTRUMENT SERIA TOLERANC IEUBKUUSHU.5PZZONXI J/A LOOP DIAGRAM NUMBER HOOK UP DRAWING NUMBER N/A NIA NIA LINE SIZE / SCHEDULE # LINE/VESSEL # NIA N/A CALIBRATION DATA METHOD: BENCH ADDITIONAL INSTRUMENT INFORMATION **IPF** TËST EQUIPMENT. MODEL # SERTAL # CAL DATE 7./20/16 FIVILE 124 331050101 OUTPUT AS LEFT DEVIATION DESIRED TEST EQUIPMENT NET? AS FOUND : ASLEEF 61.9 F N/A AMBIENT N/A NIA N/A INSTRUMENT IS IN TOLERANCE: X YES D NO . COMMENTS RANGE: 180°F-420°F AMBIENT + FUNCTION CHECK ONLY. 8/16 an DATE CALIBRATED B OPERATIONS REPRESENTATIVE (SIGN) DATE ENTATIVE (SIGN IF APPLICABLE) TIC QUALITY CONTROL (SIGN IF APPLICABLE) DATE

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TCA 3.1

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t	Samthearn district	TRANSDU RECORD	ANSMITTER, JCER, INDICATOR, ER CALIBRATION	DATE: AUG 8, 2010
	Project Name:	Grand River Energy Center U	nit 3 Project	#= 102739
æ	System #: TCA 31		Work Package #:	T-8120-INST-004
	Location: TCA/ROTOR A	HIR COOLE	Area: 08A-BO	Ρ.
	Drawing #: 204-071-1A	-07044B Specification:	88.15.02.002	2D
•	Description (Type): BFW	TUA PMP 03B 5	SUCT TEMP.	
19	INSTRUMENT TAG #	P&ID	SRRVICE	INSTRUMENT DATA SHEET#
	MANUFACTURER	MODEL NUMBER	INSTRUMENT SERIAL NUMBER	TOLERANCE
	JMS SOUTH EAST. HOOK UP DRAWING NUMBER	JUNCTION BOX	IDOP DIAGRA	M NUMBER
	N/A LINE/VESSEL#	N/A	LINE SIZE/SCHEDULE #	· · ·
*	NIA	CAT TODA'A	NIA	<sup>0</sup>
	METHOD: BENCH	CALIDRA		
j.				
Ĭ		ADDITIONAL INSTRU	MENT INFORMATION	
-	T/C TYPE E.			
e	TËST EQUIPMENT.	MODEL#	SEŔĬAL#	CALDATE
· [	FLUKE	. 724	3365061	7/20/16
Ľ.	TEST EQUIPMENT	AS FOUND	ASLINEF DESIRED	AS LEFT DEVIATION
L	NIA	AMBIENT	60.8°F	N/A
L		· ·		
•	2			
	N/A			NIA
	1. •	INSTRUMENT IS IN TOLERAN	ice: 🛛 yes 🗆 no .	
-	PANGE: 180'F - 42	0°F AN	ABIENT + FUNCTION	CHECK ONLY
	tat 1/ F	olalu	NA	
CALIBR	MATED BY	- X/S/16 ACCE	PTED BY	DATE
K	may fulling the	12-55-16	NA	
FOREM	AN (SIGN)	DATE OPERA	TIONS REPRESENTATIVE (SIGN)	DATE 6 1.
a l	ALL	12/7/16 D	THE REAL AND A CHINA THE ADDA THAT AND	12/1/16
TICONAL	and a contraction of Architemest	·	ALL	ACCUSE A CONSTRUCTION

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TGA 3.1

Southern Distri	ict	TRANS TRANSDUCE RECORDER	SMITTER, R, INDICAT CALIBRATI	TOR, DAT	E: Aug 8,2016
Project Name:	Grand River I	Energy Center Unit 3		Project #:	102739
System #: TCA 3.1			Work Package #	INST-	8120-INST-006
Location: TCA/ROT	OR AIR COC	LER	Area:	OBA-BOP	
Drawing #: 2014-011-	1A-08042B	Specification:	88.1	5.02.002	D
Description (Type):	COOLING AT	R COOLER IN	LET FEED	WATER.	
INSTRUMENT TAG #	Pain R-0/0	F			INSTRUMENT DATA SHEET #
MANUFACTURER	MODEL NUMBER	( ( ( ) )	INSTRUMENT SERIAL N	UMBER	TOLERANCE
HOOK UP DRAWING NUMBER	JUNCTI	ON BOX	1975	LOOP DIAGRAM N	
LINE / VESSEL #		- 19/7	LINE SIZE / SCHEDULE #	A ( /A	NIA
NIA		CALIBRATI	ION DATA	MIA	
METHOD: BEI	JCH.				
T/1 TYPE	ADDI	CIONAL INSTRUM	$\mathbf{\Delta}$	IATION	
	<u>с</u> .	1471			
TEST EQUIPMENT	M	ODEL #	SERI	AT. #	CAL DATE
	The second s		A CONTRACTOR OF A CONTRACTOR O		CALDATE
FLUKE	72	.4	3365	661	7/20/16
FLUK-E TEST EQUIPMENT	72	OUTPUT	AS LEFT	OCI DESIRED	AS LEFT DEVIATION
FLUKE TEST EQUIPMENT	72 MARIT AN	OUTPUT AS FOUND BIENT	3365 ASLEFT	olei desired •F	$\frac{1}{20}/10$ as left deviation $N/A$
FLUKE TEST EQUIPMENT	72 MARIT AN	OUTPUT AS FOUND ABIENT	3365 AS LEFT	olei desired •F	$\frac{1}{20}/10$ AS LEFT DEVIATION $\frac{N}{A}$
FLUKE TEST EQUIPMENT	72 NANT AN	OUTPUT AS FOUND ABIENT	3365 AS LEFT	oleined •F	$\frac{1}{20}/10$ AS LEFT DEVIATION $\frac{N}{A}$
FLUKE TEST EQUIPMENT	72 MARIT AN	OUTPUT AS FOUND ABIENT	AS LEFT	oleined •F	AS LEFT DEVIATION
FLUKE TEST EQUIPMENT	AN	OUTPUT AS FOUND ABIENT	33(g5 AS LEFT (g).2	oleined •F	N/A
FLUKE TEST EQUIPMENT	AN INSTRUM	OUTPUT AS FOUND ABIENT IENT IS IN TOLERA	AS LEFT (a).2 NCE: YES	oleined •F	AS LEFT DEVIATION
FLUKE TEST EQUIPMENT	72 1000000 100000 AN AN INSTRUM 2.F - 1652.	OUTPUT AS FOUND ABIENT IENT IS IN TOLERA	AS LEFT (27.2) NCE: YES AMBIEN		N/A N/A
FLUKE TEST EQUIPMENT	72 MARIT AN INSTRUM 2°F - 1652	OUTPUT AS FOUND ABJENT MENT IS IN TOLERA	AS LEFT (J.2 NCE: YES AMBIEN	OQI DESIRED •F □ NO T + FUNCTION	N/A N/A N/A N/A
FLUKE TEST EQUIPMENT N/A N/A COMMENTS RANGLE: 32	72 MINEUT AN INSTRUM 2°F - 1652	OUTPUT AS FOUND ABJENT MENT IS IN TOLERA F	AS LEFT (J.2 NCE: VES AMBIEN MA	OQI DESIRED •F □ NO T + FUNCTION	N/A N/A N/A N/A
FLUKE TEST EQUIPMENT N/A N/A COMMENTS RANGLE: 32 Stanly Varie		OUTPUT AS FOUND ABJENT ABJENT MENT IS IN TOLERA F	AS LEFT (J.2 (J.2 NCE: YES AMBIEN MA CCEPTED BY	OQI DESIRED •F □ NO T+FUNCTI	T / ZO / IG AS LEFT DEVIATION N/A N/A ON CHECK ONLY.
FLUKE TEST EQUIPMENT N/A N/A N/A COMMENTS RANGLE: 32 Stanly Vince CALIBRATED BY	72 MARIT AN INSTRUM 2°F - 1652 2°F - 1652	OUTPUT AS FOUND ABJENT IBJENT IENT IS IN TOLERA F	AS LEFT (J.2. AS LEFT (J.2. A.2.	OQI DESIRED •F □ NO T+FUNCT	AS LEFT DEVIATION N/A N/A N/A ON CHECK ONLY. DATE
FLUKE TEST EQUIPMENT N/A N/A COMMENTS RANGLE: 32 Stanly Vine CALIBRATED BY CALIBRATED BY CALIBRATED BY COMMENTS	72 MODICINE AN AN INSTRUM 2°F - 1052 AT AN AN AN AN AN AN AN AN AN AN	OUTPUT AS FOUND ABJENT IBJENT IENT IS IN TOLERA F 8/8/16 AC 2-07.16 0	AS LEFT (J.2. AS LEFT (J.2. (J.2		T / ZO / IG AS LEFT DEVIATION N/A N/A N/A ON CHECK ONLY. DATE
FLUKE TEST EQUIPMENT N/A N/A COMMENTS RANGLE: 32 Stanly Vare Stanly Vare Stanly Vare Milbrated By N/A	72 MOREST AN AN AN INSTRUM 2°F - 1652 Cont Date Date Date Date Date Date Date Dat	$\frac{24}{\text{OUTPUT}}$ $\frac{35 \text{FOUND}}{\text{AS FOUND}}$ $1000000000000000000000000000000000000$	AS LEFT (J.2. AS LEFT (J.2.		DATE

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TCA 3.1

Southern D	istrict	TRAN TRANSDUC RECORDER	SMITTER, ER, INDICATOR CALIBRATION	R, DATE	AUOS 8,2016
Project Name:	Grand Rive	er Energy Center Unit	3	Project #:	102739
System #: TCA	3.		Work Package #:	INST-8	120-1NST-006
Location: TCA/R	OTOR AIR FE	ED WATER	Area: 08A	-BOP	
Drawing #: 2014-	071-1A-08042	B Specification:	88.15.0	2.0020	
Description (Type):	GT COOLING	AIR COLER	OUTLET FEED V	NATER	
INSTRUMENT TAG #	ANT PRID		SERVICE		INSTRUMENT DATA SHEET #
MANUFACTURER	MODEL NUMB	yə Ber	INSTRUMENT SERIAL NUMBER		TOLERANCE
HOOK UP DRAWING NUMBER	451 LEUBKI	CTION BOX	N/A	OOP DIAGRAM NUI	MA MBER
LINE / VESSEL #	IA	N/A	LINE SIZE / SCHEDULE #		NA
NIA			N/M	•	
METHOD DE	W(H	CALIBRA	TION DATA		
	NOT:				
	ADE	DITIONAL INSTRU	MENT INFORMATI	ON	
T/C TYPE E	·		NATURA .		
TEST EQUIPMEN	rr	MODEL #	SERIAL #		CAL DATE
FIUKE		724	330 50(0)		7/20/16
TEST EQUIPMENT		OUTPU	T DF	SIRED	AS LEFT DEVIATION
	INPUT	ASTOUND	ASLEFT		
N/A	AMB	IENT	17.9°F		NA
N/A	AMB	IENT	77.9°F		N/A
N/A	AMB	IENT	<u>77.9°F</u>		N/A
N/A	AMB	IENT	AS LEFT 77.9°F		
N/A       	AMB	UMENT IS IN TOLER	AS LEFT 77.9°F	NO	N/A N/A
	AMB INSTRI	UMENT IS IN TOLER	AS LEFT $77.9^{\circ}F$ ANCE: YES $\Box$	NO	N/A N/A
N/A N/A N/A COMMENTS RANGE: 32	INSTRI F -1652:F	UMENT IS IN TOLER	AS LEFT 77.9°F ANCE: A YES MBIENT + FUN	NO	N/A N/A OHECK ONLY
N/A N/A N/A COMMENTS RANGE: 32	AMB INSTRI F -1652:F	UMENT IS IN TOLER	AS LEFT 77.9°F ANCE: N YES MBIENT + FUN MA	NO	N/A N/A OHECK ONLY
N/A N/A N/A COMMENTS PANGE: 32 Stanley M	AMB INSTRI F -1652:F	UMENT IS IN TOLER 8/8/16	AS LEFT 17.9°F ANCE: VI YES MBLENT + FUN MA ACCEPTED BY	NO	N/A N/A OHECK ONLY
N/A N/A N/A COMMENTS PANGE: 32 Stanley Manual Manua	AMB INSTRI F -1652:F	UMENT IS IN TOLER 8/8/16	AS LEFT 17.9°F ANCE: VIES MBLENT + FUN MA ACCEPTED BY MA	NO	N/A N/A OHECK ONW
N/A N/A N/A COMMENTS PANGE: 32 Stanley Manual Control of the second seco	AMB INSTR F -1652:F	UMENT IS IN TOLER 8/8/16 12-07-16	AS LEFT 17.9°F ANCE: A YES MBIENT + FUN MA ACCEPTED BY NA OPERATIONS BEPRESENTATIVE	NO	N/A N/A N/A OHECK ONW DATE
N/A N/A N/A COMMENTS PANGE: 32 Stanlage	AMB INSTRU F -1652:F	UMENT IS IN TOLER 12-07-16 12/7/16	AS LEFT 17.9°F 17.9°F ANCE: YES MBIENT + FUN MA ACCEPTED BY MA OPERATIONS REPRESENTATIVE MA	NO ICTION (SIGN)	N/A N/A N/A OHECK ONW DATE DATE

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TCA 3.1

Southern D	istrict	TRAN TRANSDUCI RECORDER	SMITTER, ER, INDICATO CALIBRATIO	R, DATI N	E: AUX 8,2016
Project Name:	Grand Rive	r Energy Center Unit :	3	Project #:	102739
System #: TCA	3.1		Work Package #:	INST-8	3120-INST-006
Location: TCA/R	OTOR AIR FE	ed water	Area: 08A	-BOP	
Drawing #: 2014-	071-1A-08042	<b>B</b> Specification:	88.15.0	12.0020	
Description (Type):	GT COOLING	AIR COLER	OUTLET FEED	WATER	
INSTRUMENT TAG #	P&ID	4	SERVICE		INSTRUMENT DATA SHEET #
US-IE-005	MODEL NUMB	25 ER	INSTRUMENT SERIAL NUMB	ER	N/A TOLERANCE
JMS SOUTHE	AST IE4BKI	A.55HLPZZZNXI	NIA	LOOP DIAGRAM NI	NIA
NE/VESSEL #	IA	NA	IT THE EVOL / CONTROL IT P		NIA
NIA			N/	/ł	
METHOD: DE	A 1/ 81-	CALIBRAT	TON DATA		
METHOD: SE	NUT.				
	ADD	ITIONAL INSTRU	MENT INFORMAT	ION	
T/C TYPE E	,		INTERNA.		
TEST EQUIPMEN	r	MODEL #	SERIAL	#	CALDATE
FIUKE		724 336506			7/20/16
TEST EQUIPMENT	INFORMAT	OUTPU AS FOUND	AS LEFT D	ESIRED	AS LEFT DEVIATION
N/A	AMBI	ENT	77.9%	-	NA
NIA					NA
54 	INSTRU	MENT IS IN TOLER	ANCE: 🕅 YES 🗆	] NO	
PANGE: 32	F -1652.F	A	UBLENT + FUN	JCTION	CHECK ONLY.
et n	1		,		
JERATED BY	nent .	8/8/16 -	NA- CCEPTED BY		DATE
Ime Jacks	THE THE	2-07-11	NA		
IEMAN (SIGN)		ATE O	PERATIONS REPRESENTATIVE	(SIGN)	DATE 6
QUALITY CONTROL SIGN IF APRLI	CABLE)	2/7/ G	HENT REPRESENTATIVE (SIGN	IF APPLICABLE)	DATE 12/1/16

BFW 3.1

Southern Distric	:1	TRANS TRANSDUCE RECORDER	SMITTER, ER, INDIC CALIBRA	ATOR, I TION	DATE: 12-02-16
Project Name:	Grand Rive	er Energy Center Unit 3	6	Project	#:102739
System #:	î		Work Packag	e#: _IN	15T-8120-INST-003
Location: HPSO			Area:	03A-HI	2507 1
Drawing #: 2014-071-1	A-080420	- Specification:	- 86.	15.02.007	20
Description (Type): HP [	SH SPRAN	WTR TEMP.			
INSTRUMENT TAG #	PEID	100-20-1004-001	SERVICE	Δ	INSTRUMENT DATA SHEET #
MANUFACTURER DID AN A ATI AL	MODEL NUME	HUID TIOTSS-51-10	INSTRUMENT SERIA	L NUMBER	TOLERANCE
HOOK UP DRAWING NUMBER	JUN	ICTION BOX	03100-717	LOOP DIAGE	
LINE / VESSEL #		10/14	LINE SIZE / SCHEDU	LE#	
NIA		CALIBRAT	ION DATA	NIA	
METHOD: BENCH	L				~
					NATIONAL PROPERTY AND AND ADDRESS OF THE OWNER
T/C THPE E	, ADI	DITIONAL INSTRU	MEINT INFO	RMATION	
TEST EQUIPMENT		MODEL #	SI	ERIAL #	CAL DATE
TEST EQUIPMENT	7	MODEL #	sı 336	erial # 5061	CAL DATE 7/20/16
TEST EQUIPMENT	7	MODEL # 2.4 OUTPUT AS FOUND	SI 336 F AS LEFT	ERIAL # 5061 DESIRED	CAL DATE 7/20/16 AS LEFT DEVIATION
TEST EQUIPMENT	7 Amble	MODEL # 2.4 OUTPUT AS FOUND	ST 336 AS LEFT 77	erial # 60(e) desired 9 'F	CAL DATE 7/20/16 AS LEFT DEVIATION
TEST EQUIPMENT	Amole	MODEL # 2.4 OUTPUT AS FOUND	51 336 AS LEFT 77	erial # 60(e) desired 9 'F	CAL DATE 7/20/16 AS LEFT DEVIATION
TEST EQUIPMENT	Amole	MODEL # 2.4 OUTPUT AS FOUND	51 336 AS LEFT 77	erial # 6061 desired 9 F	CAL DATE 7/20/16 AS LEFT DEVIATION
TEST EQUIPMENT	Amole	MODEL # 2.4 OUTPUT AS FOUND TNT	51 336 AS LEFT 77	erial # 60(e) desired 9 'F	CAL DATE 7/20/16 AS LEFT DEVIATION
TEST EQUIPMENT	Amble MA	MODEL # 2.4 OUTPUT AS FOUND TNT	51 336 AS LEFT 77	$\frac{1}{5061}$ $\frac{1}{9}$	CAL DATE 7/20/16 AS LEFT DEVIATION N/A
TEST EQUIPMENT	Amble Amble MA	MODEL # 2.4 OUTPUT AS FOUND TNT	51 336 AS LEFT 77	ERIAL # 50(e) DESIRED 9'F $\int / A$ $2s \square NO$	CAL DATE 7/20/16 AS LEFT DEVIATION N/A
TEST EQUIPMENT	Amble Amble MA INSTR	MODEL # 2.4 OUTPUT AS FOUND TNT	SI 336 AS LEFT 77 ANCE: X YE	ERIAL # 50[e] DESIRED 9''F $5/e^{A}$ $5 \square NO$ 131ENT+F	CAL DATE 7/20/16 AS LEFT DEVIATION N/A N/A
TEST EQUIPMENT FIUKE TEST EQUIPMENT N/A N/A N/A COMMENTS RANGE: 0-380	Amble Amble MA INSTR F	MODEL # 2.4 OUTPUT AS FOUND INT UMENT IS IN TOLER	SI 336 AS LEFT 77 ANCE: X YE ANCE: X ANCE: X	ERIAL # 60(e) DESIRED 9'F 5/A $5S \square NO$ ABIENT + F	CAL DATE 7/20/16 AS LEFT DEVIATION N/A
TEST EQUIPMENT FIUKE TEST EQUIPMENT N/A N/A N/A COMMENTS PANGE: 0-380 CALIBRATED BY	Amble Amble MA INSTR F	MODEL # 2.4 OUTPUT AS FOUND TNT UMENT IS IN TOLER. S/2/16	SI 336 AS LEFT 77 ANCE: X YA ANCE: X YA ANCE: X YA	ERIAL # 6061 DESIRED $9^{+}F$ $5^{-}/A$ $5^{-}NO$ ABIENT + F	CAL DATE 7/20/10 AS LEFT DEVIATION N/A N/A
TEST EQUIPMENT FIUKE TEST EQUIPMENT N/A N/A N/A COMMENTS RANGE: 0-380	Amble Amble MA INSTR F	MODEL # 2.4 OUTPUT AS FOUND TNT UMENT IS IN TOLER B/2/16 DATE 7	SI 336 AS LEFT 77 ANCE: X YA ANCE: X YA ACCEPTED BY MA OPERATIONS REPARTS	ERIAL # 60(e) DESIRED 9'F 0/A $2S \square NO$ ABIENT+F	CAL DATE 7/20/16 AS LEFT DEVIATION N/A N/A N/A DATE DATE



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### **M.I. THERMOCOUPLE CABLE CALIBRATION CERTIFICATION REPORT**

Cable Type:	304-K125	Nom. O/D:	.125	
Customer Name:	MCHALE & ASSOCIATES			
Customer PO Number:	DR033012	Our Order Number:	203928841	

The following coils of **Omega Thermocouple Cable** have been calibrated at the temperatures shown and conforms to ASTM E230-03, ANSI MC96.1 or IEC 584, with limits of error as indicated.

<b>Deviation at</b>	Deviation at	Deviation at	Deviation at	Deviation at	Deviation at
Coil I.D. #:	VK12	0116-05 <b>T</b>	Tolerance Results:		E (Class 1)
EMF Characteristics			IST Test Standard No.	.: 28	80791

| Deviation at |
|--------------|--------------|--------------|--------------|--------------|--------------|
| 212.00 °F    | 392.00 °F    | 572.00 °F    | 752.00 °F    | 1500.00 °F   | -            |
| (100.00 °C)  | (200.00 °C)  | (300.00 °C)  | (400.00 °C)  | (815.56 °C)  |              |
| -0.80 °F     | -0.10 °F     | -1.50 °F     | -2.30 °F     | 3.30 °F      | -            |
| (-0.4 °C)    | (-0.0 °C)    | (-0.8 °C)    | (-1.2 °C)    | (1.8 °C)     |              |

Nominal Sheath Typical Analysis			Nominal Conductor Typical Analysis			insulation Typical Analysis	
Batch N	<b>lo.</b> 948112	Coil N	o. RCH15021P	Coil }	lo. RAL15022P	Batch No. 13474JR-R5	
C:	0.023	Alloy:	CHROMEGA	Alloy:	ALOMEGA	MgO:	99.8
Mn:	1.70					SiO <sub>2</sub> :	0.03
S:	0.016	Ni:	90.0	Ni:	94.0	CaO:	0.03
Si:	0.46	Cr:	9.57	Cr:	-	Fe203:	0.02
Cr:	18.18	Mn:	-	Mn:	2.0	Al203:	0.14
Ni:	8.5	Si:	0.46	Si:	1.0	Other:	0.03
N:	-	Al:	-	Al:	2.0		
P:	-	Fe:	ue.	Fe:	<del></del>		
Mo:	-	Co:	-	Co:	-		
Al:	-	Cu:	-	Cu:	-		
Fe:	BAL.	C:	-	C:			
Cu:	-			1			
Titaniúm:	-						
Co:	*		······································	1		1	
Cotumbium:	-			1			
Tantalum:	-						

Dan Harrity

**Quality Assurance Supervisor** 

Date 13 April 2012



## REPORTOFCALIBRATION

4700 Coster Road Knoxville, TN 37934 . 865-588-2654

#### McHalePerformance.com

UNIT UNDER TEST:	DMM	TEST RESULT: CAL DATE:	PASS 24 March 2017
SERIAL NUMBER:	80550063	CAL DUE:	24 March 2018
PROCEDURE NAME:	Fluke 112 : (1 year) CAL VER /5520	TEMPERATURE:	22.00 •C
PROCEDURE REV.: CALIBRATED BY:	0 - 11/31/2005 Grant Shropshire	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as found and as left.

Brant Shaphin

Calibrated By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
14001	Fluke 5520A Multi-Function Calibrator	8635015	3/14/2017	3/14/2018	

#### Test Results

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AMPS FUSE TEST				_		
FUSE TEST				Pass		
BYCKIICHU DESU						
BACKLIGHT TEST				Pass		
BROKETONI TEDI				1 835		
DISPLAY TEST						
DISPLAY TEST				Pass		
PUSHBUTTON SWITCH TH	EST					
PUSHBUTTON SWITCH TH	EST			Pass		
AC VOLTAGE TEST						
0.300 V @ 50 Hz	0.300V	6.0000V	0	Pass	5.8e-004V	
0.300 V @ 500 Hz	0.300V	6.0000V	0	Pass	5.8e-004V	
5.000 V @ 50 Hz	5.003V	0.0530V	5.66	Pass	1.2e-003V	
5.000 V @ 500 Hz	4.990V	0.0530V	18.9	Pass	1.2e-003V	
50.00 V @ 500 Hz	50.10V	0.530V	18.9	Pass	1.1e-002V	
600.0 V @ 500 Hz	601.0V	6.30V	15.9	Pass	1.6e-001V	
FREQUENCY TEST						
50.00 kHz @ 5 V	49.95kHz	70Hz	71.4	Pass	5.8e+000Hz	
DC VOLTAGE TEST						
0.000 V	0.000V	0.0020V	0	Pass	5.8e-004V	
5.000 V	5.005V	0.0370V	13.5	Pass	5.8e-004V	
-50.00 V	-50.09V	0.370V	24.3	Pass	5.8e-003V	
600.0 V	601.4V	4.40V	31.8	Pass	5.9e-002V	
CONTINUITY						
beeper on						
Result of Operator H	Evaluation			Pass		
beeper off						
Result of Operator H	Evaluation			Pass		
RESISTANCE TEST						
0.0 Ohm	0.10hm	0.20Ohm	50	Pass	5.8e-002Ohm	
500.0 Ohm	500.20hm	4.70Ohm	4.26	Pass	5.9e-002Ohm	
5.000 kOhm	4.999kOhm	46.00hm	2.17	Pass	5.9e-0010hm	
50.00 kOhm	50.01kOhm	460Ohm	2.17	Pass	5.9e+0000hm	
500.0 kOhm	500.6kOhm	4600Ohm	13	Pass	5.9e+0010hm	
5.000 MOhm	5.000MOhm	46000Ohm	0	Pass	7.9e+002Ohm	
30.00 MOhm	30.01MOhm	4800000hm	2.08	Pass	9.7e+003Ohm	
DIODE TEST						
2.000 V	2.003V	0.0200V	15	Pass	5.8e-004V	
CAPACITANCE TEST						
800 nF	799nF	0.000000170F	5.88	Pass	2.4e-009F	
AC AMPS TEST						
9.00 A @ 500 Hz	9.03A	0.170A	17.6	Pass	1.0e-002A	

Test Results								
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>		
DC AMPS TEST								
5.000 A	5.005A	0.0530A	9.43	Pass	2.4e-003A			
-5.000 A	-5.007A	0.0530A	13.2	Pass	2.4e-003A			
9.00 A	9.04A	0.120A	33.3	Pass	7.0e-003A			

\*\*\*\*\* End of Report \*\*\*\*\*



Coster Road - Knoxville, 14, 37934 - 565 688 2654

# REPORTOFCALIBRATION

UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 30 May 2017
SERIAL NUMBER:	950849	CAL DUE:	30 May 2018
ASSET NUMBER:	10158	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Agilent 34970A: RS-232/5520A (1 year) (Auto)	<b>TEMPERATURE:</b>	22.00 °C
PROCEDURE REV.:	0 - 05/26/04	HUMIDITY:	45 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

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**REMARKS:** Operating within tolerance as found and as left.

Grant Shaphin

Calibrated Bv:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
SELF TEST	_					
0.00 status	0.0status		0	Pass		
ZERO TESTS						
100 mVDC Range						
0.0000 mV	0.0003mV		6.53	Pass		
1 VDC Range						
0.000000 V	0.000000V		1.86	Pass		
10 VDC Range						
0.00000 V	V000000		0	Pass		
100 VDC Range						
0.0000 V	0.0000V		2.17	Pass		
300 VDC Range						
0.000 V	0.000V		0.778	Pass		
100 Ohm Range, 2-Wi	ire					
0.0000 Ohm	-0.00000hm		0.00388	Pass		
100 Ohm Range, 4-Wi	ire					
0.0000 Ohm	0.0006Ohm		15.2	Pass		
1 kOhm Range, 2-Win	re					
0.000000 kOhm	-0.000242kOhm		24	Pass		
1 kOhm Range, 4-Win	re					
0.000000 kOhm	0.000001kOhm		12.9	Pass		
10 kOhm Range, 2-Wi	ire					
0.00000 kOhm	-0.00024kOhm		21.9	Pass		
10 kOhm Range, 4-Wi	ire			-		
	0.00001kOhm		7.8	Pass		
100 kOhm Range, 2-V	Nire		•	5		
	-0.0002kOhm		9	Pass		
100 KOnm Range, 4-V	0.0004kOhm			Dese		
	0.0001kOnm		1.1	Pass		
0 000000 MOhm	0.00000MOhm		0.00	Dees		
1 Mohm Dongo 4 Mia			2.36	Pass		
0 000000 MOhm	0.000001MOhm		5.0	Deee		
			5.2	Pass		
0 00000 MOhm	0.00000 <b>MO</b> bm		2.57	Dooo		
0.00000 MONIN			2.57	Fd55		
10 MOhm Range 4-Wi	ire					
0 00000 MOhm	0.00001MOhm		5.2	Pass		
100 MOhm Range, 2-W	Nire		5.2	1 435		
0.0000 MOhm	0.0000MOhm		0	Pass		
100 MOhm Range, 4-W	Nire		0	1 455		
0.0000 MOhm	0.0000MOhm		0	Pass		
10 mADC Range	0.0000000000000000000000000000000000000		0	1 455		
0.00000 mA	0.00003mA		1 73	Pass		
100 mADC Range						
0.00000 mA	0.00003mA		0.52	Pass		
1 ADC Range						
0.000000 A	0.000001A		1.44	Pass		
DC VOLTAGE:						
100mV Range						
50.0000 mV	50.0008mV	0.0000650V	12.2	Pass	1.6e-006V	3.25

Test Results						
Standard Reading	IIIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	TUR
100.0000 mV	100.0004mV	0.00000900V	4.11	Pass	2.3e-006V	3.00
1V Range						
0.5000000 V	0.5000005V	0.00002700V	1.74	Pass	5.8e-006V	3.60
1.000000 V	1.000000V	0.0000470V	0.851	Pass	1.0e-005V	3.62
1017 Domes						
	F 000001/	0.000051/	40 5	-		0.04
5.00000 V	5.00002V	0.0002250	10.5	Pass	6.2e-005V	2.81
10.00000 V	10.00005V	0.00040000000001V	13.2	Pass	1.1e-004V	2.86
100V Range						
50.0000 V	50.0000V	0.00285V	0.456	Pass	8.2e-004V	2.71
100.0000 V	99.9998V	0.00510V	3.86	Pass	1.5e-003V	2.62
300V Range						
150 0000 V	140.00831/	0.01575\/	11 1	Dooo	2 20 0021/	
130.0000 V	149.9963	0.01575V	11.1	Pass	2.2e-003V	
300.0000 V	299.9960V	0.02250V	17.6	Pass	4.3e-003V	
AC VOLTAGE:						
100mV Range						
100.0000 mV @ 1 kHz	99.9691mV	0.00010000V	30.9	Pass	1.7e-005V	
100.0000 mV @ 50 kHz	99.9471mV	0.00017000V	31.1	Pass	3.3e-005V	3.95
1V Range						
1.000000 V @ 1 kHz	0.999689V	0.0010000V	31.1	Pass	1.6e-004V	
1.000000 V @ 50 kHz	0.999300V	0.0017000V	41.2	Pass	2.7e-004V	
10V Pango						
	0.00000\/	0.040000\/	20.4	Dees	4.0- 0001/	
10.00000 V @ T KHZ	9.996967	0.010000	30.4	Pass	1.6e-003V	
10.00000 V @ 50 KHZ	9.99315V	0.017000V	40.3	Pass	3.2e-003V	
10.00000 V @ 10 Hz	9.99606V	0.010000V	39.4	Pass	2.8e-003V	2.74
100V Range						
100.0000 V @ 1 kHz	99.9696V	0.10000V	30.4	Pass	1.6e-002V	
100.0000 V @ 50 kHz	99.9787V	0.17000V	12.5	Pass	2.8e-002V	
300V Pange						
300 000 V @ 1 kHz	200 0201/	0.4200\/	17	Dooo	4.60.0021/	
200.000 V @ T KHZ	299.9297	0.4200V	17	Pass	4.6e-002V	
300.000 V @ 30 KHZ	299.959V	0.7200V	5.71	Pass	7.4e-002V	
2-WIRE OHMS:						
100 Ohm Range				_		
100.0000 Ohm	99.86650hm	1.01400Ohm	13.2	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	0.999900kOhm	1.1100Ohm	9	Pass	2.3e-002Ohm	
10 kOhm Range						
10.00000 kOhm	10.00020kOhm	2.100Ohm	9.71	Pass	2.3e-0010hm	
100 kOhm Range						
100.0000 kOhm	100.0032kOhm	12.00Ohm	26.7	Pass	2.3e+0000hm	4.00
1 MOhm Range	4 00005 41 (2)	444.00	<i>(</i> <b>2</b> ·	-		0.05
	1.000054MOhm	111.00hm	48.4	Pass	2.6e+0010hm	3.26

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range 10.00000 MOhm	10.00000MOhm	4100Ohm	0.0488	Pass	1.0e+003Ohm	3.04
100 MOhm Range 100.0000 MOhm 4-WIRE OHMS:	99.8692MOhm	810000Ohm	16.2	Pass	4.1e+004Ohm	
100 Ohm Range 100.0000 Ohm	100.0020Ohm	0.01400Ohm	14.4	Pass	3.3e-003Ohm	3.33
1 kOhm Range 1.000000 kOhm	1.000035kOhm	0.1100Ohm	31.7	Pass	2.3e-0020hm	3.67
10 kOhm Range 10.00000 kOhm	10.00035kOhm	1.100Ohm	32.2	Pass	2.3e-001Ohm	3.67
100 kOhm Range 100.0000 kOhm FREQUENCY - Gain Ve	100.0034kOhm rification	11.00Ohm	30.5	Pass	2.3e+000Ohm	3.67
100mV Range 100.0000 Hz @ 10 mV	99.9696Hz	0.10000Hz	30.4	Pass	2.1e-004Hz	
1V Range 100.0000 kHz @ 1 V DC CURRENT:	100.0001kHz	10.00Hz	1.4	Pass	2.0e-001Hz	
10mA Range 10.00000 mA	9.99996mA	0.000007000A	0.553	Pass	9.7e-007A	
100mA Range 100.0000 mA	99.9985mA	0.00005500A	2.66	Pass	9.7e-006A	
1A Range 1.000000 A AC CURRENT:	0.999764A	0.0011000A	21.4	Pass	1.9e-004A	
10mA Range 10.00000 mA @ 1 kHz	9.99433mA	0.000014000A	40.5	Pass	4.7e-006A	2.33
100mA Range 100.0000 mA @ 1 kHz	99.8840mA	0.00060000A	19.3	Pass	4.7e-005A	
1A Range 1.000000 A @ 1 kHz	0.999660A	0.0014000A	24.3	Pass	4.7e-004A	2.33

\*\*\*\*\* End of Report \*\*\*\*\*



#### 700 Coster Road . Knoxville, TN 37934 . 865-588-2654

## **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Pitot Tube, Stinger	TEST RESULT: CAL DATE:	PASS 13 September 2016
SERIAL NUMBER:	WF-26	CAL DUE:	13 September 2019
ASSET NUMBER:	10289	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Pitot Tube: CAL VER 3 Pt	TEMPERATURE:	23.00 °C
PROCEDURE REV.:	0 - 4/23/09	HUMIDITY:	45 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille, TN, 37012		N/A
		CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as left with new coefficients

Approved By: **Calibrated By:** Standards Used Asset # **Description** Serial # Cal Date **Due Date** 

#### Test Results

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Average Area of Te Calculated Blockag Corrected Average	est Pipe = 1.985ft^2 ge of Test Instrumer Area of Test Pipe =	2 ht= 0.061ft^2 = 1.924ft^2				
Average Square Roo at Low Flow Test 1	ot Deflection of Tes Point= 2.154InH20	st Instrument				
Average Square Roo at Mid Flow Test 1	ot Deflection of Tes Point= 4.149InH2O	st Instrument				
Average Square Roo at High Flow Test	ot Deflection of Tes Point= 6.217InH20	st Instrument				
Flow Calibratio	on Results					
Low Flow Coefficie 3516.8600-gpm	ent: 0.817 3519.130-gpm	35.1686-gpm	6.45	Pass	2.6e+001-gpm	1.35
Mid Flow Coefficie 6772.7800-gpm	ent: 0.816 6770.200-gpm	67.7278-gpm	3.81	Pass	5.0e+001-gpm	1.35
High Flow Coeffic: 10152.0300 -gpm	ient: 0.817 10157.120-gpm	101.5203-gpm	5.01	Pass	7.5e+001-gpm	1.35
Averaged Flow Coe:	fficient: 0.8167					
Equation Used to (	Calculate Flow from	Deflection:				
Water Flow in gpm= where:	= 1039.352*c*A*d^0.5	5				
c= Average Coeffic	cient					
A= Average Correct	ted Area					
d= Deflection of 3	Instrument at Flow 1	ate				
1039.352= Combined	d conversion factors	s of sec-min,				
ft3-gal,	, ft-in, and acceler	ration of gravity				

\*\*\*\*\* End of Report \*\*\*\*\*



0 Coster Road - Knoxville 14 37934 - Sún 688 2004

# **REPORTOFCALIBRATION**

McHaiePerformance and

UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 26 May 2017
SERIAL NUMBER:	US37025906	CAL DUE:	26 May 2018
ASSET NUMBER:	21136	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Agilent 34970A: RS-232/5520A (1 year) (Auto)	TEMPERATURE:	22.00 °C
PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	0 - 05/26/04 Jessica Trent McHale & Associates	HUMIDITY:	45 %
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

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**REMARKS:** Operating within tolerance as found and as left.

1	-	4 A
-1	ssion	Juit
-0	Calibrated	By:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
0.00 status ZERO TESTS	0.0status		0	Pass		
100 mVDC Range 0.0000 mV	-0.0032mV		80.6	Pass		
1 VDC Range 0.000000 V	-0.00003V		45.4	Pass		
10 VDC Range 0.00000 V	-0.00000V		5.4	Pass		
0.0000 V	-0.0000V		6.67	Pass		
0.000 V	-0.000V		0.333	Pass		
0.0000 Ohm 100 Ohm Range 4-Wi	0.0002Ohm		0.0173	Pass		
0.0000 Ohm 1 kOhm Range, 2-Win	0.0009Ohm		23.5	Pass		
0.000000 kOhm	-0.000010kOhm		1.02	Pass		
0.000000 kOhm	0.000001kOhm		12.1	Pass		
0.00000 kOhm	-0.00004kOhm		3.43	Pass		
10 kOhm Range, 4-Wi 0.00000 kOhm	ire 0.00000kOhm		4	Pass		
100 kOhm Range, 2-V 0.0000 kOhm	√ire -0.0003kOhm		13.5	Pass		
0.0000 kOhm Range, 4-V	0.0001kOhm		6.7	Pass		
0.000000 MOhm	-0.000001MOhm		12.2	Pass		
0.000000 MOhm 10 MOhm Range, 2-Wi	0.000001MOhm		5.4	Pass		
0.00000 MOhm	0.00000MOhm		2.67	Pass		
10 MOhm Range, 4-Wi 0.00000 MOhm 100 MOhm Range, 2-W	ire 0.00000MOhm Vire		0	Pass		
0.0000 MOhm	0.0000MOhm		0	Pass		
0.0000 MOhm	0.0000MOhm		0	Pass		
0.00000 mA	-0.00006mA		3.23	Pass		
0.00000 mA	-0.00016mA		3.12	Pass		
0.000000 A DC VOLTAGE:	-0.00007A		7.3	Pass		
100mV Range 50.0000 mV	49.9986mV	0.0000650V	21.9	Pass	1.6e-006V	3.25
Test Results						
------------------------------------	--------------	----------------------	--------------------	-----------	---------------	------
Standard Reading	IIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	TUR
100.0000 mV	99.9996mV	9.0000000001e-006	4.57	Pass	2.3e-006V	3.00
1V Range						
0.5000000 V	0.5000031V	0.00002700V	11.4	Pass	5.8e-006V	3.60
1.000000 V	1.000010V	0.0000470V	22.3	Pass	1.0e-005V	3.62
10V Range						
5.00000 V	5.00006V	0.000225V	28.7	Pass	6.2e-005V	2.81
10.00000 V	10.00013V	0.00040000000001V	33.5	Pass	1.1e-004V	2.86
100V Range						
50 0000 V	50 0003\/	0.00285\/	12.1	Pass	8 20-0041/	2 71
100.0000 V	100.0003V	0.00283V 0.00510V	5.1	Pass	1.5e-003V	2.62
300V Range 150.0000 V	149.9995V	0.01575V	3.11	Pass	2.2e-003V	
300 0000 V	200 0085\/	0.02250\/	6.58	Pass	4 30-003\/	
AC VOLTAGE:	200.0000	0.02200	0.00	1 435	4.00 000 0	
100mV Range						
100.0000 mV @ 1 kHz	99.9637mV	0.00010000V	36.3	Pass	1.7e-005V	
100.0000 mV @ 50 kHz	99.9826mV	0.00017000V	10.2	Pass	3.3e-005V	3.95
1V Range						
1.000000 V @ 1 kHz	0.999610V	0.0010000V	39	Pass	1.6e-004V	
1.000000 V @ 50 kHz	0.999786V	0.0017000V	12.6	Pass	2.7e-004V	
10V Range						
10.00000 V @ 1 kHz	9.99613V	0.010000V	38.7	Pass	1.6e-003V	
10.00000 V @ 50 kHz	9 99696	0.017000V	17.9	Pass	3 2e-003V	
10.00000 V @ 10 Hz	9.99564V	0.010000V	43.6	Pass	2.8e-003V	2.74
100V Banga						
	00 05 97\/	0.40000\/	44.0	Deee	1.60.000\/	
100.0000 V @ 1 KHZ	99.9587V	0.100000	41.3	Pass	1.6e-002V	
100.0000 V @ 50 KHZ	99.96297	0.170000	21.8	Pass	2.8e-002V	
300V Range						
300.000 V @ 1 kHz	299.883V	0.4200V	27.8	Pass	4.6e-002V	
300.000 V @ 50 kHz 2-WIRE OHMS:	299.869V	0.7200V	18.3	Pass	7.4e-002V	
100 Ohm Range						
100.0000 Ohm	100.1204Ohm	1.01400Ohm	11.9	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	1.000135kOhm	1.1100Ohm	12.2	Pass	2.3e-0020hm	
10 kOhm Range						
10.00000 kOhm	10.00018kOhm	2.1000hm	8.48	Pass	2.3e-0010hm	
100 kOhm Range						
100.0000 kOhm	100.0009kOhm	12.000hm	7.83	Pass	2.3e+0000hm	4.00
1 MOhm Range						
1.000000 MOhm	1.000020MOhm	111.00hm	17.7	Pass	2.6e+0010hm	3.26

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range 10.00000 MOhm	9.99903MOhm	4100Ohm	23.8	Pass	1.0e+003Ohm	3.04
100 MOhm Range 100.0000 MOhm 4-WIRE OHMS:	99.8739MOhm	810000Ohm	15.6	Pass	4.1e+004Ohm	
100 Ohm Range 100.0000 Ohm	99.99910hm	0.01400Ohm	6.3	Pass	3.3e-003Ohm	3.33
1 kOhm Range 1.000000 kOhm	1.000016kOhm	0.1100Ohm	14.9	Pass	2.3e-002Ohm	3.67
10 kOhm Range 10.00000 kOhm	10.00009kOhm	1.100Ohm	7.91	Pass	2.3e-001Ohm	3.67
100 kOhm Range 100.0000 kOhm FREQUENCY - Gain Ve	100.0014kOhm rification	11.00Ohm	13	Pass	2.3e+0000hm	3.67
100mV Range 100.0000 Hz @ 10 mV	100.0275Hz	0.10000Hz	27.5	Pass	2.1e-004Hz	
1V Range 100.0000 kHz @ 1 V DC CURRENT:	100.0000kHz	10.00Hz	0.4	Pass	2.0e-001Hz	
10mA Range 10.00000 mA	10.00003mA	0.000007000A	0.5	Pass	9.7e-007A	
100mA Range 100.0000 mA	100.0003mA	0.00005500A	0.473	Pass	9.7e-006A	
1A Range 1.000000 A AC CURRENT:	0.999791A	0.0011000A	19	Pass	1.9e-004A	
10mA Range 10.00000 mA @ 1 kHz	9.99252mA	0.000014000A	53.4	Pass	4.7e-006A	2.33
100mA Range 100.0000 mA @ 1 kHz	99.9998mA	0.00060000A	0.0348	Pass	4.7e-005A	
1A Range 1.000000 A @ 1 kHz	0.999513A	0.0014000A	34.8	Pass	4.7e-004A	2.33



### 700 Coster Road Knoxville, TN 37934 865-588-2654

### **REPORTOFCALIBRATION**

McHalePerformance c

UNIT UNDER TEST:	Handheld Barometer	TEST RESULT: CAL DATE:	PASS 17 April 2017
SERIAL NUMBER:	74001081	CAL DUE:	17 April 2018
ASSET NUMBER:	21352	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Druck DPI 740: Cal Ver DHI RPM4	TEMPERATURE:	21.00 •C
PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	0 - 07/18/2008 Jessica Trent McHale & Associates	HUMIDITY:	30 %
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	10~15 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

### Test Results

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
PRESSURE VERIFICATIO	ON					
10.00000 -PSIA	9.9992-PSIA	0.00330-PSIA	24.2	Pass	8.0e-004-PSIA	
11.00000 -PSIA	10.9992-PSIA	0.00330-PSIA	24.2	Pass	8.8e-004-PSIA	3.75
12.00000 -PSIA	11.9992-PSIA	0.00330-PSIA	24.2	Pass	9.7e-004-PSIA	3.42
13.00000 -PSIA	12.9992-PSIA	0.00330-PSIA	24.2	Pass	1.0e-003-PSIA	3.17
14.00000 -PSIA	13.9992-PSIA	0.00330-PSIA	24.2	Pass	1.1e-003-PSIA	2.95
15.00000 -PSIA	14.9992-PSIA	0.00330-PSIA	24.2	Pass	1.2e-003-PSIA	2.75
14.00000 -PSIA	13.9993-PSIA	0.00330-PSIA	21.2	Pass	1.3e-003-PSIA	2.58
13.00000 -PSIA	12.9992-PSIA	0.00330-PSIA	24.2	Pass	1.3e-003-PSIA	2.58
12.00000 -PSIA	11.9993-PSIA	0.00330-PSIA	21.2	Pass	1.3e-003-PSIA	2.58
11.00000 -PSIA	10.9992-PSIA	0.00330-PSIA	24.2	Pass	1.3e-003-PSIA	2.58
10.00000 -PSIA	9.9993-PSIA	0.00330-PSIA	21.2	Pass	1.3e-003-PSIA	2.58



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## **REPORTOFCALIBRATION**

McHalePerformance and

UNIT UNDER TEST: SERIAL NUMBER: ASSET NUMBER:	Current Clamp, Flexible 31680065 21930	TEST RESULT: CAL DATE: CAL DUE: DATA TYPE:	PASS 14 February 2017 14 February 2018 FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Fluke i2000FLEX: CAL VER 3458 0 - 09/08/05 Grant Shropshire	TEMPERATURE: HUMIDITY:	22.00 °C 31 %
		CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found and as left.

Grant Shaphin

Calibrated Bv:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017	
14024	Hewlett Packard 3458A DMM	2823A14550	10/21/2016	10/21/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	<u>Expanded Unc.</u>	<u>TUR</u>
AC CURRENT ACCURACY						
200A RANGE						
50.0 AAC @ 60 Hz	50.07AAC	2.000AAC	3.5	Pass	1.8e-001AAC	
100.0 AAC @ 60 Hz	100.15AAC	2.000AAC	7.5	Pass	1.6e-001AAC	
200.0 AAC @ 60 Hz	200.31AAC	2.000AAC	15.5	Pass	9.6e-001AAC	2.08
2000A RANGE						
200.0 AAC @ 60 Hz	199.89AAC	20.000AAC	0.55	Pass	3.4e-001AAC	
500.0 AAC @ 60 Hz	499.67AAC	20.000AAC	1.65	Pass	7.4e-001AAC	
750.0 AAC @ 60 Hz	749.50AAC	20.000AAC	2.5	Pass	1.1e+000AAC	
1000.0 AAC @ 60 Hz	999.57AAC	20.000AAC	2.15	Pass	1.6e+000AAC	



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## **REPORTOFCALIBRATION**

McHalePerformance and

UNIT UNDER TEST:	Meteorological Station	TEST RESULT:	PASS
		CAL DATE:	08 March 2017
SERIAL NUMBER:	81513	CAL DUE:	08 March 2018
ASSET NUMBER:	23084	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	RM Young 05103VM/05305VM-AQ: Cal Ver CH.309_310	<b>TEMPERATURE:</b>	21.00 °C
PROCEDURE REV.:	2 - 03/08/2017	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found-left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	Cal Date Due Date		
14004	R.M. Young 18802 Anemometer Drive	CA02996	No Calibration Required		
14008	R.M. Young 18802 Anemometer Drive	CA2990	2/28/2017 2/28/2018		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	<u>Expanded Unc.</u>	<u>TUR</u>
Wind Direction Test						
Wind Station Output	= 0.88336308 VDC					
45.0000 °	44.800	2.0000	10	Pass	5.0e-001	4.00
Wind Station Output	= 0.7565669 VDC					
90.0000 °	90.280	2.0000	14	Pass	5.0e-001	4.00
Wind Station Output	= 0.5053837 VDC					
180.0000 °	180.360	2.0000	18	Pass	5.0e-001	4.00
Wind Station Output	= 0.2579119 VDC					
270.0000 °	269.120	2.0000	44	Pass	5.0e-001	4.00
Wind Station Output	= 0.0311339 VDC					
350.0000 °	350.450	2.0000	22.5	Pass	5.0e-001	4.00
Regression Values						
Equation: $y = mX + k$	)					
m = -358.645172021						
b = 361.614254893						
Wind Speed Test						
Wind Station Output	DC Volts= 0.0209937	14 VDC				
2.2900 -mph	2.310-mph	0.6000-mph	3.33	Pass	1.1e-002-mph	
Wind Station Output	DC Volts= 0.0411750	97 VDC				
4.5800 -mph	4.560-mph	0.6000-mph	3.33	Pass	1.1e-002-mph	
Wind Station Output	DC Volts= 0.061779	VDC				
6.8700 -mph	6.860-mph	0.6000-mph	1.67	Pass	1.1e-002-mph	
Wind Station Output	DC Volts= 0.1029034	4 VDC				
11.4500 -mph	11.450-mph	0.6000-mph	0	Pass	1.1e-002-mph	
Wind Station Output	DC Volts= 0.5133627	6 VDC				
57.2500 -mph	57.250-mph	0.6000-mph	0	Pass	1.1e-002-mph	
Regression Values						
Equation: $y = mX + h$	)					
m = 111.581872798						
b = -0.0308931237407	7					



#### 4700 Coster Road Knoxville, TN 37934 865-588-2654

## **REPORT**OF**CALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	Handheld Power Quality Analyzer	TEST RESULT: CAL DATE:	PASS 10 February 2017
SERIAL NUMBER:	DM9440528	CAL DUE:	10 February 2018
ASSET NUMBER:	23098	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Fluke 43/43B: CAL VER 0 - 08/01/05 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 31 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

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**REMARKS:** Unit is operating within tolerance as found and as left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
14001	Fluke 5520A Multi-Function Calibrator	8635015	2/24/2016	2/23/2017	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Display and Backlid	ght Test			Pass		
Input 1 DC Voltage	Accuracy Test					
15.0 mV	15.4mV	0.00060V	66.7	Pass	5.8e-005V	
30.0 mV	30.0mV	0.00070V	0	Pass	5.8e-005V	
60.0 mV	60.0mV	0.00080V	0	Pass	5.8e-005V	
150.0 mV	149.6mV	0.00130V	30.8	Pass	5.8e-005V	
300.0 mV	300.0mV	0.00200V	0	Pass	5.8e-005V	
500.0 mV	500.0mV	0.00300V	0	Pass	5.8e-005V	
-500.0 mV	-500.2mV	0.00300V	6.67	Pass	5.8e-005V	
0.0 mV	-0.2mV	0.00050V	40	Pass	5.8e-005V	
1.500 V	1.497V	0.0130V	23.1	Pass	5.8e-004V	
3.000 V	3.002V	0.0200V	10	Pass	5.8e-004V	
5.000 V	4.998V	0.0300V	6.67	Pass	5.8e-004V	
-5.000 V	-5.001V	0.0300V	3.33	Pass	5.8e-004V	
0.000 V	0.000V	0.0050V	0	Pass	5.8e-004V	
15.00 V	14.96V	0.130V	30.8	Pass	5.8e-003V	
30.00 V	30.01V	0.200V	5	Pass	5.8e-003V	
50.00 V	49.98V	0.300V	6.67	Pass	5.8e-003V	
-50.00 V	-49.98V	0.300V	6.67	Pass	5.8e-003V	
0.00 V	0.01V	0.050V	20	Pass	5.8e-003V	
150.0 V	149.7V	1.30V	23.1	Pass	5.8e-002V	
300.0 V	300.0V	2.00V	0	Pass	5.8e-002V	
Input 2 DC Voltage	Accuracy Test					
15.00 mV	15.01mV	0.000130V	7.69	Pass	5.9e-006V	
30.00 mV	29.99mV	0.000200V	5	Pass	5.9e-006V	
60.00 mV	60.00mV	0.000350V	0	Pass	6.0e-006V	
150.0 mV	150 0mV	0.00130V	0	Pass	5 8e-005V	
300.0 mV	300.0mV	0.00200V	0	Pass	5 8e-005V	
500.0 mV	500 1mV	0.00300V	3 33	Pass	5.8e-005V	
-500.0 mV	-500 0mV	0.00300V	0	Pass	5.8e-005V	
0.0 mV	0.0m\/	0.00050V	0	Pass	5.8e-005\/	
1 500 V	1 5021/	0.0130V	15.4	Pass	5.8e-004\/	
3 000 V	3.001V	0.0200V	5	Pass	5.8e-004\/	
5.000 V	5.001V	0.0200V	3 33	Pass	5.80-0041/	
-5 000 V	-/ 999//	0.0300V	3 33	Pass	5.80-0041/	
0.000 V	-4.999 V	0.0000V	20	Pass	5.80-0041/	
15 00 V	15.01V	0.00000	7 60	Pass	5.80-0031/	
30.00 V	20.001/	0.100V	7.09	Pass	5.80.003\/	
50.00 V	29.990	0.200V	5	Fass	5.00-0031	
-50.00 V	40.001/	0.300V	2 22	Pass	5.00-0031	
-30.00 V	-49.990	0.300V	3.33	Fass	5.00-003	
150 0 V	0.010	0.050V	20	Pass	5.00-003V	
200.0.1/	150.1V	1.30V	7.09	Pass	5.8e-002V	
300.0 V	300.0V	2.00V	0	Pass	5.8e-002V	
Input 1 AC Voltage	Accuracy Test					
500.0 mV @ 60 Hz	496.2mV	0.00600V	63.3	Pass	1.2e-004V	
500.0 mV @ 20 kHz	501.6mV	0.01400V	11.4	Pass	1.3e-004V	
5.000 V @ 20 kHz	5 036V	0 1400\/	25.7	Pass	1.5e-003V	
5.000 V @ 60 Hz	4 961V	0.0600\/	65	Pass	1.2e-003V	
50.00 V @ 60 Hz	49 60V	0.6001/	66 7	Pass	1 1e-002V	
50.00 V @ 20 kHz	50.25V	1.400V	17.9	Pass	1.5e-002V	
	00.201					

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Input 2 AC Voltage	Accuracy Test					
500.0 mV @ 60 Hz	496.5mV	0.00600V	58.3	Pass	1.2e-004V	
5.000 V @ 60 Hz	4.966V	0.0600V	56.7	Pass	1.2e-003V	
50.00 V @ 60 Hz	49.65V	0.600V	58.3	Pass	1.1e-002V	
Input 1 AC Input C	oupling Test					
500.0 mV @ 10 Hz	403.7mV	0.15600V	61.7	Pass	1.7e-004V	
500.0 mV @ 33 Hz	487.8mV	0.03100V	39.4	Pass	1.7e-004V	
500.0 mV @ 60 Hz	496.0mV	0.01350V	29.6	Pass	1.2e-004V	
Input 2 AC Input C	oupling Test					
500.0 mV @ 10 Hz	408.7mV	0.15600V	58.5	Pass	1.7e-004V	
500.0 mV @ 33 Hz	489.3mV	0.03100V	34.5	Pass	1.7e-004V	
500.0 mV @ 60 Hz	496.6mV	0.01400V	24.3	Pass	1.2e-004V	
Input 1 Volts Peak	Measurement Test					
5.00 Vpp @ 1 kHz	4.96Vpp	0.500Vpp	8	Pass	5.8e-003Vpp	
Input 2 Volts Peak	Measurement Test					
5.00 Vpp @ 1 kHz	4.93Vpp	0.500Vpp	14	Pass	5.8e-003Vpp	
Phase Measurements	Test (-2 to +2 Ind	ication)		Pass		
Input 1 High Volta	ge AC & DC Accuracy	Test				
0.0 V	0.0V	0.50V	0	Pass	5.8e-002V	
500.0 V	500.0V	3.00V	0	Pass	5.8e-002V	
-500.0 V	-499.4V	3.00V	20	Pass	5.8e-002V	
600.0 V	600.0V	8.00V	0	Pass	5.9e-002V	
-600.0 V	-599.0V	8.00V	12.5	Pass	5.9e-002V	
0.0 V	0.0V	5.00V	0	Pass	5.8e-002V	
600.0 V @ 10 kHz	603.0V	30.00V	10	Pass	1.6e-001V	
600.0 V @ 60 Hz	600.0V	16.00V	0	Pass	1.6e-001V	
500.0 V @ 60 Hz	499.0V	6.00V	16.7	Pass	1.4e-001V	
500.0 V @ 10 kHz	500.8V	14.00V	5.71	Pass	1.4e-001V	
Input 2 High Volta	ge AC & DC Accuracy	Test				
0.0 V	0.0V	0.50V	0	Pass	5.8e-002V	
500.0 V	499.9V	3.00V	3.33	Pass	5.8e-002V	
-500.0 V	-499.3V	3.00V	23.3	Pass	5.8e-002V	
600.0 V	601.0V	8.00V	12.5	Pass	5.9e-002V	
-600.0 V	-601.0V	8.00V	12.5	Pass	5.9e-002V	
0.0 V	0.0V	5.00V	0	Pass	5.8e-002V	
600.0 V @ 60 Hz	601.0V	16.00V	6.25	Pass	1.6e-001V	
500.0 V @ 60 Hz	499.6V	6.00V	6.67	Pass	1.4e-001V	
Resistance Measure	ments Test					
0.0 Ohm	0.00hm	0.50Ohm	0	Pass	5.8e-002Ohm	
400.0 Ohm	400.00hm	2.900hm	0	Pass	5.9e-002Ohm	
4.000 kOhm	4.003kOhm	29.00hm	10.3	Pass	5.9e-0010hm	
40.00 kOhm	40.02kOhm	2900hm	6.9	Pass	5.9e+0000hm	
400.0 kOhm	400.1kOhm	2900Ohm	3.45	Pass	5.9e+0010hm	
4.000 MOhm	4.000MOhm	290000hm	0	Pass	7.3e+002Ohm	
30.00 MOhm	30.02MOhm	2300000hm	8.7	Pass	9.7e+003Ohm	

#### <u>TUR</u> **Test Tol** % Tol Error PASS/FAIL Expanded Unc. **UUT Reading** Standard Reading Diode Test Function Test 0.500 V 0.488V 0.0750V 5.8e-004V 16 Pass 1.000 V 0.998V 0.0250V 8 Pass 5.8e-004V Continuity Function Test Beeper "ON" @ 25 Ohms and Below Pass Beeper "OFF" @ 35 Ohms and Above Pass Capacitance Measurements Test 40 00 nF 40.20nF 0.00000000900F 22.2 Pass 1.6e-010F 300.0 nF 300.0nF 0.0000000700F 0 Pass 8.2e-010F 3.000 µF 3.000µF 0.000000700F 0 Pass 8.2e-009F 30.00 µF 30.06µF 0.00000700F 8.57 Pass 1.2e-007F 300.0 µF 300.5µF 0.00000700F 7.14 Pass 1.3e-006F UUT Indication 0.00 to 0.10 with Inputs Removed Pass Inrush Current Test 1.50 kA 1.50kA 120A 0 Pass 5.8e+000A Input 1 Sags & Swells Test Result Pass Input 2 Sags & Swells Test Result Pass Harmonics Test Result Pass Volts Test 0 V 0V 0.1V 4 Pass 5.8e-001V 5.50 V @ 70 Hz 5.48V 0.160V 12.5 Pass 5.9e-003V Hertz Test 70.0 Hz @ 5.5 V 70.0Hz 0.60Hz 0 5.8e-002Hz Pass 70.0 Hz @ 4.5 V 70.0Hz 5.8e-002Hz 0.60Hz 0 Pass Amps Test 0.00 A 0.02A 0.100A 20 Pass 5.8e-003A 5.50 A @ 70 Hz 5.50A 0.160A 1.25 Pass 5.8e-003A 4.500 A @ 70 Hz 4.498A 0.0550A 3.64 Pass 5.8e-004A Watts Test 5.8e-002W 0.0 W 0.0W 0.40W 0 Pass 20.0 W @ 60 Hz 20.0W 0.60W 0 Pass 5.8e-002W 35.0 W @ 60 Hz 35.0W 0.70W ٥ Pass 5.8e-002W VA Test 0 0.0\_VA\_ Pass 5.8e-002\_VA\_ 0.0\_VA\_ 0.40\_VA\_ 20.0 \_VA\_ @ 60 Hz 0 Pass 20.0\_VA\_ 0.60\_VA\_ 5.8e-002\_VA 35.0 \_VA\_ @ 60 Hz 0 35.0\_VA\_ 0.70\_VA\_ Pass 5.8e-002\_VA\_ VAR Test 0.0 \_VAR\_ 0.0\_VAR 0.40\_VAR\_ 0 Pass 5.8e-002\_VAR\_ 0.0 \_VAR\_ @ 60 Hz 5.8e-002 VAR 0.0\_VAR\_ 0.40\_VAR\_ 0 Pass 0.0 \_VAR\_ @ 60 Hz 5.8e-002\_VAR\_ 0.0\_VAR\_ 0.40\_VAR\_ 0 Pass PF Test 1.00 \_PF\_ @ 60 Hz Pass 1.00 PF 1.000e+099 PF 0 5.8e-003 PF 1.00 \_PF\_ @ 60 Hz 1.00\_PF\_ 1.000e+099 PF 0 Pass 5.8e-003\_PF\_ DPF Test 1.00 \_dPF\_ @ 60 Hz 1.00\_dPF\_ 1.000e+099\_dPF\_ 0 Pass 5.8e-003\_dPF\_ 1.00 \_dPF\_ @ 60 Hz 1.00\_dPF\_ 1.000e+099\_dPF\_ 0 Pass 5.8e-003\_dPF\_ Hz Test 60.0 Hz 60.0Hz 0.50Hz 0 Pass 5.8e-002Hz 60.0 Hz 0.50Hz 0 Pass 60 0Hz 5.8e-002Hz Operation of Transients Test Function Pass

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



# **REPORTOFCALIBRATION**

#### 4700 Coster Road Knoxville, TN 37934 . 865-588-2654

#### McHalePerformance com

UNIT UNDER TEST:	Current Clamp, Flexible	TEST RESULT: CAL DATE:	PASS 14 December 2016
SERIAL NUMBER:	197326FDDV	CAL DUE:	14 December 2017
ASSET NUMBER:	23735	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	AEMC 24-3001/24-3002 Flexible Current Clamp	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 9/21/2010	HUMIDITY:	28 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found and as left.

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$\rightarrow$	Calibrated	d By:

**Approved By:** 

Standards Used				
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	Cal Date <u>Due Date</u>	
14001	Fluke 5520A Multi-Function Calibrator	8635015	2/24/2016 2/23/2017	
14003	Hewlett Packard 3458A DMM	2823A13699	3/3/2016 3/3/2017	
14027	Fluke 5500A/Coil 50 Turn Coil	MCH0731	No Calibration Required	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
***LIMITED CALIBR	ATION*** Calibrated u	up to 1000AAC onl	-У			
300A Range						
60 A	60.052A	1.7000A	3.06	Pass	1.6e-001A	
90 A	90.091A	2.3000A	3.96	Pass	2.3e-001A	
150 A	150.115A	3.5000A	3.29	Pass	4.6e-001A	
210 A	210.174A	4.7000A	3.7	Pass	6.0e-001A	
270 A	270.226A	5.9000A	3.83	Pass	7.4e-001A	
3000A Range						
200 A	200.143A	4.5000A	3.18	Pass	5.8e-001A	
400 A	400.302A	8.5000A	3.55	Pass	1.0e+000A	
600 A	600.506A	12.5000A	4.05	Pass	1.5e+000A	
800 A	800.755A	16.5000A	4.58	Pass	2.0e+000A	
1000 A	1001.307A	20.5000A	6.38	Pass	2.5e+000A	



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### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Current Clamp	TEST RESULT: CAL DATE:	PASS 02 December 2016
SERIAL NUMBER:	23	CAL DUE:	02 December 2017
ASSET NUMBER:	24243	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Fluke 80i-500s: CAL VER	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 3/28/16	HUMIDITY:	32 %
CALIBRATED BY: CUSTOMER:	Jessica Trent McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found and as left.

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Calibrated By:

**Approved By:** 

Standards	Used			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14001	Fluke 5520A Multi-Function Calibrator	8635015	2/24/2016	2/23/2017
14021	Fluke 8508A Reference Multimeter	45963	4/20/2016	4/20/2017

#### Test Results Expanded Unc. <u>TUR</u> Test Tol PASS/FAIL <u>% Tol Error</u> **UUT Reading** Standard Reading AC CURRENT ACCURACY 50 AAC @ 50 Hz 49.780AAC 2.5000AAC 8.8 Pass 1.8e-001AAC 50 AAC @ 60 Hz 49.795AAC 2.5000AAC 8.2 Pass 1.8e-001AAC 300 AAC @ 50 Hz 303.131AAC 6.0000AAC 52.2 Pass 1.1e+000AAC 300 AAC @ 60 Hz 303.326AAC 6.0000AAC 55.4 Pass 1.1e+000AAC 300 AAC @ 100 Hz 15.0000AAC 1.1e+000AAC 303.569AAC 23.8 Pass 500.0 AAC @ 50 Hz 10.0000AAC 1.6e+000AAC 499.431AAC 5.69 Pass 500.0 AAC @ 60 Hz 500.318AAC 10.0000AAC 1.6e+000AAC 3.18 Pass



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## **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 25 May 2017
SERIAL NUMBER:	US37039332	CAL DUE:	25 May 2018
ASSET NUMBER:	24424	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Agilent 34970A: RS-232/5520A (1 year) (Auto)	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	0 - 05/26/04	HUMIDITY:	45 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

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$\nabla$	Calibrate	d Bv:

**Approved By:** 

Standards U	Used			
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
0.00 status ZERO TESTS	0.0status		0	Pass		
100 mVDC Range 0.0000 mV	-0.0009mV		21.3	Pass		
1 VDC Range 0.000000 V	-0.000001V		13.1	Pass		
10 VDC Range 0.00000 V	-0.00000V		2.6	Pass		
0.0000 V 300 VDC Range	0.0000V		6.67	Pass		
0.000 V 100 Ohm Range, 2-W	0.000V ire		1.33	Pass		
0.0000 Ohm 100 Ohm Range, 4-W:	-0.0002Ohm		0.0172	Pass		
0.0000 Ohm 1 kOhm Range, 2-Win	-0.0002Ohm		5	Pass		
0.000000 kOhm 1 kOhm Range, 4-Win	0.000023kOhm		2.25	Pass		
0.000000 kOhm 10 kOhm Range, 2-W	-0.000000kOhm ire		4	Pass		
0.00000 kOhm	0.00002kOhm		1.45	Pass		
10 kOhm Range, 4-W: 0.00000 kOhm	ire -0.00000kOhm		4	Pass		
0.0000 kOhm 100 kOhm Range, 4-4	-0.0001kOhm		3.35	Pass		
0.0000 kOhm 1 MOhm Range, 2-Wij	-0.0000kOhm		1.3	Pass		
0.000000 MOhm 1 MOhm Range, 4-Win	0.000000MOhm		0	Pass		
0.000000 MOhm 10 MOhm Range, 2-W	0.000000MOhm ire		2.7	Pass		
0.00000 MOhm	0.00000MOhm		0	Pass		
10 MOhm Range, 4-W: 0.00000 MOhm 100 MOhm Range, 2-W	ire 0.00000MOhm Nire		0	Pass		
0.0000 MOhm 100 MOhm Range, 4-W	0.0000MOhm Nire		0	Pass		
0.0000 MOhm 10 mADC Range	0.0000MOhm		0	Pass		
<b>0.00000 mA</b> 100 mADC Range	0.00001mA		0.45	Pass		
0.00000 mA 1 ADC Range	0.00005mA		1.04	Pass		
0.000000 A DC VOLTAGE:	0.000001A		1.44	Pass		
100mV Range 50.0000 mV	49.9999mV	6.50000000001e-006	1.52	Pass	1.6e-006V	3.25

Test Results						
		Test Tol	% Tol Error	PASS/FAIL	Expanded Unc.	TUR
<u>Standard Reading</u> 100.0000 mV	100.0000mV	0.00000900V	0.178	Pass	2.3e-006V	3.00
1V Range						
0.5000000 V	0 4999979\/	2 7000000001e-005	7.96	Pass	5 8e-006V	3 60
1 000000 V	0.900007\/	1 6000000000000000000000000000000000000	6.13	Pass	1.0e-005\/	3.62
1.000000 V	0.9999977	4.099999999999999-000	0.15	F 855	1.08-003 V	5.02
10V Range						
5.00000 V	5.00000V	0.000225V	0.533	Pass	6.2e-005V	2.81
10.00000 V	10.00001V	0.00040000000001V	2.5	Pass	1.1e-004V	2.86
100V Range						
50 0000 V	50 0003\/	0.00285\/	10.1	Pass	8 20-004\/	2 71
	100.00031/	0.002031	6.47	Pass	1.50.003\/	2.71
100.0000 V	100.00037	0.005100	0.47	Pass	1.50-0037	2.02
300V Range						
150.0000 V	149.9977V	0.01575V	14.4	Pass	2.2e-003V	
300.0000 V	299.9990V	0.02250V	4.53	Pass	4.3e-003V	
AC VOLTAGE:						
100mV Range						
100.0000 mV @ 1 kHz	100.0103mV	0.00010000V	10.3	Pass	1.7e-005V	
100.0000 mV @ 50 kHz	99.9749mV	0.00017000V	14.8	Pass	3.3e-005V	3.95
1V Pange						
	1 000000\/	0.0010000\/	0.16	Deee	1.60.0041/	
	1.0000921	0.0010000	9.10	F d S S	0.7-0041	
1.000000 V @ 50 KHZ	1.000032V	0.00170000	1.88	Pass	2.76-004V	
10V Range						
10.00000 V @ 1 kHz	10.00041V	0.010000V	4.13	Pass	1.6e-003V	
10.00000 V @ 50 kHz	9.99911V	0.017000V	5.26	Pass	3.2e-003V	
10.00000 V @ 10 Hz	9.99873V	0.010000V	12.7	Pass	2.8e-003V	2.74
10077 5						
100V Range		a (aaaa) (		_	(	
100.0000 V @ 1 KHZ	99.9999V	0.10000V	0.135	Pass	1.6e-002V	
100.0000 V @ 50 kHz	99.9708V	0.17000V	17.2	Pass	2.8e-002V	
300V Range						
300.000 V @ 1 kHz	300.000V	0.4200V	0.0548	Pass	4.6e-002V	
300.000 V @ 50 kHz	300.003V	0.7200V	0.375	Pass	7.4e-002V	
2-WIRE OHMS:						
100 Ohm Range						
100.0000 Ohm	100.1358Ohm	1.014000hm	13.4	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	1.000137kOhm	1.1100Ohm	12.3	Pass	2.3e-002Ohm	
10 hohm Dommo						
	40.000401.01	0.40001	7.45	_	0.0.00101	
	10.00016kOhm	2.1000hm	7.43	Pass	2.3e-0010hm	
100 kOhm Range						
100.0000 kOhm	100.0002kOhm	12.00Ohm	1.83	Pass	2.3e+0000hm	4.00
1 201 -						
1 MOhm Range	4 00004-1401	111.00		_		
	1.000015MOhm	111.00hm	14	Pass	2.6e+0010hm	3.26

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range 10.00000 MOhm	10.00046MOhm	4100Ohm	11.2	Pass	1.0e+003Ohm	3.04
100 MOhm Range 100.0000 MOhm 4-WIRE OHMS:	100.1281MOhm	810000Ohm	15.8	Pass	4.1e+004Ohm	
100 Ohm Range 100.0000 Ohm	100.0004Ohm	0.01400Ohm	3.14	Pass	3.3e-003Ohm	3.33
1 kOhm Range 1.000000 kOhm	1.000003kOhm	0.1100Ohm	2.73	Pass	2.3e-0020hm	3.67
10 kOhm Range 10.00000 kOhm	10.00004kOhm	1.100Ohm	3.55	Pass	2.3e-001Ohm	3.67
100 kOhm Range 100.0000 kOhm FREQUENCY - Gain Ve	100.0004kOhm rification	11.00Ohm	3.64	Pass	2.3e+000Ohm	3.67
100mV Range 100.0000 Hz @ 10 mV	99.9681Hz	0.10000Hz	31.9	Pass	2.1e-004Hz	
1V Range 100.0000 kHz @ 1 V DC CURRENT:	100.0001kHz	10.00Hz	1.5	Pass	2.0e-001Hz	
10mA Range 10.00000 mA	9.99992mA	0.000007000A	1.19	Pass	9.7e-007A	
100mA Range 100.0000 mA	99.9970mA	0.00005500A	5.53	Pass	9.7e-006A	
1A Range 1.000000 A AC CURRENT:	0.999923A	0.0011000A	7.02	Pass	1.9e-004A	
10mA Range 10.00000 mA @ 1 kHz	9.99821mA	0.000014000A	12.8	Pass	4.7e-006A	2.33
100mA Range 100.0000 mA @ 1 kHz	100.0153mA	0.00060000A	2.56	Pass	4.7e-005A	
1A Range 1.000000 A @ 1 kHz	1.000030A	0.0014000A	2.13	Pass	4.7e-004A	2.33



### 4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

### **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 72"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A 100006	CAL DUE: DATA TYPE:	03 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

**Calibrated By:** 

**Approved By:** 

Standards U	Used			
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= 100006					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.84667 Oh	ms				
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.2375 Ohm	S				
65.3590 F	65.354F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.626 Ohms					
90.3710 F	90.375F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.99217 Oh	ms				
115.3880 F	115.387F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.3375 Ohm	S				
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
*****	es C***********					
Resistance Value at	t Temp = 101.84667 Oh	ms				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.2375 Ohm	S				
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.626 Ohms					
32.4280 c	32.430c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.99217 Oh	ms				
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.3375 Ohm	s				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at '	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.02231						
Alpha= 0.003849601						
Delta= 1.3809562772	21					

A= 0.00390276230666

B= -5.31613066572e-007



### 4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

### **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 72"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	03 April 2018
ASSET NUMBER:	300006	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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$- \bigtriangledown$	Calibrated By	:	

**Approved By:** 

Standards U	Jsed			
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= 300006					
Probe Calibration R	ange = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.80317 Ohms					
40.4160 F	40.422F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 107.20733 Ohms					
65.3590 F	65.349F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 112.58867 Ohms					
90.3710 F	90.365F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 117.9325 Ohms					
115.3880 F	115.404F	0.1000F	16	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 123.22283 Ohms					
140.3980 F	140.390F	0.1000F	8	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	: Temp = 101.80317 Ohms					
4.6760 c	4.679c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 107.20733 Ohms					
18.5320 c	18.527c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.58867 Ohms					
32.4280 c	32.425c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 117.9325 Ohms					
46.3270 c	46.336c	0.0560c	16.1	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 123.22283 Ohms					
60.2210 c	60.217c	0.0560c	7.14	Pass	1.9e-002c	2.95
As Left Coefficient	.s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C$ and	l Rt = Resistance at Te	np				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.96788						
Alpha= 0.003819575						
Delta= 2.8649932662	21					
A= 0.0039290055	6655					

-1.09430566548e-006

B=



#### 4700 Coster Road Knoxville, TN 37934 . 865-588-2654

### **REPORT**OF**CALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 08 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	08 March 2018
ASSET NUMBER:	CT006	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	0 - 09/30/04 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20-200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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A	2210~	Juit
$\overline{}$	Calibrated I	By:

**Approved By:** 

Standards U	Jsed			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT006					
Probe Calibration F	Range = 20 to 200 Deg F = -6.7 to	93.3 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 97.488 Ohms					
20.4240 F	20.434F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 103.98083 Ohms					
50.3690 F	50.355F	0.1000F	14	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 110.446 Ohms					
80.3260 F	80.320F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 116.8865 Ohms					
110.3440 F	110.344F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.2905 Ohms			_		
140.3600 F	140.372F	0.1000F	12	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 129.65783 Ohms			_		
170.3970 F	170.403F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 135.98633 Ohms		_	_	0 / 0005	
200.4350 F	200.427F	0.1000F	8	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	Temp = 97.488 Ohms					
-6.4310 c	-6.425c	0.0560c	10.7	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 103.98083 Ohms					
10.2050 c	10.197c	0.0560c	14.3	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 110.446 Ohms					
26.8480 c	26.844c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 116.8865 Ohms					
43.5250 c	43.524c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 123.2905 Ohms					
60.2000 c	60.206c	0.0560c	10.7	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 129.65783 Ohms					
76.8870 c	76.890c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 135.98633 Ohms					
93.5750 c	93.571c	0.0560c	7.14	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Tem	np				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.00216						
Alpha= 0.003841264						
Delta= 1.7490579987	7					

A= 0.00390844993524

B=

-6.71859352432e-007



#### 4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

### **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 08 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	08 March 2018
ASSET NUMBER:	CT021	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	0 - 09/30/04 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20-200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards U	Used			
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT021					
Probe Calibration	Range = 20 to 200 Deg F = -6.7 t	:0 93.3 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 97.48583 Ohms		_	_		
20.4240 F	20.429F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 103.9835 Ohms			_		
50.3690 F	50.359F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 110.4565 Ohms	0 40005	4	Daar		0.04
OU.3200 F	80.327F	0.1000F	1	Pass	3.4e-002F	2.94
110 3//0 F	110 3/3E	0 10005	1	Dooo	3 40 0025	2.04
Resistance Value a	+ Temp = 123 32617 Ohms	0.10001	· ·	F 855	5.46-0021	2.94
140.3600 F	140.365F	0 1000F	5	Pass	3 4e-002F	2 94
Resistance Value a	t Temp = 129.71517 Ohms	0.10001	0	1 400	0.10 0021	2.01
170.3970 F	170.400F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 136.07033 Ohms					
200.4350 F	200.432F	0.1000F	3	Pass	3.4e-002F	2.94
************Degre	es C***********					
Resistance Value a	t Temp = 97.48583 Ohms					
-6.4310 c	-6.428c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 103.9835 Ohms					
10.2050 c	10.200c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 110.4565 Ohms					
26.8480 c	26.848c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 116.90717 Ohms					
43.5250 c	43.524c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.32617 Ohms					
60.2000 c	60.203c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 129.71517 Ohms			_		
76.8870 C	76.889c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 136.07033 Ohms	0.0500	0.57	5	4.0000	0.05
93.5750 C	93.573c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C$ an	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(R)]	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.00162						
Alpha= 0.00385074						
Delta= 1.535960825	18					
A= 0.003909885	85788					

-5.91458578796e-007

B=



#### 4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

### **REPORT**OF CALIBRATION

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	03 April 2018
ASSET NUMBER:	СТ030	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	0 - 09/30/04 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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- <del>C</del>	Calibrate	d Bv:

**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT030					
Probe Calibration	Range = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.8345 Ohms					
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.2295 Ohms					
65.3590 F	65.353F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.623 Ohms					
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.993 Ohms					
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.343 Ohms					
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degre	es C***********					
Resistance Value a	t Temp = 101.8345 Ohms					
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.2295 Ohms					
18.5320 c	18.529c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.623 Ohms					
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.993 Ohms					
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.343 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C$ an	d Rt = Resistance at Te	mp				
T = [-RoA + Sqrt(R	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.00858						
Alpha= 0.003853285						

Delta= 1.38167310762

A= 0.0039065248026 B= -5.32398026049e-007



### 4700 Coster Road Knoxville, TN 37934 . 865-588-2654

### **REPORTOFCALIBRATION**

#### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	03 April 2018
ASSET NUMBER:	CT047	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
	Jessica Trent MeHalo & Associatos		
COSTOMER.	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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	Calibrated	d By:

**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT047					
Probe Calibration H	Range = $40$ to $140$ Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.84283 Ohms					
40.4160 F	40.419F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.2345 Ohms					
65.3590 F	65.350F	0.1000F	9	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.62733 Ohms					
90.3710 F	90.375F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.99867 Ohms					
115.3880 F	115.390F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.349 Ohms					
140.3980 F	140.396F	0.1000F	2	Pass	3.4e-002F	2.94
***********Degree	es C********					
Resistance Value at	t Temp = 101.84283 Ohms					
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.2345 Ohms					
18.5320 c	18.528c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.62733 Ohms					
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.99867 Ohms					
46.3270 c	46.328c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.349 Ohms					
60.2210 c	60.220c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at Tem	np				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.01769						
Alpha= 0.00385386						
Delta= 1.2916409968	89					
A= 0.0039036380	03572					

-4.97780357228e-007

B=



#### 4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

### **REPORT**OF**CALIBRATION**

#### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	03 April 2018
ASSET NUMBER:	R112	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	0 - 09/30/04 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R112					
Probe Calibration 1	Range = 40 to 140 Dec	ſ F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.79183 Of	ims				
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.19867 Of	ims				
65.3590 F	65.354F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.60033 Oh	ims				
90.3710 F	90.377F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.975 Ohms	;				
115.3880 F	115.384F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.32783 Of	ims		_		
140.3980 F	140.399F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value a	t Temp = 101.79183 Of	ms				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.19867 Of	ims				
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.60033 Oh	ims				
32.4280 c	32.432c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.975 Ohms	5				
46.3270 c	46.324c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.32783 Of	ims				
60.2210 c	60.222c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.96155						
Alpha= 0.003857181						
Delta= 1.587874120	61					
A= 0.003918428	17888					

-6.12471788841e-007

B=



#### 4700 Coster Road Knoxville, TN 37934 . 865-588-2654

### **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R254	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Calibrated By:** 

**Approved By:** 

Standards Used								
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>				
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017				
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018				
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018				

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R254					
Probe Calibration F	ange = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.94733 Ohms					
40.4050 F	40.402F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 107.36433 Ohms					
65.3590 F	65.364F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 112.76483 Ohms					
90.3580 F	90.358F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 118.14317 Ohms					
115.3640 F	115.358F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.50333 Ohms					
140.3800 F	140.383F	0.1000F	3	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	: Temp = 101.94733 Ohms					
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 107.36433 Ohms					
18.5320 c	18.536c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.76483 Ohms					
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 118.14317 Ohms					
46.3130 c	46.310c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 123.50333 Ohms					
60.2110 c	60.213c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	.s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C and$	l Rt = Resistance at Ter	mp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.11869						
Alpha= 0.003854874						
Delta= 1.5766528953	31					
A= 0.0039156519	8253					

-6.07779825316e-007

B =


# **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	14 April 2018
ASSET NUMBER:	R381	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R381					
Probe Calibration F	ange = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.80967 Ohms					
40.4050 F	40.402F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 107.21817 Ohms					
65.3590 F	65.367F	0.1000F	8	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 112.60833 Ohms					
90.3580 F	90.355F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 117.97917 Ohms					
115.3640 F	115.360F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.33033 Ohms					
140.3800 F	140.383F	0.1000F	3	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	: Temp = 101.80967 Ohms					
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 107.21817 Ohms					
18.5320 c	18.537c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.60833 Ohms					
32.4210 c	32.419c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 117.97917 Ohms					
46.3130 c	46.311c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 123.33033 Ohms					
60.2110 c	60.213c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	.s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C and$	l Rt = Resistance at Te	mp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.98436						
Alpha= 0.003853924						
Delta= 1.5610737236	57					
A= 0.0039140865	9489					

-6.0162594894e-007



## **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00032	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille, TN, 27012	CAL RANGE:	40~140 Dog 5
	KIOXVIIIE, IN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00032					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4 t	o 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.91717 Ohm	S				
40.4160 F	40.441F	0.1000F	25	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 107.2635 Ohms					
65.3590 F	65.302F	0.1000F	57	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 112.6505 Ohms					
90.3710 F	90.392F	0.1000F	21	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 118.0145 Ohms					
115.3880 F	115.415F	0.1000F	27	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 123.35783 Ohm	s		_		
140.3980 F	140.380F	0.1000F	18	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	: Temp = 101.91717 Ohm	S				
4.6760 c	4.689c	0.0560c	23.2	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 107.2635 Ohms					
18.5320 c	18.501c	0.0560c	55.4	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.6505 Ohms					
32.4280 c	32.440c	0.0560c	21.4	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 118.0145 Ohms					
46.3270 c	46.342c	0.0560c	26.8	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 123.35783 Ohm	S				
60.2210 c	60.211c	0.0560c	17.9	Pass	1.9e-002c	2.95
As Left Coefficient						
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 100.10017						
Alpha= 0.003850088						
Delta= 0.5689228014	189					
A= 0.0038719920	02851					

-2.19040285094e-007



# **REPORTOFCALIBRATION**

### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	RTD00037	CAL DUE:	03 April 2018
ASSET NUMBER:		DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	standards Used					
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00037					
Probe Calibration H	Range = 40 to 140 Deg	ſ F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.75917 Oh	ims				
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.15033 Oh	ims				
65.3590 F	65.355F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.5365 Ohm	15		_		
90.3710 F	90.374F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.89917 Oh	ims		_	0 4 0005	
115.3880 F	115.387F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.23917 Oh	ims	0	Data		0.04
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 101.75917 Oh	ims				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.15033 Oh	ims				
18.5320 c	18.531c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.5365 Ohm	IS				
32.4280 c	32.430c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.89917 Oh	ims				
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.23917 Oh	ims				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
where $T = Deg C$ and	d Pt - Pasistance at	Temp				
T = [-RoA + Sar+(Pr)]	$2^{2} \times 2^{-1} \times 2^{-4} \times 2^$	1/(2*Ro*R)				
Ro= 99 93455	2 2 11 2 310 D(10 1(C))	], (2 10 1)				
Alpha= 0.003849376						
Delta= 1.5024802278	33					

0.00390721211329 -5.78361132949e-007

A=

B =



# **REPORT**OF**CALIBRATION**

### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00039	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, IN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrate	ed By:	

**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00039					
Probe Calibration	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.75333 Oh	ms				
40.4160 F	40.416F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.14967 Oh	ms				
65.3590 F	65.357F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.53933 Oh	ms				
90.3710 F	90.374F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.90433 Oh	ms				
115.3880 F	115.384F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.2475 Ohm	S				
140.3980 F	140.399F	0.1000F	1	Pass	3.4e-002F	2.94
************Degre	es C************					
Resistance Value a	t Temp = 101.75333 Oh	ms				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.14967 Oh	ms				
18.5320 c	18.532c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.53933 Oh	ms				
32.4280 c	32.430c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.90433 Oh	ms				
46.3270 c	46.324c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.2475 Ohm	S				
60.2210 c	60.222c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = De\sigma C$ and	d Rt = Resistance at '	Temp				
T = [-RoA + Sart(R)]	o^2*A^2-4Ro*B(Ro-Rt.))	]/(2*Ro*B)				
Ro= 99.92726	( 1.0,) )					
Alpha= 0.003851444						
Delta= 1.551682741	86					
A= 0.003911206	19186					

-5.97621918606e-007



## **REPORTOFCALIBRATION**

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER: ASSET NUMBER:	RTD00043	CAL DUE: DATA TYPE:	03 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00043					
Probe Calibration H	Range = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.75433 Ohms					
40.4160 F	40.416F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.16283 Ohms					
65.3590 F	65.358F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t  Temp = 112.56467  Ohms					
90.3710 F	90.372F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.94417 Ohms					
115.3880 F	115.387F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.30033 Ohms					
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C**********					
Resistance Value at	t Temp = 101.75433 Ohms					
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.16283 Ohms					
18.5320 c	18.532c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.56467 Ohms					
32.4280 c	32.429c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.94417 Ohms					
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.30033 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	mp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.92422						
Alpha= 0.003861463						
Delta= 1.510002576	75					
A= 0.0039197713	1908					

-5.83081908002e-007

B =



## **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	RTD00045	CAL DUE:	03 April 2018
ASSET NUMBER:		DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00045					
Probe Calibration 1	Range = 40 to 140 Deg 1	F				
	= 4.4 to	5 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.79567 Ohms	5				
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.18667 Ohm:	5				
65.3590 F	65.353F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.57433 Ohm:	5				
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.93733 Ohm:	3	-	_	0 / 0005	
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a: 140.3980 F	t Temp = 123.27817 Ohm: 140.398F	₅ 0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C**********					
Resistance Value a	t Temp = 101.79567 Ohm:	5				
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.18667 Ohm:	3				
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.57433 Ohma	5				
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.93733 Ohma	5				
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.27817 Ohm:	3				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal.	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))],	/(2*Ro*B)				
Ro= 99.97072						
Alpha= 0.003848583						
Delta= 1.494277927	52					
A= 0.003906091	52629					

-5.75085262914e-007

B =



## **REPORT**OF**CALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00046	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140 Dog 5
		CAL UNITS:	Dey F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00046					
Probe Calibration F	Range = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.819 Ohms					
40.4160 F	40.416F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 107.23 Ohms					
65.3590 F	65.357F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 112.63517 Ohms					
90.3710 F	90.377F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 118.01367 Ohms					
115.3880 F	115.381F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.37217 Ohms					
140.3980 F	140.400F	0.1000F	2	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	Temp = 101.819 Ohms					
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 107.23 Ohms					
18.5320 c	18.531c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 112.63517 Ohms					
32.4280 c	32.432c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 118.01367 Ohms					
46.3270 c	46.323c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 123.37217 Ohms					
60.2210 c	60.222c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	mp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.98791						
Alpha= 0.003859596						
Delta= 1.5546595354	12					
A= 0.0039195995	57724					

-6.00035772427e-007



## **REPORT**OF**CALIBRATION**

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00052	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140 Dog 5
	KIOXVIIIE, IN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00052					
Probe Calibration F	Range = 40 to 140 Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 101.8255 Ohms					
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 107.22483 Ohms					
65.3590 F	65.352F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 112.62117 Ohms			_		
90.3710 F	90.377F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 117.99133 Ohms	0.40005	0	5		
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
140 3080 E	140 2005	0 10005	0	Deee	2 40 0025	2.04
140.39001	140.390F	0.1000F	0	Pass	3.40-002F	2.94
***********Degree	es C*********					
Resistance Value at	Temp = 101.8255 Ohms					
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 107.22483 Ohms					
18.5320 c	18.529c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 112.62117 Ohms					
32.4280 c	32.432c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 117.99133 Ohms					
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 123.33917 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Ter	qn				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.99739						
Alpha= 0.003852637						
Delta= 1.5328111339	94					
A= 0.0039116906	54889					

-5.90536488865e-007

B =



# **REPORTOFCALIBRATION**

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00055	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00055					
Probe Calibration 1	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.82117 Oh	ms				
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.21967 Oh	ms				
65.3590 F	65.353F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.61533 Oh	ms				
90.3710 F	90.377F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.98533 Oh	ms				
115.3880 F	115.385F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.334 Ohms					
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value a	t Temp = 101.82117 Oh	ms				
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.21967 Oh	ms				
18.5320 c	18.529c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.61533 Oh	ms				
32.4280 c	32.432c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.98533 Oh	ms				
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.334 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.99363						
Alpha= 0.003853101						
Delta= 1.495799867	19					

0.00391073567964 -5.76346796407e-007

A=

B =



# **REPORT**OF**CALIBRATION**

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00056	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille TN 37912	CAL RANGE:	40~140 Deg E
		CAL UNITS.	Degi

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00056					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.7795 Ohm	5				
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.1825 Ohm	S				
65.3590 F	65.353F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.582 Ohms					
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.956 Ohms					
115.3880 F	115.385F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.30817 Ohr	ns				
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
*****	es C**********					
Resistance Value at	t Temp = 101.7795 Ohm	5				
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.1825 Ohm	5				
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.582 Ohms					
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.956 Ohms					
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.30817 Ohr	ns				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at '	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.95048						
Alpha= 0.003857368						
Delta= 1.512616834	4 6					

A= 0.00391571519774

B= -5.83471977351e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	RTD00060	CAL DUE:	03 April 2018
ASSET NUMBER:		DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00060					
Probe Calibration H	Range = 40 to 140 Deg B	F				
	= 4.4 to	o 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.87083 Ohms	S				
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.27433 Ohms	S				
65.3590 F	65.354F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.67367 Ohms	S				
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 118.04783 Ohms	S				
115.3880 F	115.385F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.4 Ohms					
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 101.87083 Ohms	S				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.27433 Ohms	S				
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.67367 Ohms	S				
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 118.04783 Ohms	S				
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.4 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))],	/(2*Ro*B)				
Ro= 100.04178						
Alpha= 0.003853833						

Delta= 1.51902682195

A= 0.00391237375694

B= -5.8540756943e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## REPORTOFCALIBRATION

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00062	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140 Dog 5
	KIOXVIIIE, IN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00062					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.8255 Ohm	S				
40.4160 F	40.416F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.22667 Oh	ms				
65.3590 F	65.357F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.62217 Oh	ms				
90.3710 F	90.374F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.9935 Ohm	S				
115.3880 F	115.384F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.34333 Oh	ms				
140.3980 F	140.399F	0.1000F	1	Pass	3.4e-002F	2.94
*****	es C***********					
Resistance Value at	t Temp = 101.8255 Ohm	s				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.22667 Oh	ms				
18.5320 c	18.531c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.62217 Oh	ms				
32.4280 c	32.430c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.9935 Ohm	S				
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.34333 Oh	ms				
60.2210 c	60.222c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at '	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.99778						
Alpha= 0.003853549						
Delta= 1.5100081703	19					
A= 0.003911737	90474					

-5.81889047424e-007



# **REPORT**OF**CALIBRATION**

### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	RTD00064	CAL DUE:	03 April 2018
ASSET NUMBER:		DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00064					
Probe Calibration H	Range = 40 to 140 Deg H	7				
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.78033 Ohms	3				
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 107.171 Ohms					
65.3590 F	65.356F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 112.55667 Ohms	3				
90.3710 F	90.374F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 117.91867 Ohms	3				
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 123.25833 Ohms	3				
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	Temp = 101.78033 Ohms	3				
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 107.171 Ohms					
18.5320 c	18.531c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.55667 Ohms	5				
32.4280 c	32.430c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 117.91867 Ohms	3				
46.3270 c	46.326c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 123.25833 Ohms	3				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	- (2*Ro*B)				
Ro= 99.95593						
Alpha= 0.003848202						
Delta= 1.5009812649	91					
A= 0.0039059627	79106					

-5.77607910557e-007



## **REPORT**OF**CALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00070	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00070					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4 t	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.86767 Ohr	ns				
40.4160 F	40.418F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.27367 Ohr	ns				
65.3590 F	65.353F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.67617 Ohr	ns				
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 118.053 Ohms					
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.40783 Ohr	ns				
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value at	t Temp = 101.86767 Ohr	ns				
4.6760 c	4.677c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.27367 Ohr	ns				
18.5320 c	18.529c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.67617 Ohr	ns				
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 118.053 Ohms					
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.40783 Ohr	ns				
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at S	Гemp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.03757						
Alpha= 0.003855975						
Delta= 1.5200076312	28					

A= 0.00391458611426

B= -5.86111142602e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R413	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

**Calibrated By:** 

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	IIIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R413					
Probe Calibration F	Range = 40 to 140 Deg	F				
	= 4.4 t	o 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 101.80767 Ohm	IS				
40.4050 F	40.402F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 107.21517 Ohm	IS				
65.3590 F	65.364F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 112.608 Ohms					
90.3580 F	90.361F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 117.97817 Ohm	IS				
115.3640 F	115.355F	0.1000F	9	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 123.3335 Ohms					
140.3800 F	140.384F	0.1000F	4	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	: Temp = 101.80767 Ohm	IS				
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 107.21517 Ohm	IS				
18.5320 c	18.536c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 112.608 Ohms					
32.4210 c	32.423c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 117.97817 Ohm	IS				
46.3130 c	46.308c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 123.3335 Ohms					
60.2110 c	60.214c	0.0560c	5.36	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 99.98257						
Alpha= 0.003855792						
Delta= 1.4931331579	95					
A= 0.0039133641	10885					

-5.75721088534e-007



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R443	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R443					
Probe Calibration R	ange = 40 to 140 Deg	F				
	= 4.4 t	o 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 101.86917 Ohm	S				
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 107.282 Ohms					
65.3590 F	65.363F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 112.67967 Ohm	S				
90.3580 F	90.358F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 118.056 Ohms					
115.3640 F	115.361F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.41333 Ohm	S				
140.3800 F	140.382F	0.1000F	2	Pass	3.4e-002F	2.94
****	C C**************					
Posistance Value at	$T_{\rm own} = 101, 96017, 0$	-				
A 6700 c	1668c	0.0560c	2 57	Dooo	1.00.0020	2.05
Posistance Value at	4.0000	0.05000	3.57	Pass	1.98-0020	2.95
18 5320 c	18 535c	0.0560c	5 36	Pass	1.00.0020	2.05
Pesistance Value at	$T_{\text{emp}} = 112 \ 67967 \ \text{Ohm}$	0.00000	5.50	F 855	1.96-0020	2.95
32 4210 c	32 421c	0.0560c	0	Pass	1.00.0020	2.05
Resistance Value at	32.4210 Temp = 118 056 Obms	0.05000	0	F 855	1.96-0020	2.95
46 3130 c	16 311c	0.0560c	3 57	Pass	1.90-0020	2 05
Resistance Value at	$T_{emp} = 123 41333 \text{ Ohm}$	5	5.57	1 455	1.36-0020	2.55
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C$ and	Rt = Resistance at T	emp				
T = [-RoA + Sart(Ro	^2*A^2-4Ro*B(Ro-Rt.))1	/(2*Ro*B)				
Ro= 100.04165	( / / ]					
Alpha= 0.003856249						
Delta= 1.5435667981						
A= 0.0039157727	7922					

-5.95237792161e-007



# **REPORT**OF**CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R526	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Calibrated By:** 

**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R526					
Probe Calibration	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.85617 Oh	ms				
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t  Temp = 107.26767  Oh	ms				
65.3590 F	65.363F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.66383 Oh	ms				
90.3580 F	90.357F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 118.039 Ohms					
115.3640 F	115.361F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.39517 Oh	ms	_	_		
140.3800 F	140.382F	0.1000F	2	Pass	3.4e-002F	2.94
***********Degre	es C***********					
Resistance Value a	t Temp = 101.85617 Oh	ms				
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.26767 Oh:	ms				
18.5320 c	18.535c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.66383 Oh	ms				
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 118.039 Ohms					
46.3130 c	46.311c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.39517 Oh:	ms				
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien Equation Used= Cal where $T = Deg C$ an T = [-RoA + Sqrt(RRo= 100.02919 Alpha= 0.003855881	ts: lendar-Van Dusen d Rt = Resistance at o^2*A^2-4Ro*B(Ro-Rt))	Temp ]/(2*Ro*B)				
Delta= 1.537434237	01					

0.00391516263463 -5.92816346322e-007

A=



# **REPORT**OF**CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R616	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R616					
Probe Calibration 3	Range = $40$ to $140$ Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = $101.72$ Ohms					
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.1235 Ohms					
65.3590 F	65.363F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.51183 Ohms					
90.3580 F	90.358F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.879 Ohms			_		
115.3640 F	115.360F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.2275 Ohms	0.40005	0	-	0 4 0005	0.04
140.3800 F	140.382F	0.1000F	2	Pass	3.4e-002F	2.94
*****	oo (************					
Resistance Value a	t Temp = 101 72 Ohms					
4 6700 c	4 668c	0.0560c	3 57	Pass	1 9e-002c	2 95
Resistance Value a	t Temp = 107.1235 Ohms	0.00000	0.07	1 435	1.00 0020	2.00
18.5320 c	18 535c	0.0560c	5 36	Pass	1 9e-002c	2 95
Resistance Value a	t Temp = 112.51183 Ohms	0.00000	0.00			2.00
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.879 Ohms					
46.3130 c	46.311c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.2275 Ohms					
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Tem	ıp				
T = [-RoA + Sqrt(Relation)]	o^2*A^2-4Ro*B(Ro-Rt))]/(	2*Ro*B)				
Ro= 99.89573						
Alpha= 0.00385542						
Delta= 1.534461652	69					

A= 0.00391457994145

B= -5.91599414503e-007

\*\*\*\*\* End of Report \*\*\*\*\*


# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R631	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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$\rightarrow$	Calibrat	ed By:	

**Approved By:** 

Standards	Used			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R631					
Probe Calibration 1	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.89067 Oh	ms				
40.4050 F	40.401F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.30033 Oh	ms				
65.3590 F	65.367F	0.1000F	8	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.6915 Ohm	S				
90.3580 F	90.357F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 118.06067 Oh	ms				
115.3640 F	115.357F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.4115 Ohm	S				
140.3800 F	140.384F	0.1000F	4	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value a	t Temp = 101.89067 Oh	ms				
4.6700 c	4.667c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.30033 Oh	ms				
18.5320 c	18.537c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.6915 Ohm	S				
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 118.06067 Oh	ms				
46.3130 c	46.310c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.4115 Ohm	S				
60.2110 c	60.213c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal.	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.06484						
Alpha= 0.003850064						
Delta = 1.6158682963	83					

Delta= 1.61586829683 A= 0.00391227596358

B= -6.22119635836e-007



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R832	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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	Calibrated	By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R832					
Probe Calibration 3	Range = $40$ to $140$ Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.814 Ohms	0.40005	2	-	0 4 0005	
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance value a	t Temp = 107.222 Onms	0.40005	4	Dava	0.4-0005	0.04
05.3390 F	65.363F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance value a	t Temp = 112.614 Onms	0 40005	2	Dees	2 4- 0025	2.04
90.3360 F	90.356F	0.1000F	2	Pass	3.4e-002F	2.94
115 2640 E	115 262E	0 10005	2	Deee	2 40 002E	2.04
	113.302F	0.1000F	2	Pass	3.40-002F	2.94
140 3800 F	140 382E	0 10005	2	Pass	3 40 002E	2.04
140.00001	140.3621	0.10001	2	F 855	3.46-0021	2.94
*************Degre	es C***********					
Resistance Value a	t Temp = 101.814 Ohms					
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.222 Ohms					
18.5320 c	18.535c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.614 Ohms					
32.4210 c	32.420c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.98533 Ohms					
46.3130 c	46.312c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.3365 Ohms					
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C an$	d Rt = Resistance at Tem	np				
T = [-RoA + Sqrt(Re)]	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.98811						
Alpha= 0.003854168						
Delta= 1.564182758	05					
A= 0.003914454	23132					

-6.02862313221e-007

B=



# **REPORT**OF**CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R919	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards	Used			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R919					
Probe Calibration 1	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.8265 Ohm	IS				
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.23417 Oh	ms				
65.3590 F	65.362F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.6265 Ohm	IS				
90.3580 F	90.357F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 117.9975 Ohm	IS				
115.3640 F	115.362F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.34867 Oh	ms				
140.3800 F	140.382F	0.1000F	2	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value a	t Temp = 101.8265 Ohm	IS				
4.6700 c	4.669c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.23417 Oh	ms				
18.5320 c	18.535c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.6265 Ohm	IS				
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 117.9975 Ohm	IS				
46.3130 c	46.312c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.34867 Oh	ms				
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient Equation Used= Cal. where $T = Deg C$ and T = [-RoA + Sqrt(RoRo= 100.00056 Alpha= 0.00385364	ts: lendar-Van Dusen d Rt = Resistance at o^2*A^2-4Ro*B(Ro-Rt))	Temp ]/(2*Ro*B)				
Delta= 1.564203934	48					

0.0039139187885 -6.02787885008e-007

A=

B=



# **REPORT**OF**CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R996	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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Calibrated By:

**Approved By:** 

Standards U	Used			
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R996					
Probe Calibration	Range = 40 to 140 Deg	F				
	= 4.4 t	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 101.834 Ohms					
40.4050 F	40.403F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.24117 Ohn	ıs				
65.3590 F	65.363F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.633 Ohms					
90.3580 F	90.358F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 118.0035 Ohms	3				
115.3640 F	115.360F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.35567 Ohn	ns a tabar		_		
140.3800 F	140.383F	0.1000F	3	Pass	3.4e-002F	2.94
*****	oo (*************					
Resistance Value a	t Temp = 101 834 Obms					
4 6700 c	4 668c	0.0560c	3 57	Pass	1 9e-002c	2 95
Resistance Value a	t. Temp = 107.24117 Ohn	15	0.07	1 465	1.00 0020	2.00
18.5320 c	18.535c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.633 Ohms					
32.4210 c	32.421c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 118.0035 Ohms	3				
46.3130 c	46.311c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.35567 Ohm	ns				
60.2110 c	60.213c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C$ an	d Rt = Resistance at 1	lemp				
T = [-RoA + Sqrt(R	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 100.00857						
Alpha= 0.003853578						
Delta= 1.535238918	86					

A= 0.00391273962922

B= -5.91616292247e-007



# **REPORT**OF**CALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R1104	CAL DUE: DATA TYPE:	14 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	40~140 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R1104					
Probe Calibration 1	Range = 40 to 140 Deg	F				
	= 4.4	to 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 102.07117 Oh	ms				
40.4050 F	40.402F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 107.4885 Ohm	IS				
65.3590 F	65.365F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 112.8895 Ohm	IS				
90.3580 F	90.356F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 118.2705 Ohm	IS				
115.3640 F	115.360F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 123.63267 Oh	ms				
140.3800 F	140.382F	0.1000F	2	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value a	t Temp = 102.07117 Oh	ms				
4.6700 c	4.668c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 107.4885 Ohm	IS				
18.5320 c	18.536c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 112.8895 Ohm	IS				
32.4210 c	32.420c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 118.2705 Ohm	IS				
46.3130 c	46.311c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 123.63267 Oh	ms				
60.2110 c	60.212c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.24261						
Alpha= 0.00385184						
Delta = 1 523244169	3					

Delta= 1.5232441693 A= 0.00391051292821

B= -5.86729282109e-007



### **REPORT**OF CALIBRATION

#### McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00028	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140 Dog
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards	Used			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00028					
Probe Calibration H	Range = 40 to 140 Deg H	7				
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.92317 Ohms	3				
40.4160 F	40.423F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.27333 Ohms	3				
65.3590 F	65.340F	0.1000F	19	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.6395 Ohms					
90.3710 F	90.384F	0.1000F	13	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.98617 Ohms	3				
115.3880 F	115.389F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.32167 Ohms	3				
140.3980 F	140.395F	0.1000F	3	Pass	3.4e-002F	2.94
***********Degree	es C***********					
Resistance Value at	t Temp = 101.92317 Ohms	5				
4.6760 c	4.680c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.27333 Ohms	3				
18.5320 c	18.522c	0.0560c	17.9	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.6395 Ohms					
32.4280 c	32.435c	0.0560c	12.5	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.98617 Ohms	5				
46.3270 c	46.327c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.32167 Ohms	3				
60.2210 c	60.219c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.11197						
Alpha= 0.00383826						
Delta= 0.760785541	671					
A= 0.003867460	92713					

-2.92009271317e-007

B =



### **REPORT**OF**CALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:		CAL DUE:	03 April 2018
ASSET NUMBER:	RTD00029	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd.	CAL RANGE:	40~140
	KIOXVIIIE, IN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00029					
Probe Calibration H	Range = $40$ to $140$ Deg F					
	= 4.4 to	60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 101.84633 Ohms					
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 107.24283 Ohms					
65.3590 F	65.354F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 112.635 Ohms					
90.3710 F	90.375F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 118.0025 Ohms					
115.3880 F	115.386F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 123.348 Ohms					
140.3980 F	140.398F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	Temp = 101.84633 Ohms					
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 107.24283 Ohms					
18.5320 c	18.530c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 112.635 Ohms					
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 118.0025 Ohms					
46.3270 c	46.325c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 123.348 Ohms					
60.2210 c	60.221c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Tem	ıp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/(	2*Ro*B)				
Ro= 100.01975						
Alpha= 0.003849884						

Delta= 1.50931920215 A= 0.00390799103847

B= -5.81070384726e-007



# **REPORTOFCALIBRATION**

#### McHalePerformance com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 6"	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER:	RTD00030	CAL DUE:	03 April 2018
ASSET NUMBER:		DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	40~140
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Calibrated By:** 

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= RTD00030					
Probe Calibration H	Range = 40 to 140 Deg	F				
	= 4.4 t	o 60 Deg C				
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 101.7735 Ohms					
40.4160 F	40.417F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 107.16467 Ohm	S				
65.3590 F	65.355F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 112.5515 Ohms					
90.3710 F	90.376F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 117.91333 Ohm	s		_		
115.3880 F	115.384F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 123.25467 Ohm	S		_		
140.3980 F	140.399F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C**********					
Resistance Value at	t Temp = 101.7735 Ohms					
4.6760 c	4.676c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 107.16467 Ohm	s				
18.5320 c	18.531c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 112.5515 Ohms					
32.4280 c	32.431c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 117.91333 Ohm	S				
46.3270 c	46.324c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 123.25467 Ohm	S				
60.2210 c	60.222c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 99.949						
Alpha= 0.003849127						
Delta= 1.4911303612	29					
A= 0.0039065225	50134					

-5.73955013414e-007

B=

# Certificate of Calibration

Page 1 of 1

# 24297

Certificate Number: 24297 Certificate Date: 2/7/2017

 Manufacturer:
 Fluke

 Model:
 1735

 Serial Number:
 S120714120B6

 Description:
 Three-Phase Power Logger - Analyst w/Shield

Date Received:	02/07/2017
Date of Calibration:	2/7/2017
Recommended Due Date:	2/7/2018
Temperature:	23.30 °C
Relative Humidity:	44.5 %RH

Cal Procedure FLUK-1735-CAL

Customer Name: McHale & Associates Inc Customer Address: 5025 Thomas Edison Dr Waldford MD PO Number: CRM Order Number: End of Rental

This Calibration is traceable to the International System of Units (SI), through National Metrology Institutes, ratio metric techniques, or natural physical constants. This certificate applies only to the item identified and shall not be reproduced other than in full, without the specific written approval by ATEC Corporation Laboratory. The calibration has been completed in accordance with ATEC Corporation Quality System.

This calibration conforms to the requirements of ISO/IEC 17025 2005 and ANSI/NCSL Z540-1-1994 (R2002).

In the attached measurement results, deviation may be expressed with units, Measured Value (MV) - Nominal Value (NV) or as a proportion of the

nominal value ((MV-NV)/NV), expressed without units with a scalar multiplier such as % (0.01), or as a ratio of the units (mA/A, µV/V, etc.)

Descriptions such as  $\mu A/A$ ,  $\mu V/V$ , and others, where used to annotate results or column headings are the preferred replacements for what was historically labeled as "ppm" or parts-per-million and described the results in that column, unless otherwise noted by units symbols.

Where applicable, the expanded uncertainty of measurement at the time of test is given in the following pages. They are calculated in accordance with the method described in the ISO Guide to the Expression of Uncertainty in Measurement (GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, such that the confidence level approximates 95%.

This Calibration certificate may contain data that is not covered by the A2LA Scope of Accreditation. Unaccredited material, where applicable is indicated by an asterisk (\*), or confined to clearly marked sections. Functional (Pass / Fail) tests are not accredited.

No statement of compliance with specifications is made or implied on this certificate. However, measurement results are reviewed, where applicable, to establish where any measurement result exceeded the manufacturer's specifications.

Measured values (MV) greater than the Manufacturer's specification (Spec) are indicated by "X".

Calibration Performed By:		Authorized by:	
McNair, Shane P	Technician	Javier Estrada	02/07/2017
Name	Title	Metrology Supervisor	Certificate Date

ATEC Corporation calibration documents are electronically signed utilizing MudCats Metrology Software Suite of Applications

ATEC Corporation 10401 Roselle St. San Diego, CA 92121 Telephone 888-488-2832

Facsimile 858-588-6570 Internet www.ATECorp.com QF21/122713



# Certificate of Calibration

Page 1 of 1

### Work Order 22844

Certificate	Number:	22844
Certificate	Date:	2/7/2017

 Manufacturer:
 Fluke

 Model:
 1735

 Serial Number:
 S150635991B6

 Description:
 Three-Phase Power Logger - Analyst w/Shield

Date Received:	10/18/2016
Date of Calibration:	10/18/2016
Recommended Due Date:	10/18/2017
Temperature:	2,333.00 °C
<b>Relative Humidity:</b>	40.0 %RH

Cal Procedure FLUK-1735-CAL

Customer Name:McHale & Associates IncCustomer Address:5025 Thomas Edison Dr Waldford MDPO Number:CRM Order Number:End of Rental

This Calibration is traceable to the International System of Units (SI), through National Metrology Institutes, ratio metric techniques, or natural physical constants. This certificate applies only to the item identified and shall not be reproduced other than in full, without the specific written approval by ATEC Corporation Laboratory. The calibration has been completed in accordance with ATEC Corporation Quality System.

This calibration conforms to the requirements of ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994 (R2002).

In the attached measurement results, deviation may be expressed with units, Measured Value (MV) - Nominal Value (NV) or as a proportion of the

nominal value ((MV-NV)/NV), expressed without units with a scalar multiplier such as % (0.01), or as a ratio of the units (mA/A, µV/V, etc.)

Descriptions such as  $\mu A/A$ ,  $\mu V/V$ , and others, where used to annotate results or column headings are the preferred replacements for what was historically labeled as "ppm" or parts-per-million and described the results in that column, unless otherwise noted by units symbols.

Where applicable, the expanded uncertainty of measurement at the time of test is given in the following pages. They are calculated in accordance with the method described in the ISO Guide to the Expression of Uncertainty in Measurement (GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, such that the confidence level approximates 95%.

This Calibration certificate may contain data that is not covered by the A2LA Scope of Accreditation. Unaccredited material, where applicable is indicated by an asterisk (\*), or confined to clearly marked sections. Functional (Pass / Fail) tests are not accredited.

No statement of compliance with specifications is made or implied on this certificate. However, measurement results are reviewed, where applicable, to establish where any measurement result exceeded the manufacturer's specifications.

Measured values (MV) greater than the Manufacturer's specification (Spec) are indicated by "X".

### Standards Utilized

Asset I.D.	Manufacturer	Model No.	Description	Cal. Date	Due Date
L-3132	Fluke	FLUK-5520A	Calibrators / Standards (10037)	10/29/2015	10/28/2016

Calibration Performed By:		Authorized by:	
Vancelette, John M	Technician	Javier Estrada	02/07/2017
Name	Title	Metrology Supervisor	Certificate Date

ATEC Corporation calibration documents are electronically signed utilizing MudCats Metrology Software Suite of Applications

ATEC Corporation 10401 Roselle St. San Diego, CA 92121 Telephone 888-488-2832

Facsimile 858-588-6570 Internet www.ATECorp.com QF21/122713



### **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 29 March 2017
SERIAL NUMBER:	1113236	CAL DUE:	29 March 2018
ASSET NUMBER:	1011	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA01011					
Calibrated Span =	5 PSI					
Calibration Tolera	nce = 0.00325 PSI					
Upscale Tests						
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
2.5000 psi	2.500psi	0.00325psi	0	Pass	6.1e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
Downscale Tests						
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
2.5000 psi	2.500psi	0.00325psi	0	Pass	6.1e-004psi	
1.2500 psi	1.250psi	0.00325psi	0	Pass	6.1e-004psi	
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 29 March 2017
SERIAL NUMBER:	1060094	CAL DUE:	29 March 2018
ASSET NUMBER:	1014	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA01014					
Calibrated Span = !	5 PSI					
Calibration Toleran	nce = 0.00325 PSI					
Upscale Tests						
0.5000 psi	0.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
2.5000 psi	2.500psi	0.00325psi	0	Pass	6.1e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
Downscale Tests						
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
2.5000 psi	2.500psi	0.00325psi	0	Pass	6.1e-004psi	
1.2500 psi	1.250psi	0.00325psi	0	Pass	6.1e-004psi	
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	



### **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER: ASSET NUMBER:	125248 1059	CAL DUE: DATA TYPE:	03 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA01059					
Calibrated Span =	150 PSI					
Calibration Tolera	nce = 0.0975 PSI					
Upscale Tests						
15.0000 psi	15.006psi	0.0975psi	6.15	Pass	7.3e-003psi	
37.5000 psi	37.505psi	0.0975psi	5.13	Pass	7.3e-003psi	
75.0000 psi	74.992psi	0.0975psi	8.21	Pass	7.3e-003psi	
112.5000 psi	112.492psi	0.0975psi	8.21	Pass	9.0e-003psi	
150.0000 psi	149.996psi	0.0975psi	4.1	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.006psi	0.0975psi	6.15	Pass	1.2e-002psi	
112.5000 psi	112.503psi	0.0975psi	3.08	Pass	9.0e-003psi	
75.0000 psi	75.004psi	0.0975psi	4.1	Pass	7.3e-003psi	
37.5000 psi	37.503psi	0.0975psi	3.08	Pass	7.3e-003psi	
15.0000 psi	15.000psi	0.0975psi	0	Pass	7.3e-003psi	



### **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 29 March 2017
SERIAL NUMBER:	1543986	CAL DUE:	29 March 2018
ASSET NUMBER:	1074	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA01074					
Calibrated Span =	5 PSI					
Calibration Tolera	nce = 0.00325 PSI					
Upscale Tests						
0.5000 psi	0.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
Downscale Tests						
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
3.7500 psi	3.750psi	0.00325psi	0	Pass	6.5e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	



### REPORTOFCALIBRATION

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UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 29 March 2017
SERIAL NUMBER: ASSET NUMBER:	1099228 1081	CAL DUE: DATA TYPE:	29 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~5 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA01081					
Calibrated Span =	5 PSI					
Calibration Tolera	ance = 0.00325 PSI					
Upscale Tests						
0.5000 psi	0.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
3.7500 psi	3.749psi	0.00325psi	30.8	Pass	6.5e-004psi	
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
Downscale Tests						
5.0000 psi	5.000psi	0.00325psi	0	Pass	7.0e-004psi	
3.7500 psi	3.749psi	0.00325psi	30.8	Pass	6.5e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	



### **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 29 March 2017
SERIAL NUMBER:	1046926	CAL DUE:	29 March 2018
ASSET NUMBER:	1082	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUISTOMER:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA01082					
Calibrated Span = 5	5 PSI					
Calibration Tolerar	nce = 0.00325 PSI					
Upscale Tests						
0.5000 psi	0.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.249psi	0.00325psi	30.8	Pass	6.1e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
3.7500 psi	3.749psi	0.00325psi	30.8	Pass	6.5e-004psi	
5.0000 psi	4.999psi	0.00325psi	30.8	Pass	7.0e-004psi	
Downscale Tests						
5.0000 psi	4.999psi	0.00325psi	30.8	Pass	7.0e-004psi	
3.7500 psi	3.749psi	0.00325psi	30.8	Pass	6.5e-004psi	
2.5000 psi	2.499psi	0.00325psi	30.8	Pass	6.1e-004psi	
1.2500 psi	1.248psi	0.00325psi	61.5	Pass	6.1e-004psi	
0.5000 psi	0.500psi	0.00325psi	0	Pass	6.1e-004psi	



Doster Road Knoxville, IN 37934 805 588 2054

**REPORTOFCALIBRATION** 

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UNIT UNDER TEST:	Agilent 34970A Data Logger	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER:	US37030138	CAL DUE:	10 May 2018
ASSET NUMBER:	2010	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Agilent 34970A: RS-232/5520A (1 year) (Auto) 0 - 05/26/04 Grant Shropshire McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
COOTOMER.	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

Grant Shaphin

Calibrated By:

**Approved By:** 

Standards U	Jsed			
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017

Test Results							
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>	
0.00 status ZERO TESTS	0.0status		0	Pass			
100 mVDC Range 0.0000 mV	-0.0038mV		94.8	Pass			
1 VDC Range 0.000000 V	-0.000004V		53.9	Pass			
10 VDC Range 0.00000 V	-0.00001V		10	Pass			
0.0000 V	-0.0000V		2.17	Pass			
0.000 V	0.000V		0.889	Pass			
0.0000 Ohm 100 Ohm Range 4-Wi	-0.0001Ohm		0.0101	Pass			
0.0000 Ohm 1 kOhm Range, 2-Win	-0.0004Ohm		8.85	Pass			
0.000000 kOhm	0.000000kOhm		0.0129	Pass			
0.000000 kOhm	-0.000000kOhm		1.3	Pass			
0.00000 kOhm	-0.00003kOhm		2.75	Pass			
10 kOhm Range, 4-Wi 0.00000 kOhm	ire -0.00000kOhm		3.8	Pass			
0.0000 kOhm	-0.0004kOhm		19	Pass			
0.0000 kOhm	-0.0000kOhm		3.8	Pass			
0.000000 MOhm	-0.000000MOhm		4.55	Pass			
0.000000 MOhm	0.000000MOhm		2.5	Pass			
0.00000 MOhm	-0.00001MOhm		12.4	Pass			
10 MOhm Range, 4-Wi 0.00000 MOhm 100 MOhm Range 2-W	ire 0.00001MOhm Vire		5	Pass			
0.0000 MOhm	0.0000MOhm		0	Pass			
0.0000 MOhm	0.0000MOhm		0	Pass			
0.00000 mA	-0.00001mA		0.625	Pass			
0.00000 mA	-0.00005mA		0.98	Pass			
0.000000 A DC VOLTAGE:	-0.00003A		2.77	Pass			
100mV Range 50.0000 mV	49.9948mV	0.0000650V	80.7	Pass	1.6e-006V	3.25	

Test Results							
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>	
100.0000 mV	99.9929mV	9.0000000001e-006	79.2	Pass	2.3e-006V	3.00	
1V Range							
0.5000000 V	0.4999917V	2.70000000001e-005	30.6	Pass	5.8e-006V	3.60	
1.000000 V	0.999987V	4.69999999999e-005	27.1	Pass	1.0e-005V	3.62	
10V Range							
5.00000 V	5.00000V	0.000225V	0.933	Pass	6.2e-005V	2.81	
10.00000 V	9.99999V	0.00040000000001V	2.57	Pass	1.1e-004V	2.86	
100V Range							
50.0000 V	50.0002V	0.00285V	5.4	Pass	8.2e-004V	2.71	
100.0000 V	100.0000V	0.00510V	0	Pass	1.5e-003V	2.62	
300V Range							
150.0000 V	150.0004V	0.01575V	2.48	Pass	2.2e-003V		
300.0000 V	300.0003V	0.02250V	1.42	Pass	4.3e-003V		
AC VOLTAGE:							
100mV Range							
100.0000 mV @ 1 kHz	100.0118mV	0.00010000V	11.8	Pass	1.7e-005V		
100.0000 mV @ 50 kHz	100.0012mV	0.00017000V	0.694	Pass	3.3e-005V	3.95	
1V Range				_			
1.000000 V @ 1 kHz	1.000125V	0.0010000V	12.5	Pass	1.6e-004V		
1.000000 V @ 50 kHz	1.000126V	0.0017000V	7.39	Pass	2.7e-004V		
10V Range							
10.00000 V @ 1 kHz	10.00094V	0.010000V	9.44	Pass	1.6e-003V		
10.00000 V @ 50 kHz	10.000291/	0.017000V	1 72	Pass	3 2e-003V		
10 00000 V @ 10 Hz	9 99910\/	0.010000V	9	Pass	2.80-003\/	2 74	
	0.000101	0.010000	5	1 400	2.00 0001	2.14	
100V Range							
100.0000 V @ 1 kHz	100.0266V	0.10000V	26.6	Pass	1.6e-002V		
100.0000 V @ 50 kHz	99.9773V	0.17000V	13.3	Pass	2.8e-002V		
300V Range							
300.000 V @ 1 kHz	300.121V	0.4200V	28.9	Pass	4.6e-002V		
300.000 V @ 50 kHz	300.130V	0.7200V	18.1	Pass	7.4e-002V		
100 Ohm Range							
100.0000 Ohm	100.1101Ohm	1.01400Ohm	10.9	Pass	3.3e-003Ohm		
1 kOhm Range							
1.000000 kOhm	1.000109kOhm	1 1100Ohm	9.83	Pass	2 3e-0020hm		
	1.000103KOhim	1.110001111	9.03	1 835	2.36-00201111		
10 kOhm Range							
10.00000 kOhm	10.00009kOhm	2.1000hm	4.19	Pass	2.3e-0010hm		
100 kOhm Range							
100.0000 kOhm	99.9999kOhm	12.000hm	0.758	Pass	2.3e+0000hm	4.00	
1 MOhm Range							
1.000000 MOhm	1.000021MOhm	111.00hm	19	Pass	2.6e+001Ohm	3.26	

Test Results	Fest Results							
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>		
10 MOhm Range 10.00000 MOhm	10.00039MOhm	4100Ohm	9.44	Pass	1.0e+003Ohm	3.04		
100 MOhm Range 100.0000 MOhm 4-WIRE OHMS:	99.6151MOhm	810000Ohm	47.5	Pass	4.1e+004Ohm			
100 Ohm Range 100.0000 Ohm	99.9956Ohm	0.01400Ohm	31.2	Pass	3.3e-003Ohm	3.33		
1 kOhm Range 1.000000 kOhm	0.999998kOhm	0.1100Ohm	2.09	Pass	2.3e-0020hm	3.67		
10 kOhm Range 10.00000 kOhm	10.00002kOhm	1.100Ohm	1.55	Pass	2.3e-001Ohm	3.67		
100 kOhm Range 100.0000 kOhm FREQUENCY - Gain Ve	100.0003kOhm rification	11.00Ohm	2.82	Pass	2.3e+000Ohm	3.67		
100mV Range 100.0000 Hz @ 10 mV	99.9773Hz	0.10000Hz	22.7	Pass	2.1e-004Hz			
1V Range 100.0000 kHz @ 1 V DC CURRENT:	100.0002kHz	10.00Hz	1.7	Pass	2.0e-001Hz			
10mA Range 10.00000 mA	9.99964mA	0.000007000A	5.18	Pass	9.7e-007A			
100mA Range 100.0000 mA	99.9958mA	0.00005500A	7.72	Pass	9.7e-006A			
1A Range 1.000000 A AC CURRENT:	0.999901A	0.0011000A	9.02	Pass	1.9e-004A			
10mA Range 10.00000 mA @ 1 kHz	9.99990mA	0.000014000A	0.748	Pass	4.7e-006A	2.33		
100mA Range 100.0000 mA @ 1 kHz	100.1164mA	0.00060000A	19.4	Pass	4.7e-005A			
1A Range 1.000000 A @ 1 kHz	1.000226A	0.0014000A	16.2	Pass	4.7e-004A	2.33		



### **REPORTOFCALIBRATION**

McHalePerformance sum

UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER:	MY41005806	CAL DUE:	10 May 2018
ASSET NUMBER:	2028	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Agilent 34970A: RS-232/5520A (1 year) (Auto)	<b>TEMPERATURE:</b>	22.00 °C
PROCEDURE REV.:	0 - 05/26/04	HUMIDITY:	45 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as left.

Grant Shaphin

Calibrated By:

**Approved By:** 

Standards U	Jsed			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017

Test Results							
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>	
0.00 status ZERO TESTS	0.0status		0	Pass			
100 mVDC Range 0.0000 mV	-0.0005mV		12.7	Pass			
1 VDC Range 0.000000 V	-0.000001V		11.1	Pass			
0.00000 V	0.00000V		0	Pass			
0.0000 V 300 VDC Range	0.0000V		2.17	Pass			
0.000 V 100 Ohm Range, 2-W:	0.000V ire		0.556	Pass			
0.0000 Ohm 100 Ohm Range, 4-W	-0.0001Ohm ire		0.0141	Pass			
0.0000 Ohm 1 kOhm Range, 2-Win	-0.0002Ohm		3.88	Pass			
0.000000 kOhm 1 kOhm Range, 4-Win	0.000002kOhm		0.166	Pass			
0.000000 kOhm 10 kOhm Range, 2-W:	-0.000000kOhm ire		1.3	Pass			
10 kOhm Range, 4-W	ire		0.827	r ass			
0.00000 kOhm 100 kOhm Range, 2-4	0.00000kOhm Nire		1.3	Pass			
0.0000 kOhm 100 kOhm Range, 4-W	-0.0001kOhm Mire		4.55	Pass			
0.0000 kOhm 1 MOhm Range, 2-Win	0.0000kOhm re		2.6	Pass			
0.000000 MOhm 1 MOhm Range, 4-Win	0.000000MOhm re		2.36	Pass			
0.000000 MOhm 10 MOhm Range, 2-W:	0.000000MOhm ire		0	Pass			
10 MOhm Range 4-W-	-0.00000MOnm		2.57	Pass			
0.00000 MOhm 100 MOhm Range, 2-4	0.00000MOhm Nire		2.6	Pass			
0.0000 MOhm 100 MOhm Range, 4-W	0.0000MOhm Mire		0	Pass			
0.0000 MOhm 10 mADC Range	0.0000MOhm		0	Pass			
<b>0.00000 mA</b> 100 mADC Range	0.00005mA		2.47	Pass			
0.00000 mA 1 ADC Range	0.00000mA		0	Pass			
0.000000 A DC VOLTAGE:	0.000002A		2.22	Pass			
100mV Range 50.0000 mV	49.9995mV	0.0000650V	7.28	Pass	1.6e-006V	3.25	
Test Results							
--	----------------	-------------------	-------------	-----------	---------------	------	
		Test Tol	% Tol Error	PASS/FAIL	Expanded Unc.	TUR	
<u>Standard Reading</u> 100.0000 mV	99.9993mV	0.00000900V	7.9	Pass	2.3e-006V	3.00	
1V Range							
0.5000000 V	0.5000002\/	0 00002700\/	0.667	Pass	5 8e-006\/	3 60	
1 000000 V	1.00000021	0.000027007	0.638	Pass	1.0e-005\/	3.62	
1.000000	1.000000	0.00004707	0.050	1 835	1.08-003 V	5.02	
10V Range							
5.00000 V	5.00000V	0.000225V	1.64	Pass	6.2e-005V	2.81	
10.00000 V	10.0000V	0.00040000000001V	1.17	Pass	1.1e-004V	2.86	
100V Range							
50.0000 V	50.0001V	0.00285V	3.65	Pass	8.2e-004V	2.71	
100.0000 V	99.9999V	0.00510V	1.02	Pass	1.5e-003V	2.62	
	00.0000	0.000101	1.02	1 466	1.00 0001	2.02	
300V Range				_			
150.0000 V	149.9994V	0.01575V	3.68	Pass	2.2e-003V		
300.0000 V	299.9971V	0.02250V	13.1	Pass	4.3e-003V		
AC VOLTAGE:							
100mV Range				_			
100.0000 mV @ 1 kHz	99.9990mV	0.00010000V	0.974	Pass	1.7e-005V		
100.0000 mV @ 50 kHz	99.9660mV	0.00017000V	20	Pass	3.3e-005V	3.95	
1V Range							
1.000000 V @ 1 kHz	0.999997V	0.0010000V	0.262	Pass	1.6e-004V		
1.000000 V @ 50 kHz	0.999988V	0.0017000V	0.682	Pass	2.7e-004V		
10V Pango							
	10 0001 41/	0.010000\/	1.05	Deee	1.60.002\/		
10.00000 V @ T KHZ	10.000140	0.0100000	1.35	Pass	1.6e-003V		
10.00000 V @ 30 KHZ	9.99693	0.0170000	0.31	Pass	3.2e-003V	0.74	
10.00000 V @ 10 HZ	10.000100	0.010000	1.02	Pass	2.86-0037	2.74	
100V Range							
100.0000 V @ 1 kHz	100.0014V	0.10000V	1.36	Pass	1.6e-002V		
100.0000 V @ 50 kHz	100.0258V	0.17000V	15.2	Pass	2.8e-002V		
300V Range							
300.000 V @ 1 kHz	300 011V	0 4200\/	2 61	Pass	4 6e-002\/		
300 000 V @ 50 kHz	300.060V	0.7200\/	8.32	Pass	7.40-0021		
2-WIRE OHMS:	000.000 V	0.72007	0.02	1 400	1.40 0021		
100 Ohm Range							
100.0000 Ohm	100.1176Ohm	1.01400Ohm	11.6	Pass	3.3e-003Ohm		
1 1-01							
1 KORM Range	4 000 4 401 01	4 4 4 9 9 9	10.0	-	0.0.0000		
1.000000 kOhm	1.000118kOhm	1.1100Ohm	10.6	Pass	2.3e-0020hm		
10 kOhm Range							
10.00000 kOhm	10.00013kOhm	2.100Ohm	6 14	Pass	2.3e-0010hm		
		2.10001111	0.14	1 400	2.00 00101111		
100 kOhm Range							
100.0000 kOhm	100.0001kOhm	12.00Ohm	0.75	Pass	2.3e+000Ohm	4.00	
1 MOhm Pange							
1 000000 MOhm	1 000005MObm	111 00hm	1 50	Pace	2 60±0010hm	3 26	
			4.09	r 999	2.00700101111	3.20	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range 10.00000 MOhm	10.00008MOhm	4100Ohm	1.88	Pass	1.0e+003Ohm	3.04
100 MOhm Range 100.0000 MOhm 4-WIRE OHMS:	99.9416MOhm	810000Ohm	7.21	Pass	4.1e+004Ohm	
100 Ohm Range 100.0000 Ohm	100.0003Ohm	0.01400Ohm	2.14	Pass	3.3e-003Ohm	3.33
1 kOhm Range 1.000000 kOhm	1.000002kOhm	0.1100Ohm	1.45	Pass	2.3e-0020hm	3.67
10 kOhm Range 10.00000 kOhm	10.00003kOhm	1.100Ohm	3.09	Pass	2.3e-001Ohm	3.67
100 kOhm Range 100.0000 kOhm FREQUENCY - Gain Ve	100.0001kOhm rification	11.00Ohm	0.636	Pass	2.3e+000Ohm	3.67
100mV Range 100.0000 Hz @ 10 mV	100.0449Hz	0.10000Hz	44.9	Pass	2.1e-004Hz	
1V Range 100.0000 kHz @ 1 V DC CURRENT:	100.0002kHz	10.00Hz	1.6	Pass	2.0e-001Hz	
10mA Range 10.00000 mA	10.00003mA	0.000007000A	0.457	Pass	9.7e-007A	
100mA Range 100.0000 mA	100.0002mA	0.00005500A	0.364	Pass	9.7e-006A	
1A Range 1.000000 A AC CURRENT:	0.999956A	0.0011000A	4.03	Pass	1.9e-004A	
10mA Range 10.00000 mA @ 1 kHz	9.99850mA	0.000014000A	10.7	Pass	4.7e-006A	2.33
100mA Range 100.0000 mA @ 1 kHz	99.9658mA	0.00060000A	5.7	Pass	4.7e-005A	
1A Range 1.000000 A @ 1 kHz	1.000117A	0.0014000A	8.34	Pass	4.7e-004A	2.33



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Power Meter, Digital	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	32-69374 9131	CAL DUE: DATA TYPE:	11 May 2018 FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Nexus 1250/1252/1500: CAL VER 60Hz 0 - 03/28/17 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as found and as left.

Grant Shaphin

Calibrated By:

**Approved By:** 

Standards Used								
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>				
14001	Fluke 5520A Multi-Function Calibrator	8635015	3/14/2017	3/14/2018				
14002	Rotek MSB100 Power and Energy Standard	173	2/25/2017	2/25/2018				

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AC VOLTAGE TESTS - 6	50Hz					
100 000 V	100.0140\/	0.000001/	17 5	Deee	1.60.002\/	2.04
120.000 V	100.0140V	0.00000	17.5	Pass	1.0e-002V	3.01 2.07
240.000 V	120.0130V	0.096007	13.5	Pass	1.9e-002V	3.07
240.000 V	240.04107	0.192000	21.4	Pass	3.7e-002v	
100 000 V	100 0110\/	0.08000\/	13 7	Pass	1.60.002\/	2 91
120.000 V	120.0150\/	0.00000	15.7	Pass	1.00-0021	3.01 2.07
240 000 V	240.0420\/	0.09000V	15.0	Fass	3.70.0021	3.07
Phase C -	240.0420V	0.192000	21.9	Fd55	5.7 E-002 V	
100 000 V	100 0200\/	0.08000\/	25	Pass	1.60.002\/	2 91
120.000 V	120.0200V	0.00000	20 9	Pass	1.00-0021	2.01
240 000 V	240.0410	0.09000V	20.0	Pass	3.70.0021	5.07
240.000 V	240.04100	0.192007	21.4	Fd55	3.70-0020	
AC CURRENT TESTS - 6	50Hz					
Phase A - 1A Range						
1.00030 A	1 0002A	0 00100A	10	Pass	2 6e-004A	3 89
	1.0002/1	0.001007		1 400	2.00 00 11 (	0.00
Phase B - 1A Range						
1.00030 A	1 0002A	0.00100A	10	Pass	2 6e-004A	3 89
						0.00
Phase C - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase A - 2.5A Range	e					
2.50060 A	2.4999A	0.00200A	35	Pass	6.5e-004A	3.11
Phase B - 2.5A Range	e					
2.50060 A	2.5005A	0.00200A	5	Pass	6.5e-004A	3.11
Phase C - 2.5A Range	e					
2.50060 A	2.5008A	0.00200A	10	Pass	6.5e-004A	3.11
Phase A - 5A Range						
5.00170 A	5.0009A	0.00400A	20	Pass	1.3e-003A	3.11
Phase B - 5A Range						
5.00170 A	5.0020A	0.00400A	7.5	Pass	1.3e-003A	3.11
Phase C - 5A Range						
5.00160 A	5.0019A	0.00400A	7.5	Pass	1.3e-003A	3.11
AC WATT TESTS - 60Hz	z - PF 1.0					
Phase A - 1A Range						
120.03250 W	120.0229W	0.09600W	10	Pass	7.6e-003W	
Phase B - 1A Range						
120.03240 W	120.0376W	0.09600W	5.42	Pass	7.6e-003W	
Phase C - 1A Range			<b>.</b>	_		
120.03310 W	120.0543W	0.09600W	22.1	Pass	7.6e-003W	

Phase A - 2.5A Range

Date Printed: May 12, 2017

Test Results						
<u>Standard Reading</u> 300.07280 W	<u>UUT Reading</u> 299.9951W	<u>Test Tol</u> 0.24000W	<u>% Tol Error</u> 32.4	<u>PASS/FAIL</u> Pass	Expanded Unc. 3.5e-002W	<u>TUR</u>
Phase B - 2.5A Range 300.07200 W	300.0721W	0.24010W	0.0416	Pass	3.5e-002W	
Phase C - 2.5A Range 300.07330 W	300.1334W	0.24000W	25	Pass	3.5e-002W	
Phase A - 5A Range 600.20020 W	600.0889W	0.48000W	23.2	Pass	1.4e-001W	
Phase B - 5A Range 600.19600 W	600.2154W	0.48000W	4.04	Pass	1.4e-001W	
Phase C - 5A Range 600.20180 W	600.2774W	0.48000W	15.7	Pass	1.4e-001W	
AC WATT TESTS - 60Hz	- PF 0.75 Lead/La	ag				
Phase A - 0.75 Lag 450.27520 W	450.2192W	0.36000W	15.6	Pass	9.0e+002W	
Phase B - 0.75 Lag 450.27480 W	450.2617W	0.36000W	3.64	Pass	8.7e-003W	
Phase C - 0.75 Lag 450.27190 W	450.2956W	0.36000W	6.58	Pass	8.7e-003W	
Phase A - 0.75 Lead 450.00550 W	449.7418W	0.36000W	73.2	Pass	9.0e+002W	
Phase B - 0.75 Lead 450.00320 W	449.8639W	0.36000W	38.7	Pass	8.7e-003W	
Phase C - 0.75 Lead 450.00480 W	449.9557W	0.36000W	13.6	Pass	8.7e-003W	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER:	US37018653	CAL DUE:	11 May 2018
ASSET NUMBER:	10063	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Agilent 34970A: RS-232/5520A (1 year) (Auto)	TEMPERATURE:	22.00 •C
PROCEDURE REV.:	0 - 05/26/04	HUMIDITY:	45 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille TN 37012		N/A
	(10XVIIIE, 11) 37912	CAL UNITS:	IN/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

Grant Shaphin Calibrated By:

**Approved By:** 

Standards U	Standards Used							
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date				
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017				

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
SELF TEST 0.00 status ZERO TESTS	0.0status		0	Pass		
100 mVDC Range 0 0000 mV	-0 0018m\/		43.9	Pass		
1 VDC Range 0.000000 V	-0.000001V		20.6	Pass		
10 VDC Range 0.00000 V	0.00000V		0	Pass		
100 VDC Range 0.0000 V	-0.0000V		6.5	Pass		
300 VDC Range 0.000 V	0.000V		0	Pass		
100 Ohm Range, 2-Wi 0.0000 Ohm	.re 0.0002Ohm		0.0198	Pass		
100 Ohm Range, 4-Wi 0.0000 Ohm	.re 0.0030Ohm		76.1	Pass		
1 kOhm Range, 2-Wir 0.000000 kOhm	e 0.000000kOhm		0.0257	Pass		
1 kOhm Range, 4-Wir 0.000000 kOhm	e 0.000003kOhm		34.4	Pass		
10 kOhm Range, 2-Wi 0.00000 kOhm	.re -0.00001kOhm		1.33	Pass		
10 kOhm Range, 4-Wi	re			_		
0.00000 kOhm 100 kOhm Range, 2-W	0.00004kOhm Nire		35.7	Pass		
100 kOhm Range, 4-W	-0.0002kOhm Nire		8.6	Pass		
1 MOhm Range, 2-Wir	0.0003kOnm		30.4	Pass		
1 MOhm Range, 4-Wir	0.000000000000000000000000000000000000		2.36	Pass		
10 MOhm Range, 2-Wi	.re		7.9	Pass		
10 MOhm Bange, 4-Wi	re		0	Fass		
0.00000 MOhm 100 MOhm Range, 2-W	0.00001MOhm Vire		10.6	Pass		
0.0000 MOhm 100 MOhm Range, 4-W	0.0000MOhm		0	Pass		
0.0000 MOhm 10 mADC Range	0.0000MOhm		0	Pass		
<b>0.00000 mA</b> 100 mADC Range	-0.00001mA		0.4	Pass		
<b>0.00000 mA</b> 1 ADC Range	0.00003mA		0.52	Pass		
0.000000 A DC VOLTAGE:	-0.000002A		2.49	Pass		
100mV Range 50.0000 mV	50.0000mV	6.5000000001e-006	0.477	Pass	1.6e-006V	3.25

Test Results						
Standard Deading	UUT Dooding	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	TUR
<u>Standard Reading</u> 100.0000 mV	100.0009mV	9.0000000001e-006	10.1	Pass	2.3e-006V	3.00
1V Range						
0.5000000 V	0 5000064V	0 00002700V	23.7	Pass	5 8e-006V	3 60
1 000000 V	1 000014\/	0.000027001	30.4	Pass	1.0e-005\/	3.62
1.000000	1.0000140	0.00004700	50.4	1 835	1.08-003 V	5.02
10V Range						
5.00000 V	5.00009V	0.000225V	41.4	Pass	6.2e-005V	2.81
10.00000 V	10.00019V	0.00040000000001V	46.5	Pass	1.1e-004V	2.86
100V Range						
50.0000 V	50.0004V	0.00285V	15.4	Pass	8.2e-004V	2.71
100.0000 V	100 0006V	0.00510V	12.5	Pass	1 5e-003V	2 62
				1 400		
300V Range	450 00001/			-	0.0.0001/	
150.0000 V	150.0008V	0.01575V	5.27	Pass	2.2e-003V	
300.0000 V	299.9999V	0.02250V	0.622	Pass	4.3e-003V	
AC VOLTAGE:						
100.000 m\/ @ 1 kHz	00.0760m\/	0.000100001/	22.1	Dooo	1 70 0051/	
100.0000 mV @ 1 kHz	99.9709111V	0.000100000	23.1	Pass	1.70-0050	2.05
	99.9979117	0.000170000	1.22	P855	3.3e-005V	3.95
1V Range						
1.000000 V @ 1 kHz	0.999759V	0.0010000V	24.1	Pass	1.6e-004V	
1.000000 V @ 50 kHz	0.999650V	0.0017000V	20.6	Pass	2.7e-004V	
10V Range						
10.00000 V @ 1 kHz	9 99785V	0.010000	21.5	Pass	1.6e-003V	
10 00000 V @ 50 kHz	10.00241\/	0.017000\/	14 1	Pass	3 20-0031/	
10 00000 V @ 10 Hz	9 99753\/	0.010000	24.7	Pass	2.8e-003\/	2 74
	0.007007	0.0100001	24.1	1 433	2.00-000 V	2.14
100V Range						
100.0000 V @ 1 kHz	99.9824V	0.10000V	17.6	Pass	1.6e-002V	
100.0000 V @ 50 kHz	100.0268V	0.17000V	15.7	Pass	2.8e-002V	
300V Range						
300.000 V @ 1 kHz	299.940V	0.4200V	14.4	Pass	4.6e-002V	
300.000 V @ 50 kHz	300.046V	0.7200V	6.32	Pass	7.4e-002V	
2-WIRE OHMS:						
100 Ohm Range						
100.0000 Ohm	100.1144Ohm	1.014000hm	11.3	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	1 000128kOhm	1 1100Ohm	11.5	Pass	2.3e-0020hm	
	1.000120100111		11.0	1 400	2.00 00201111	
10 kOhm Range						
10.00000 kOhm	10.00026kOhm	2.100Ohm	12.3	Pass	2.3e-0010hm	
100 kOhm Range						
100.0000 kOhm	100.0019kOhm	12.00Ohm	15.5	Pass	2.3e+000Ohm	4.00
1 MOhm Range						
1.000000 MOhm	1.000023MOhm	111 0Ohm	20.5	Pass	2 6e+001∩hm	3.26
	1.000020000100		20.0	1 455	2.00.00101111	0.20

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range				_		
10.00000 MOnm	9.99982MOhm	4100Ohm	4.42	Pass	1.0e+003Ohm	3.04
100 MOhm Range						
100.0000 MOhm	99.8297MOhm	8100000hm	21	Pass	4.1e+004Ohm	
4-WIRE OHMS:						
100.0000 Ohm	99.99940hm	0.01400Ohm	3.97	Pass	3.3e-003Ohm	3.33
1 kOhm Range						
1.000000 kOhm	1.000015kOhm	0.1100Ohm	13.7	Pass	2.3e-002Ohm	3.67
10 kOhm Range						
10.00000 kOhm	10.00019kOhm	1.100Ohm	17.4	Pass	2.3e-0010hm	3.67
100 kOhm Range						
100.0000 kOhm	100.0024kOhm	11.00Ohm	21.4	Pass	2.3e+0000hm	3.67
100mV Range	fillcation					
100.0000 Hz @ 10 mV	99.9908Hz	0.10000Hz	9.2	Pass	2.1e-004Hz	
1V Range						
100.0000 kHz @ 1 V	100.0000kHz	10.00Hz	0.21	Pass	2.0e-001Hz	
DC CURRENT: 10mA Bange						
10.00000 mA	10.00069mA	0.000007000A	9.84	Pass	9.7e-007A	
100mA Range						
100.0000 mA	100.0055mA	0.00005500A	10.1	Pass	9.7e-006A	
1A Range						
1.000000 A	0.999862A	0.0011000A	12.6	Pass	1.9e-004A	
10mA Range						
10.00000 mA @ 1 kHz	9.99715mA	0.000014000A	20.3	Pass	4.7e-006A	2.33
100mA Range						
100.0000 mA @ 1 kHz	99.7810mA	0.00060000A	36.5	Pass	4.7e-005A	
1A Range						
1.000000 A @ 1 kHz	0.999723A	0.0014000A	19.8	Pass	4.7e-004A	2.33



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 26 April 2017
SERIAL NUMBER: ASSET NUMBER:	6056 10221	CAL DUE: DATA TYPE:	26 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards Used							
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 Deg E = $-6.7$ t	:o 93.3 Deg C				
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.42927 Ohms					
20.4130 F	20.407F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.93317 Ohms	3				
50.3650 F	50.370F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.3995 Ohms					
80.3220 F	80.330F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.839 Ohms					
110.3400 F	110.338F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.2445 Ohms					
140.3640 F	140.360F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.61817 Ohms	3				
170.4160 F	170.407F	0.2590F	3.47	Pass	3.4e-002F	
Resistance Value a	at Temp = 135.95383 Ohms	3				
200.4420 F	200.450F	0.2590F	3.09	Pass	3.4e-002F	
***********Degre	es C**********					
Resistance Value a	at Temp = 97.42927 Ohms					
-6.4370 c	-6.441c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.93317 Ohms	3				
10.2030 c	10.206c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.3995 Ohms					
26.8460 c	26.850c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.839 Ohms					
43.5220 c	43.521c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.2445 Ohms					
60.2030 c	60.200c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.61817 Ohms	3				
76.8980 c	76.893c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	at Temp = 135.95383 Ohms	3				
93.5790 c	93.583c	0.1440c	2.78	Pass	1.9e-002c	
As Left Coefficier	its:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.95008 Alpha= 0.003844891 Delta= 1.73472031169 A= 0.00391158910514 B= -6.66981051394e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 10 April 2017
SERIAL NUMBER:	5791	CAL DUE:	10 April 2018
ASSET NUMBER:	10224	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Calibrated By:

**Approved By:** 

Standards Used						
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14016	Rosemount Aerospace 162CE SPRT	4211	8/19/2016	8/19/2017		

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT010224					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	2			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.24533 Ohms					
125.1290 F	125.218F	0.5000F	17.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.433 Ohms					
287.5700 F	287.441F	0.5000F	25.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 187.78083 Ohms					
450.0740 F	450.017F	0.5000F	11.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.22317 Ohms					
612.5820 F	612.643F	0.5000F	12.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.73767 Ohms					
775.1300 F	775.207F	0.5000F	15.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.328 Ohms					
937.7220 F	937.723F	0.5000F	0.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 311.98633 Ohms					
1100.1840 F	1100.141F	0.5000F	8.6	Pass	1.2e-001F	
************Degre	ees C***********					
Resistance Value a	at Temp = 120.24533 Ohms					
51.7380 c	51.788c	0.2780c	18	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.433 Ohms					
141.9830 c	141.912c	0.2780c	25.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.78083 Ohms					
232.2630 c	232.232c	0.2780c	11.2	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.22317 Ohms					
322.5460 c	322.580c	0.2780c	12.2	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.73767 Ohms					
412.8500 c	412.893c	0.2780c	15.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.328 Ohms					
503.1790 c	503.179c	0.2780c	0	Pass	6.4e-002c	
Resistance Value a	at Temp = 311.98633 Ohms					
593.4350 c	593.412c	0.2780c	8.27	Pass	6.4e-002c	
As Left Coefficien	its:					
Equation Head- Cal	londar-Van Ducon					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.18769 Alpha= 0.003838779 Delta= 1.45872995149 A= 0.00389477641904 B= -5.59974190444e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 April 2017
SERIAL NUMBER: ASSET NUMBER:	10831 10502	CAL DUE: DATA TYPE:	13 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:	

**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		

Test Results						
Standard Reading <u>UUT</u>	Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT010502					
Probe Calibration Range = 1	125 to 1100 Deg	F				
	= 51.7 to	593.3 Deg C				
AS FOUND/AS LEFT RESULTS						
Degrees F						
Resistance Value at Temp =	120.3415 Ohms					
125.1020 F 125	5.009F	0.5000F	18.6	Pass	1.2e-001F	
Resistance Value at Temp =	154.681 Ohms					
287.4470 F 287	7.597F	0.5000F	30	Pass	1.2e-001F	
Resistance Value at Temp =	188.03233 Ohms					
449.8780 F 449	9.901F	0.5000F	4.6	Pass	1.2e-001F	
Resistance Value at Temp =	220.47967 Ohms					
612.3750 F 612	2.323F	0.5000F	10.4	Pass	1.2e-001F	
Resistance Value at Temp =	252.00767 Ohms					
774.8490 F 774	1.794F	0.5000F	11	Pass	1.2e-001F	
Resistance Value at Temp =	282.62333 Ohms					
937.3750 F 937	7.356F	0.5000F	3.8	Pass	1.2e-001F	
Resistance Value at Temp =	312.30617 Ohms					
1099.8570 F 109	9.903F	0.5000F	9.2	Pass	1.2e-001F	
************Degrees C****	* * * * * * * * * *					
Resistance Value at Temp =	120.3415 Ohms					
51.7230 c 51	.671c	0.2780c	18.7	Pass	6.4e-002c	
Resistance Value at Temp =	154.681 Ohms					
141.9150 c 141	1.998c	0.2780c	29.9	Pass	6.4e-002c	
Resistance Value at Temp =	188.03233 Ohms					
232.1540 c 232	2.167c	0.2780c	4.68	Pass	6.4e-002c	
Resistance Value at Temp =	220.47967 Ohms					
322.4300 c 322	2.402c	0.2780c	10.1	Pass	6.4e-002c	
Resistance Value at Temp =	252.00767 Ohms					
412.6940 c 412	2.663c	0.2780c	11.2	Pass	6.4e-002c	
Resistance Value at Temp =	282.62333 Ohms					
502.9860 c 502	2.975c	0.2780c	3.96	Pass	6.4e-002c	
Resistance Value at Temp =	312.30617 Ohms					
593.2540 c 593	3.279c	0.2780c	8.99	Pass	6.4e-002c	
As Left Coefficients:						

As Left Coefficients: Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.27917 Alpha= 0.003844379 Delta= 1.47923469527 A= 0.00390124638799 B= -5.68673879856e-007



### REPORTOFCALIBRATION

McHalePerformance of

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 10 April 2017
SERIAL NUMBER:	10827 10504	CAL DUE:	10 April 2018 AS-I FFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	1 - 01/05/06 Grant Shropshire	HUMIDITY:	30 %
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14016	Rosemount Aerospace 162CE SPRT	4211	8/19/2016	8/19/2017		

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT010504					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 t	o 593.3 Deg (	C			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.71583 Ohms					
125.1290 F	125.062F	0.5000F	13.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 155.13833 Ohms					
287.5700 F	287.629F	0.5000F	11.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 188.60817 Ohms					
450.0740 F	450.145F	0.5000F	14.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 221.12783 Ohms					
612.5820 F	612.617F	0.5000F	7	Pass	1.2e-001F	
Resistance Value a	t Temp = 252.70083 Ohms					
775.1300 F	775.059F	0.5000F	14.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 283.34833 Ohms					
937.7220 F	937.583F	0.5000F	27.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 313.08817 Ohms					
1100.1840 F	1100.296F	0.5000F	22.4	Pass	1.2e-001F	
*************Degre	es C************					
Resistance Value a	t Temp = 120.71583 Ohms					
51.7380 c	51.701c	0.2780c	13.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 155.13833 Ohms					
141.9830 c	142.016c	0.2780c	11.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 188.60817 Ohms					
232.2630 c	232.303c	0.2780c	14.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 221.12783 Ohms					
322.5460 c	322.565c	0.2780c	6.83	Pass	6.4e-002c	
Resistance Value a	t Temp = 252.70083 Ohms					
412.8500 c	412.811c	0.2780c	14	Pass	6.4e-002c	
Resistance Value a	t Temp = 283.34833 Ohms					
503.1790 c	503.102c	0.2780c	27.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 313.08817 Ohms					
593.4350 c	593.498c	0.2780c	22.7	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.58668 Alpha= 0.003842948 Delta= 1.49401848189 A= 0.00390036235337 B= -5.74143533696e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### REPORTOFCALIBRATION

McHalePerformance of

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 11 April 2017
SERIAL NUMBER: ASSET NUMBER:	10846 10507	CAL DUE: DATA TYPE:	11 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018

		Test Tel	0/ Tal Famor	DA CC/FA H	Ennended Une	TUD
Standard Reading	<u>UUT Reading</u>	<u>1 est 1 oi</u>	<u>% 101 Error</u>	<u>PASS/FAIL</u>	<u>Expanded Unc.</u>	<u>10</u> K
Probe ID Number	= TT010507					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 t	593.3 Deg	С			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.399 Ohms					
125.1040 F	125.114F	0.5000F	2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.61917 Ohms					
287.6000 F	287.630F	0.5000F	6	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.905 Ohms					
450.0950 F	450.022F	0.5000F	14.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.31333 Ohms					
612.5950 F	612.570F	0.5000F	5	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.81133 Ohms					
775.0680 F	775.115F	0.5000F	9.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.3905 Ohms					
937.5450 F	937.610F	0.5000F	13	Pass	1.2e-001F	
Resistance Value a	t Temp = 312.02133 Ohms			_		
1099.9420 F	1099.888F	0.5000F	10.8	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	t Temp = 120.399 Ohms					
51.7240 c	51.730c	0.2780c	2.16	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.61917 Ohms					
142.0000 c	142.017c	0.2780c	6.12	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.905 Ohms					
232.2750 c	232.235c	0.2780c	14.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.31333 Ohms					
322.5530 c	322.539c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.81133 Ohms					
412.8160 c	412.841c	0.2780c	8.99	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.3905 Ohms					
503.0800 c	503.117c	0.2780c	13.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 312.02133 Ohms			_		
593.3010 c	593.271c	0.2780c	10.8	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where T = Deg C ==	A Dt - Desistance at Ma					

where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.38254 Alpha= 0.003827827 Delta= 1.45168729324 A= 0.00388339507817 B= -5.55680781662e-007



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER:	10851	CAL DUE:	14 April 2018
ASSET NUMBER:	10512	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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$\neg \bigtriangledown$	Calibrated	l By:

**Approved By:** 

Standards Used				
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT010512	_				
Probe Calibration	Range = 125 to 1100 Deg = 51 7 to	1' 5933 Decr	~			
	01.7 00		5			
AS FOUND/AS LEFT 1	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.25133 Ohms					
125.0950 F	125.097F	0.5000F	0.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.437 Ohms					
287.4450 F	287.468F	0.5000F	4.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 187.70383 Ohms					
449.8770 F	449.837F	0.5000F	8	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.08167 Ohms					
612.3720 F	612.356F	0.5000F	3.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.53583 Ohms					
774.8290 F	774.854F	0.5000F	5	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.08133 Ohms					
937.3810 F	937.413F	0.5000F	6.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 311.682 Ohms					
1099.8610 F	1099.835F	0.5000F	5.2	Pass	1.2e-001F	
************Degre	ees C***********					
Resistance Value a	at Temp = 120.25133 Ohms					
51.7200 c	51.720c	0.2780c	0	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.437 Ohms					
141.9140 c	141.927c	0.2780c	4.68	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.70383 Ohms					
232.1540 c	232.132c	0.2780c	7.91	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.08167 Ohms					
322.4290 c	322.420c	0.2780c	3.24	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.53583 Ohms					
412.6830 c	412.697c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.08133 Ohms					
502.9890 c	503.007c	0.2780c	6.47	Pass	6.4e-002c	
Resistance Value a	at Temp = 311.682 Ohms					
593.2560 c	593.242c	0.2780c	5.04	Pass	6.4e-002c	
As Left Coefficien	nts:					
Equation Used= Ca	llendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.23663 Alpha= 0.00383348 Delta= 1.4684386638 A= 0.00388977230249 B= -5.62923024892e-007

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 12 April 2017
SERIAL NUMBER: ASSET NUMBER:	TT16032 16032	CAL DUE: DATA TYPE:	12 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:	

**Approved By:** 

Standards Used				
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	TUR
Probe ID Number	= TT016032					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 to	593.3 Deg	С			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 119.89417 Ohms					
125.1080 F	125.083F	0.5000F	5	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.06083 Ohms					
287.4720 F	287.559F	0.5000F	17.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.27467 Ohms					
449.9220 F	449.853F	0.5000F	13.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.62233 Ohms					
612.4310 F	612.391F	0.5000F	8	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.0545 Ohms					
774.9110 F	774.936F	0.5000F	5	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.57717 Ohms					
937.4660 F	937.521F	0.5000F	11	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.15067 Ohms					
1099.9630 F	1099.928F	0.5000F	7	Pass	1.2e-001F	
***********Degre	es C***********					
Resistance Value a	t Temp = 119.89417 Ohms					
51.7270 c	51.713c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.06083 Ohms					
141.9290 c	141.977c	0.2780c	17.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.27467 Ohms					
232.1790 c	232.141c	0.2780c	13.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.62233 Ohms					
322.4620 c	322.440c	0.2780c	7.91	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.0545 Ohms					
412.7280 c	412.742c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.57717 Ohms					
503.0360 c	503.067c	0.2780c	11.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.15067 Ohms					
593.3130 c	593.293c	0.2780c	7.19	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	renuar-van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.90727 Alpha= 0.003841402 Delta= 1.46482646332 A= 0.00389767187306 B= -5.62698730583e-007



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 12 April 2017
SERIAL NUMBER:	2245	CAL DUE:	12 April 2018
ASSET NUMBER:	16047	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	l By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT016047					
Probe Calibration F	Range = 125 to 1100 Deg = 51.7 to	F 593.3 Deg (	2			
AS FOUND/AS LEFT RE	ESULTS					
Degrees F						
Resistance Value at	Temp = 120.362 Ohms					
125.1080 F	125.037F	0.5000F	14.2	Pass	1.2e-001F	
Resistance Value at	Temp = 154.70833 Ohms					
287.4720 F	287.605F	0.5000F	26.6	Pass	1.2e-001F	
Resistance Value at	Temp = 188.0555 Ohms					
449.9220 F	449.907F	0.5000F	3	Pass	1.2e-001F	
Resistance Value at	Temp = 220.494 Ohms					
612.4310 F	612.379F	0.5000F	10.4	Pass	1.2e-001F	
Resistance Value at	: Temp = 251.999 Ohms					
774.9110 F	774.907F	0.5000F	0.8	Pass	1.2e-001F	
Resistance Value at	: Temp = 282.56133 Ohms					
937.4660 F	937.446F	0.5000F	4	Pass	1.2e-001F	
Resistance Value at	Temp = 312.17967 Ohms					
1099.9630 F	1099.991F	0.5000F	5.6	Pass	1.2e-001F	
************Degree	es C***********					
Resistance Value at	Temp = 120.362 Ohms					
51.7270 c	51.687c	0.2780c	14.4	Pass	6.4e-002c	
Resistance Value at	Temp = 154.70833 Ohms					
141.9290 c	142.003c	0.2780c	26.6	Pass	6.4e-002c	
Resistance Value at	Temp = 188.0555 Ohms					
232.1790 c	232.171c	0.2780c	2.88	Pass	6.4e-002c	
Resistance Value at	Temp = 220.494 Ohms					
322.4620 c	322.433c	0.2780c	10.4	Pass	6.4e-002c	
Resistance Value at	Temp = 251.999 Ohms					
412.7280 c	412.726c	0.2780c	0.719	Pass	6.4e-002c	
Resistance Value at	Temp = 282.56133 Ohms					
503.0360 c	503.026c	0.2780c	3.6	Pass	6.4e-002c	
Resistance Value at	Temp = 312.17967 Ohms					
593.3130 c	593.328c	0.2780c	5.4	Pass	6.4e-002c	
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.28058 Alpha= 0.003846409 Delta= 1.50213804408 A= 0.00390418737292 B= -5.777837292e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### REPORTOFCALIBRATION

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 11 April 2017
SERIAL NUMBER:	2394	CAL DUE:	11 April 2018
ASSET NUMBER:	16080	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used					
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT016080					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 to	593.3 Deg C				
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.43633 Ohms					
125.1040 F	125.118F	0.5000F	2.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.781 Ohms					
287.6000 F	287.565F	0.5000F	7	Pass	1.2e-001F	
Resistance Value a	t Temp = 188.20667 Ohms					
450.0950 F	450.112F	0.5000F	3.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.684 Ohms					
612.5950 F	612.617F	0.5000F	4.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 252.208 Ohms					
775.0680 F	775.052F	0.5000F	3.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.80317 Ohms					
937.5450 F	937.541F	0.5000F	0.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 312.44367 Ohms					
1099.9420 F	1099.946F	0.5000F	0.8	Pass	1.2e-001F	
***********Degre	es C********					
Resistance Value a	t Temp = 120.43633 Ohms					
51.7240 c	51.732c	0.2780c	2.88	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.781 Ohms					
142.0000 c	141.981c	0.2780c	6.83	Pass	6.4e-002c	
Resistance Value a	t Temp = 188.20667 Ohms					
232.2750 c	232.284c	0.2780c	3.24	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.684 Ohms					
322.5530 c	322.565c	0.2780c	4.32	Pass	6.4e-002c	
Resistance Value a	t Temp = 252.208 Ohms					
412.8160 c	412.806c	0.2780c	3.6	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.80317 Ohms					
503.0800 c	503.078c	0.2780c	0.719	Pass	6.4e-002c	
Resistance Value a	t Temp = 312.44367 Ohms					
593.3010 c	593.303c	0.2780c	0.719	Pass	6.4e-002c	
As Left Coefficien	ts:					
	-					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.32595 Alpha= 0.003847048 Delta= 1.4936750614 A= 0.00390451039658 B= -5.7462396576e-007

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 26 April 2017
SERIAL NUMBER: ASSET NUMBER:	2256 20062	CAL DUE: DATA TYPE:	26 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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$\overline{\nabla}$	Calibrate	d By:

**Approved By:** 

Standards U	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020062	-				
Probe Calibration	Range = 20 to 200 beg $f = -6.7$	r to 93.3 Deg C				
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.47943 Ohms					
20.4130 F	20.387F	0.2590F	10	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.91533 Ohma	5				
50.3650 F	50.380F	0.2590F	5.79	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.32633 Ohms	S				
80.3220 F	80.362F	0.2590F	15.4	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.71783 Ohms	S				
110.3400 F	110.356F	0.2590F	6.18	Pass	3.4e-002F	
Resistance Value a	t Temp = 123.07983 Ohms	S				
140.3640 F	140.318F	0.2590F	17.8	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.44133 Ohms	S				
170.4160 F	170.382F	0.2590F	13.1	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.78683 Ohms	S				
200.4420 F	200.478F	0.2590F	13.9	Pass	3.4e-002F	
************Degre	es C***********					
Resistance Value a	t Temp = 97.47943 Ohms					
-6.4370 c	-6.452c	0.1440c	10.4	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.91533 Ohm	5				
10.2030 c	10.211c	0.1440c	5.56	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.32633 Ohm:	5				
26.8460 c	26.868c	0.1440c	15.3	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.71783 Ohms	S				
43.5220 c	43.531c	0.1440c	6.25	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.07983 Ohm	5				
60.2030 c	60.176c	0.1440c	18.8	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.44133 Ohm	5				
76.8980 c	76.879c	0.1440c	13.2	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.78683 Ohm:	5				
93.5790 c	93.599c	0.1440c	13.9	Pass	1.9e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C$ an	d Rt = Resistance at Te	emp				

 $T = [-RoA + Sqrt(Ro^{2}A^{2}-4Ro^{*}B(Ro-Rt))]/(2*Ro^{*}B)$ 

Ro= 99.97398 Alpha= 0.003824631

Test Results

Delta= 1.0541126364

A= 0.00386494691867

B= -4.03159186666e-007



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 April 2017
SERIAL NUMBER:	2464	CAL DUE:	13 April 2018
ASSET NUMBER:	20072	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020072					
Probe Calibration	Range = 125 to 1100 Deg	F.				
	= 51.7 to	593.3 Deg (	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.10283 Ohms					
125.1020 F	125.212F	0.5000F	22	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.07433 Ohms					
287.4470 F	287.360F	0.5000F	17.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.2085 Ohms					
449.8780 F	449.702F	0.5000F	35.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.53383 Ohms					
612.3750 F	612.399F	0.5000F	4.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 250.95783 Ohms					
774.8490 F	774.997F	0.5000F	29.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.48083 Ohms					
937.3750 F	937.487F	0.5000F	22.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.0785 Ohms					
1099.8570 F	1099.725F	0.5000F	26.4	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	t Temp = 120.10283 Ohms					
51.7230 c	51.784c	0.2780c	21.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.07433 Ohms					
141.9150 c	141.867c	0.2780c	17.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.2085 Ohms					
232.1540 c	232.057c	0.2780c	34.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.53383 Ohms					
322.4300 c	322.444c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 250.95783 Ohms					
412.6940 c	412.776c	0.2780c	29.5	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.48083 Ohms					
502.9860 c	503.048c	0.2780c	22.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.0785 Ohms					
593.2540 c	593.181c	0.2780c	26.3	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen
where T = Deg C and Rt = Resistance at Temp
T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B)
Ro= 100.17751
Alpha= 0.003814951
Delta= 1.4128672766
A= 0.0038688511943
B= -5.39001942972e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 April 2017
SERIAL NUMBER: ASSET NUMBER:	2492 20119	CAL DUE: DATA TYPE:	13 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RTD 1 - 01/05/06 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020119					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 t	o 593.3 Deg (	2			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	t Temp = 120.15617 Ohms					
125.1020 F	125.207F	0.5000F	21	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.17183 Ohms					
287.4470 F	287.394F	0.5000F	10.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.32283 Ohms					
449.8780 F	449.667F	0.5000F	42.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.674 Ohms					
612.3750 F	612.365F	0.5000F	2	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.13217 Ohms					
774.8490 F	775.037F	0.5000F	37.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.66633 Ohms					
937.3750 F	937.511F	0.5000F	27.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.26433 Ohms					
1099.8570 F	1099.702F	0.5000F	31	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	t Temp = 120.15617 Ohms					
51.7230 c	51.782c	0.2780c	21.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.17183 Ohms					
141.9150 c	141.885c	0.2780c	10.8	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.32283 Ohms					
232.1540 c	232.037c	0.2780c	42.1	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.674 Ohms					
322.4300 c	322.425c	0.2780c	1.8	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.13217 Ohms					
412.6940 c	412.798c	0.2780c	37 4	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.66633 Ohms		0111			
502.9860 c	503 062c	0.2780c	27.3	Pass	6 4e-002c	
Resistance Value a	t Temp = 311.26433 Ohms	0.2.000	27.0		00 0020	
593.2540 c	593 168c	0.2780c	30.9	Pass	6 4e-002c	
	000.1000	5.27000	00.0	1 400	0.40 0020	
As Left Coefficien	its:					
Faustion Head- Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen
where T = Deg C and Rt = Resistance at Temp
T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B)
Ro= 100.20843
Alpha= 0.003818111
Delta= 1.42008562715
A= 0.00387233144554
B= -5.42204455396e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 17 April 2017
SERIAL NUMBER:	2427	CAL DUE:	17 April 2018
ASSET NUMBER:	20171	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Calibrated By:** 

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020171					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 to	o 593.3 Deg (	C			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.26033 Ohms					
125.1000 F	125.128F	0.5000F	5.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.489 Ohms					
287.4490 F	287.415F	0.5000F	6.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 187.8225 Ohms					
449.8780 F	449.852F	0.5000F	5.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.24633 Ohms					
612.3650 F	612.375F	0.5000F	2	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.73667 Ohms					
774.8320 F	774.869F	0.5000F	7.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.29967 Ohms					
937.3620 F	937.364F	0.5000F	0.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 311.93133 Ohms					
1099.8560 F	1099.838F	0.5000F	3.6	Pass	1.2e-001F	
************Degre	ees C************					
Resistance Value a	at Temp = 120.26033 Ohms					
51.7220 c	51.738c	0.2780c	5.76	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.489 Ohms					
141.9160 c	141.897c	0.2780c	6.83	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.8225 Ohms					
232.1540 c	232.140c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.24633 Ohms					
322.4250 c	322.431c	0.2780c	2.16	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.73667 Ohms					
412.6850 c	412.705c	0.2780c	7.19	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.29967 Ohms					
502.9790 c	502.980c	0.2780c	0.36	Pass	6.4e-002c	
Resistance Value a	at Temp = 311.93133 Ohms					
593.2540 c	593.244c	0.2780c	3.6	Pass	6.4e-002c	
As Left Coefficier	nts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.2007 Alpha= 0.003842014 Delta= 1.47821575009 A= 0.00389880725607 B= -5.67932560688e-007

\*\*\*\*\* End of Report \*\*\*\*\*



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER:	2589	CAL DUE:	14 April 2018
ASSET NUMBER:	20262	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
--------------------	-----------------------------	-----------------	--------------------	-----------	---------------	------------
Probe ID Number	= TT020262					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	C			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.52067 Ohms					
125.0950 F	125.114F	0.5000F	3.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.8135 Ohms					
287.4450 F	287.434F	0.5000F	2.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 188.19767 Ohms					
449.8770 F	449.833F	0.5000F	8.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.6865 Ohms					
612.3720 F	612.387F	0.5000F	3	Pass	1.2e-001F	
Resistance Value a	at Temp = 252.234 Ohms					
774.8290 F	774.868F	0.5000F	7.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.85983 Ohms					
937.3810 F	937.376F	0.5000F	1	Pass	1.2e-001F	
Resistance Value a	at Temp = 312.55217 Ohms					
1099.8610 F	1099.848F	0.5000F	2.6	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	at Temp = 120.52067 Ohms					
51.7200 c	51.730c	0.2780c	3.6	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.8135 Ohms					
141.9140 c	141.908c	0.2780c	2.16	Pass	6.4e-002c	
Resistance Value a	at Temp = 188.19767 Ohms					
232.1540 c	232.130c	0.2780c	8.63	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.6865 Ohms					
322.4290 c	322.437c	0.2780c	2.88	Pass	6.4e-002c	
Resistance Value a	at Temp = 252.234 Ohms					
412.6830 c	412.704c	0.2780c	7.55	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.85983 Ohms					
502.9890 c	502.987c	0.2780c	0.719	Pass	6.4e-002c	
Resistance Value a	at Temp = 312.55217 Ohms					
593.2560 c	593.249c	0.2780c	2.52	Pass	6.4e-002c	
As Left Coefficier	its:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.43133 Alpha= 0.00383949 Delta= 1.47461378573 A= 0.00389610764884 B= -5.66176488416e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



# REPORT OF CALIBRATION

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 25 April 2017
SERIAL NUMBER: ASSET NUMBER:	1368313 20274	CAL DUE: DATA TYPE:	25 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20274					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	
200.0000 psi	200.168psi	0.5200psi	32.3	Pass	1.6e-002psi	
400.0000 psi	400.148psi	0.5200psi	28.5	Pass	3.2e-002psi	
600.0000 psi	600.078psi	0.5200psi	15	Pass	4.8e-002psi	
800.0000 psi	799.953psi	0.5200psi	9.04	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	799.953psi	0.5200psi	9.04	Pass	6.4e-002psi	
600.0000 psi	600.078psi	0.5200psi	15	Pass	4.8e-002psi	
400.0000 psi	400.148psi	0.5200psi	28.5	Pass	3.2e-002psi	
200.0000 psi	200.141psi	0.5200psi	27.1	Pass	1.6e-002psi	
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 08 May 2017
SERIAL NUMBER: ASSET NUMBER:	1859806 20276	CAL DUE: DATA TYPE:	08 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~250 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD20276					
Calibrated Span =	250 inH20					
Calibration Tolera	ance = 0.1625 inH20					
Upscale Tests						
0.0000 inH2O	0.001inH2O	0.1625inH2O	0.615	Pass	5.8e-003inH2O	
62.5000 inH2O	62.507inH2O	0.1625inH2O	4.31	Pass	5.8e-003inH2O	
125.0000 inH2O	125.012inH2O	0.1625inH2O	7.38	Pass	1.0e-002inH2O	
187.5000 inH2O	187.488inH2O	0.1625inH2O	7.38	Pass	1.5e-002inH2O	
250.0000 inH2O	250.000inH2O	0.1625inH2O	0	Pass	2.0e-002inH2O	
Downscale Tests						
250.0000 inH2O	250.000inH2O	0.1625inH2O	0	Pass	2.0e-002inH2O	
187.5000 inH2O	187.504inH2O	0.1625inH2O	2.46	Pass	1.5e-002inH2O	
125.0000 inH2O	125.031inH2O	0.1625inH2O	19.1	Pass	1.0e-002inH2O	
62.5000 inH2O	62.537inH2O	0.1625inH2O	22.8	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.002inH2O	0.1625inH2O	1.23	Pass	5.8e-003inH2O	



## REPORT OF CALIBRATION

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 25 April 2017
SERIAL NUMBER: ASSET NUMBER:	1036528 20298	CAL DUE: DATA TYPE:	25 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Calibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20298					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	
200.0000 psi	200.058psi	0.5200psi	11.2	Pass	1.6e-002psi	
400.0000 psi	400.034psi	0.5200psi	6.54	Pass	3.2e-002psi	
600.0000 psi	600.020psi	0.5200psi	3.85	Pass	4.8e-002psi	
800.0000 psi	799.993psi	0.5200psi	1.35	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.000psi	0.5200psi	0	Pass	6.4e-002psi	
600.0000 psi	600.012psi	0.5200psi	2.31	Pass	4.8e-002psi	
400.0000 psi	400.034psi	0.5200psi	6.54	Pass	3.2e-002psi	
200.0000 psi	200.058psi	0.5200psi	11.2	Pass	1.6e-002psi	
15.0000 psi	15.060psi	0.5200psi	11.5	Pass	7.3e-003psi	



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 06 April 2017
SERIAL NUMBER:	2088	CAL DUE:	06 April 2018
ASSET NUMBER:	20432	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020432					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 t	o 593.3 Deg (	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.24817 Ohms					
125.1110 F	125.254F	0.5000F	28.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.36217 Ohms					
287.4820 F	287.288F	0.5000F	38.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.66733 Ohms					
449.8520 F	449.758F	0.5000F	18.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.10583 Ohms					
612.3590 F	612.410F	0.5000F	10.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.619 Ohms					
774.8020 F	774.950F	0.5000F	29.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.208 Ohms					
937.3360 F	937.376F	0.5000F	8	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.8795 Ohms					
1099.8080 F	1099.714F	0.5000F	18.8	Pass	1.2e-001F	
************Degre	es C************					
Resistance Value a	t Temp = 120.24817 Ohms					
51.7280 c	51.808c	0.2780c	28.8	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.36217 Ohms					
141.9350 c	141.826c	0.2780c	39.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.66733 Ohms					
232.1400 c	232.088c	0.2780c	18.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.10583 Ohms					
322.4220 c	322.450c	0.2780c	10.1	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.619 Ohms					
412.6680 c	412.750c	0.2780c	29.5	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.208 Ohms					
502.9640 c	502.987c	0.2780c	8.27	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.8795 Ohms					
593.2260 c	593.174c	0.2780c	18.7	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.20789 Alpha= 0.003833536 Delta= 1.44125023735 A= 0.0038887868467 B= -5.5250846699e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



## **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	298573 20491	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards	Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017			
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017			
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018			

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Condi	itions					
Temperature: 22C, H	Humidity: 45%Rh, Bai	rometric Pressure	e: 14.19PSIA			
Transmitter Calibra	ation Range= 3000 ps	sia				
Transmitter Accurac	cy= 1.95 psia					
********* AS FOUN	ND/AS LEFT *******	* * *				
Upscale Pressur	re Tests (DIGITAL) -					
14.1900 psi	14.279psi	1.9500psi	4.56	Pass	2.2e-003psi	
513.1550 psi	514.016psi	1.9500psi	44.2	Pass	7.7e-002psi	
1012.6380 psi	1013.516psi	1.9500psi	45	Pass	1.5e-001psi	
2011.6050 psi	2011.906psi	1.9500psi	15.4	Pass	3.0e-001psi	
3010.5710 psi	3010.500psi	1.9500psi	3.64	Pass	4.5e-001psi	
Downscale Press	sure Tests (DIGITAL)					
3010.5710 psi	3010.563psi	1.9500psi	0.41	Pass	4.5e-001psi	
2011.6050 psi	2012.094psi	1.9500psi	25.1	Pass	3.0e-001psi	
1012.6380 psi	1013.594psi	1.9500psi	49	Pass	1.5e-001psi	
513.1550 psi	513.891psi	1.9500psi	37.7	Pass	7.7e-002psi	
14.1900 psi	14.279psi	1.9500psi	4.56	Pass	2.2e-003psi	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER:	1016394	CAL DUE:	12 May 2018
ASSET NUMBER:	20511	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
	4700 Coster Rd.	CAL RANGE:	0~800
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA20511					
Calibrated Span =	800 PSI					
Calibration Tolera	ance = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	
200.0000 psi	200.058psi	0.5200psi	11.2	Pass	1.6e-002psi	
400.0000 psi	400.008psi	0.5200psi	1.54	Pass	3.2e-002psi	
600.0000 psi	600.038psi	0.5200psi	7.31	Pass	4.8e-002psi	
800.0000 psi	800.015psi	0.5200psi	2.88	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.015psi	0.5200psi	2.88	Pass	6.4e-002psi	
600.0000 psi	600.038psi	0.5200psi	7.31	Pass	4.8e-002psi	
400.0000 psi	400.034psi	0.5200psi	6.54	Pass	3.2e-002psi	
200.0000 psi	200.058psi	0.5200psi	11.2	Pass	1.6e-002psi	
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1457872 20522	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Temperature: 22C, H	umidity: 45%Rh, Bar	ometric Pressure	e: 14.22PSIA			
Transmitter Calibra	tion Range= 3000 ps	ia				
Transmitter Accurac	y= 1.95 psia					
****** AS FOUN	D/AS LEFT *******	**				
Upscale Pressur	e Tests (DIGITAL) -					
14.2200 psi	14.278psi	1.9500psi	2.97	Pass	2.2e-003psi	
513.1850 psi	513.224psi	1.9500psi	2	Pass	7.7e-002psi	
1012.6680 psi	1012.820psi	1.9500psi	7.79	Pass	1.5e-001psi	
2011.6340 psi	2011.814psi	1.9500psi	9.23	Pass	3.0e-001psi	
3010.6000 psi	3010.877psi	1.9500psi	14.2	Pass	4.5e-001psi	
Downscale Press	ure Tests (DIGITAL)					
3010.6000 psi	3010.730psi	1.9500psi	6.67	Pass	4.5e-001psi	
2011.6340 psi	2012.012psi	1.9500psi	19.4	Pass	3.0e-001psi	
1012.6680 psi	1012.983psi	1.9500psi	16.2	Pass	1.5e-001psi	
513.1850 psi	513.483psi	1.9500psi	15.3	Pass	7.7e-002psi	
14,2200 psi	14 459nsi	1 9500psi	12 3	Pass	2 2e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT:	PASS 31 March 2017
SERIAL NUMBER: ASSET NUMBER:	1339337 20536	CAL DUE: DATA TYPE:	31 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20536					
Calibrated Span = 3	25 inH2O					
Calibration Tolera	nce = 0.025 inH20					
Upscale Tests						
0.0000 inH2O	-0.006inH2O	0.0250inH2O	24	Pass	5.8e-003inH2O	
6.2500 inH2O	6.251inH2O	0.0250inH2O	4	Pass	5.8e-003inH2O	
12.5000 inH2O	12.500inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
18.7500 inH2O	18.750inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
25.0000 inH2O	25.002inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
Downscale Tests						
25.0000 inH2O	24.998inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
18.7500 inH2O	18.750inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
12.5000 inH2O	12.499inH2O	0.0250inH2O	4	Pass	5.8e-003inH2O	
6.2500 inH2O	6.252inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
0.0000 inH2O	0.001inH2O	0.0250inH2O	4	Pass	5.8e-003inH2O	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 31 March 2017
SERIAL NUMBER: ASSET NUMBER:	1989407 20604	CAL DUE: DATA TYPE:	31 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD20604					
Calibrated Span =	25 inH2O					
Calibration Tolera	ance = 0.025 inH20					
Upscale Tests						
0.0000 inH2O	-0.007inH2O	0.0250inH2O	28	Pass	5.8e-003inH2O	
6.2500 inH2O	6.244inH2O	0.0250inH2O	24	Pass	5.8e-003inH2O	
12.5000 inH2O	12.490inH2O	0.0250inH2O	40	Pass	5.8e-003inH2O	
18.7500 inH2O	18.740inH2O	0.0250inH2O	40	Pass	5.8e-003inH2O	
25.0000 inH2O	25.000inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
Downscale Tests						
25.0000 inH2O	25.002inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
18.7500 inH2O	18.746inH2O	0.0250inH2O	16	Pass	5.8e-003inH2O	
12.5000 inH2O	12.498inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
6.2500 inH2O	6.245inH2O	0.0250inH2O	20	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.009inH2O	0.0250inH2O	36	Pass	5.8e-003inH2O	



## **REPORTOFCALIBRATION**

4700 Coster Road . Knoxville, TN 37934 . 865-588-2654

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UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 03 April 2017
SERIAL NUMBER: ASSET NUMBER:	61300106 20690	CAL DUE: DATA TYPE:	03 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA20690					
Calibrated Span =	150 PSI					
Calibration Tolera	ance = 0.0975 PSI					
Upscale Tests						
15.0000 psi	14.992psi	0.0975psi	8.21	Pass	7.3e-003psi	
37.5000 psi	37.494psi	0.0975psi	6.15	Pass	7.3e-003psi	
75.0000 psi	74.992psi	0.0975psi	8.21	Pass	7.3e-003psi	
112.5000 psi	112.492psi	0.0975psi	8.21	Pass	9.0e-003psi	
150.0000 psi	149.992psi	0.0975psi	8.21	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.000psi	0.0975psi	0	Pass	1.2e-002psi	
112.5000 psi	112.492psi	0.0975psi	8.21	Pass	9.0e-003psi	
75.0000 psi	74.992psi	0.0975psi	8.21	Pass	7.3e-003psi	
37.5000 psi	37.501psi	0.0975psi	1.03	Pass	7.3e-003psi	
15.0000 psi	15.002psi	0.0975psi	2.05	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	1852835 20705	CAL DUE: DATA TYPE:	11 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~350 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20705					
Calibrated Span =	350 inH2O					
Calibration Tolera	nce = 0.2275 inH20					
Upscale Tests						
0.0000 inH2O	0.007inH2O	0.2275inH2O	3.08	Pass	5.8e-003inH2O	
87.5000 inH2O	87.461inH2O	0.2275inH2O	17.1	Pass	7.0e-003inH2O	
175.0000 inH2O	174.945inH2O	0.2275inH2O	24.2	Pass	1.4e-002inH2O	
262.5000 inH2O	262.484inH2O	0.2275inH2O	7.03	Pass	2.1e-002inH2O	
350.0000 inH2O	350.000inH2O	0.2275inH2O	0	Pass	2.8e-002inH2O	
Downscale Tests						
350.0000 inH2O	350.000inH2O	0.2275inH2O	0	Pass	2.8e-002inH2O	
262.5000 inH2O	262.508inH2O	0.2275inH2O	3.52	Pass	2.1e-002inH2O	
175.0000 inH2O	175.008inH2O	0.2275inH2O	3.52	Pass	1.4e-002inH2O	
87.5000 inH2O	87.510inH2O	0.2275inH2O	4.4	Pass	7.0e-003inH2O	
0.0000 inH2O	0.016inH2O	0.2275inH2O	7.03	Pass	5.8e-003inH2O	



### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER: ASSET NUMBER:	71283 20722	CAL DUE: DATA TYPE:	10 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA20722					
Calibrated Span =	150 PSI					
Calibration Tolera	ance = 0.0975 PSI					
Upscale Tests						
15.0000 psi	15.005psi	0.0975psi	5.13	Pass	7.3e-003psi	
37.5000 psi	37.506psi	0.0975psi	6.15	Pass	7.3e-003psi	
75.0000 psi	75.010psi	0.0975psi	10.3	Pass	7.3e-003psi	
112.5000 psi	112.506psi	0.0975psi	6.15	Pass	9.0e-003psi	
150.0000 psi	149.999psi	0.0975psi	1.03	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.006psi	0.0975psi	6.15	Pass	1.2e-002psi	
112.5000 psi	112.510psi	0.0975psi	10.3	Pass	9.0e-003psi	
75.0000 psi	75.003psi	0.0975psi	3.08	Pass	7.3e-003psi	
37.5000 psi	37.506psi	0.0975psi	6.15	Pass	7.3e-003psi	
15.0000 psi	15.010psi	0.0975psi	10.3	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER: ASSET NUMBER:	71272 20733	CAL DUE: DATA TYPE:	10 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20733					
Calibrated Span =	150 PSI					
Calibration Tolera	nce = 0.0975 PSI					
Upscale Tests						
15.0000 psi	15.014psi	0.0975psi	14.4	Pass	7.3e-003psi	
37.5000 psi	37.511psi	0.0975psi	11.3	Pass	7.3e-003psi	
75.0000 psi	75.008psi	0.0975psi	8.21	Pass	7.3e-003psi	
112.5000 psi	112.511psi	0.0975psi	11.3	Pass	9.0e-003psi	
150.0000 psi	150.000psi	0.0975psi	0	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.000psi	0.0975psi	0	Pass	1.2e-002psi	
112.5000 psi	112.511psi	0.0975psi	11.3	Pass	9.0e-003psi	
75.0000 psi	75.019psi	0.0975psi	19.5	Pass	7.3e-003psi	
37.5000 psi	37.513psi	0.0975psi	13.3	Pass	7.3e-003psi	
15.0000 psi	15.001psi	0.0975psi	1.03	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER: ASSET NUMBER:	71280 20735	CAL DUE: DATA TYPE:	10 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA20735					
Calibrated Span =	150 PSI					
Calibration Tolera	ance = 0.0975 PSI					
Upscale Tests						
15.0000 psi	15.007psi	0.0975psi	7.18	Pass	7.3e-003psi	
37.5000 psi	37.506psi	0.0975psi	6.15	Pass	7.3e-003psi	
75.0000 psi	75.010psi	0.0975psi	10.3	Pass	7.3e-003psi	
112.5000 psi	112.506psi	0.0975psi	6.15	Pass	9.0e-003psi	
150.0000 psi	150.004psi	0.0975psi	4.1	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.002psi	0.0975psi	2.05	Pass	1.2e-002psi	
112.5000 psi	112.511psi	0.0975psi	11.3	Pass	9.0e-003psi	
75.0000 psi	75.000psi	0.0975psi	0	Pass	7.3e-003psi	
37.5000 psi	37.500psi	0.0975psi	0	Pass	7.3e-003psi	
15.0000 psi	15.008psi	0.0975psi	8.21	Pass	7.3e-003psi	



### **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 10 May 2017
SERIAL NUMBER:	71279	CAL DUE:	10 May 2018
ASSET NUMBER:	20736	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~150
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20736					
Calibrated Span =	150 PSI					
Calibration Tolera	nce = 0.0975 PSI					
Upscale Tests						
15.0000 psi	15.000psi	0.0975psi	0	Pass	7.3e-003psi	
37.5000 psi	37.491psi	0.0975psi	9.23	Pass	7.3e-003psi	
75.0000 psi	75.005psi	0.0975psi	5.13	Pass	7.3e-003psi	
112.5000 psi	112.501psi	0.0975psi	1.03	Pass	9.0e-003psi	
150.0000 psi	150.010psi	0.0975psi	10.3	Pass	1.2e-002psi	
Downscale Tests						
150.0000 psi	150.008psi	0.0975psi	8.21	Pass	1.2e-002psi	
112.5000 psi	112.507psi	0.0975psi	7.18	Pass	9.0e-003psi	
75.0000 psi	74.995psi	0.0975psi	5.13	Pass	7.3e-003psi	
37.5000 psi	37.494psi	0.0975psi	6.15	Pass	7.3e-003psi	
15.0000 psi	14.993psi	0.0975psi	7.18	Pass	7.3e-003psi	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1466932 20745	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
<u>Standard Reading</u> Environmental Condi	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Temperature: 22C, H	umidity: 45%Rh, Bar	cometric Pressure	e: 14.2274PSIA			
Transmitter Calibra Transmitter Accurac	tion Range= 3000 ps y= 1.95 psia	ia				
********* AS FOUN	D/AS LEFT ********	***				
Upscale Pressur	e Tests (DIGITAL) -					
14.2270 psi	14.548psi	1.9500psi	16.5	Pass	2.2e-003psi	
513.1920 psi	513.565psi	1.9500psi	19.1	Pass	7.7e-002psi	
1012.6750 psi	1013.074psi	1.9500psi	20.5	Pass	1.5e-001psi	
2011.6410 psi	2011.549psi	1.9500psi	4.72	Pass	3.0e-001psi	
3010.6070 psi	3010.846psi	1.9500psi	12.3	Pass	4.5e-001psi	
Downscale Press	ure Tests (DIGITAL)					
3010.6070 psi	3010.788psi	1.9500psi	9.28	Pass	4.5e-001psi	
2011.6410 psi	2012.347psi	1.9500psi	36.2	Pass	3.0e-001psi	
1012.6750 psi	1013.471psi	1.9500psi	40.8	Pass	1.5e-001psi	
513.1920 psi	514.012psi	1.9500psi	42.1	Pass	7.7e-002psi	
14.2270 psi	14.683psi	1.9500psi	23.4	Pass	2.2e-003psi	



# **REPORTOFCALIBRATION**

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 25 April 2017
SERIAL NUMBER: ASSET NUMBER:	1015724 20765	CAL DUE: DATA TYPE:	25 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Elibrat Shaphin Calibrated By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20765					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	
200.0000 psi	199.950psi	0.5200psi	9.62	Pass	1.6e-002psi	
400.0000 psi	399.981psi	0.5200psi	3.65	Pass	3.2e-002psi	
600.0000 psi	599.987psi	0.5200psi	2.5	Pass	4.8e-002psi	
800.0000 psi	800.000psi	0.5200psi	0	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	799.995psi	0.5200psi	0.962	Pass	6.4e-002psi	
600.0000 psi	600.011psi	0.5200psi	2.12	Pass	4.8e-002psi	
400.0000 psi	400.007psi	0.5200psi	1.35	Pass	3.2e-002psi	
200.0000 psi	200.004psi	0.5200psi	0.769	Pass	1.6e-002psi	
15.0000 psi	14.963psi	0.5200psi	7.12	Pass	7.3e-003psi	



### REPORT OF CALIBRATION

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 25 April 2017
SERIAL NUMBER: ASSET NUMBER:	1036524 20777	CAL DUE: DATA TYPE:	25 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
Test Results						
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Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20777					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	
200.0000 psi	200.112psi	0.5200psi	21.5	Pass	1.6e-002psi	
400.0000 psi	400.142psi	0.5200psi	27.3	Pass	3.2e-002psi	
600.0000 psi	600.119psi	0.5200psi	22.9	Pass	4.8e-002psi	
800.0000 psi	799.988psi	0.5200psi	2.31	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	799.988psi	0.5200psi	2.31	Pass	6.4e-002psi	
600.0000 psi	600.096psi	0.5200psi	18.5	Pass	4.8e-002psi	
400.0000 psi	400.142psi	0.5200psi	27.3	Pass	3.2e-002psi	
200.0000 psi	200.112psi	0.5200psi	21.5	Pass	1.6e-002psi	
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER:	1015712	CAL DUE:	12 May 2018
ASSET NUMBER:	20789	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	0~400
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Standards	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20789					
Calibrated Span =	400 PSI					
Calibration Tolera	nce = 0.26 PSI					
Upscale Tests						
15.0000 psi	15.006psi	0.2600psi	2.31	Pass	7.3e-003psi	
100.0000 psi	100.029psi	0.2600psi	11.2	Pass	8.0e-003psi	
200.0000 psi	200.004psi	0.2600psi	1.54	Pass	1.6e-002psi	
300.0000 psi	300.015psi	0.2600psi	5.77	Pass	2.4e-002psi	
400.0000 psi	400.032psi	0.2600psi	12.3	Pass	3.2e-002psi	
Downscale Tests						
400.0000 psi	400.034psi	0.2600psi	13.1	Pass	3.2e-002psi	
300.0000 psi	300.019psi	0.2600psi	7.31	Pass	2.4e-002psi	
200.0000 psi	200.008psi	0.2600psi	3.08	Pass	1.6e-002psi	
100.0000 psi	100.029psi	0.2600psi	11.2	Pass	8.0e-003psi	
15.0000 psi	15.006psi	0.2600psi	2.31	Pass	7.3e-003psi	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	1924154 20976	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20976					
Calibrated Span =	150 inH20					
Calibration Tolera	nce = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	0.001inH2O	0.0975inH2O	1.03	Pass	5.8e-003inH2O	
37.5000 inH2O	37.490inH2O	0.0975inH2O	10.3	Pass	5.8e-003inH2O	
75.0000 inH2O	74.992inH2O	0.0975inH2O	8.21	Pass	6.0e-003inH2O	
112.5000 inH2O	112.496inH2O	0.0975inH2O	4.1	Pass	9.0e-003inH2O	
150.0000 inH2O	149.998inH2O	0.0975inH2O	2.05	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	149.999inH2O	0.0975inH2O	1.03	Pass	1.2e-002inH2O	
112.5000 inH2O	112.511inH2O	0.0975inH2O	11.3	Pass	9.0e-003inH2O	
75.0000 inH2O	74.994inH2O	0.0975inH2O	6.15	Pass	6.0e-003inH2O	
37.5000 inH2O	37.494inH2O	0.0975inH2O	6.15	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.017inH2O	0.0975inH2O	17.4	Pass	5.8e-003inH2O	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	91699105 20987	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD20987					
Calibrated Span =	150 inH20					
Calibration Tolera	ance = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	-0.005inH2O	0.0975inH2O	5.13	Pass	5.8e-003inH2O	
37.5000 inH2O	37.501inH2O	0.0975inH2O	1.03	Pass	5.8e-003inH2O	
75.0000 inH2O	75.004inH2O	0.0975inH2O	4.1	Pass	6.0e-003inH2O	
112.5000 inH2O	112.506inH2O	0.0975inH2O	6.15	Pass	9.0e-003inH2O	
150.0000 inH2O	150.008inH2O	0.0975inH2O	8.21	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	150.004inH2O	0.0975inH2O	4.1	Pass	1.2e-002inH2O	
112.5000 inH2O	112.522inH2O	0.0975inH2O	22.6	Pass	9.0e-003inH2O	
75.0000 inH2O	75.023inH2O	0.0975inH2O	23.6	Pass	6.0e-003inH2O	
37.5000 inH2O	37.516inH2O	0.0975inH2O	16.4	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.014inH2O	0.0975inH2O	14.4	Pass	5.8e-003inH2O	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	4270112 21050	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards I	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD21050					
Calibrated Span =	150 inH2O					
Calibration Tolera	nce = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	-0.004inH2O	0.0975inH2O	4.1	Pass	5.8e-003inH2O	
37.5000 inH2O	37.489inH2O	0.0975inH2O	11.3	Pass	5.8e-003inH2O	
75.0000 inH2O	75.000inH2O	0.0975inH2O	0	Pass	6.0e-003inH2O	
112.5000 inH2O	112.506inH2O	0.0975inH2O	6.15	Pass	9.0e-003inH2O	
150.0000 inH2O	150.007inH2O	0.0975inH2O	7.18	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	150.006inH2O	0.0975inH2O	6.15	Pass	1.2e-002inH2O	
112.5000 inH2O	112.518inH2O	0.0975inH2O	18.5	Pass	9.0e-003inH2O	
75.0000 inH2O	75.009inH2O	0.0975inH2O	9.23	Pass	6.0e-003inH2O	
37.5000 inH2O	37.507inH2O	0.0975inH2O	7.18	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.012inH2O	0.0975inH2O	12.3	Pass	5.8e-003inH2O	
112.5000 inH2O 150.0000 inH2O 150.0000 inH2O Downscale Tests 150.0000 inH2O 112.5000 inH2O 75.0000 inH2O 37.5000 inH2O 0.0000 inH2O	112.506inH2O 112.506inH2O 150.007inH2O 112.518inH2O 75.009inH2O 37.507inH2O -0.012inH2O	0.0975inH2O 0.0975inH2O 0.0975inH2O 0.0975inH2O 0.0975inH2O 0.0975inH2O 0.0975inH2O 0.0975inH2O	6.15 7.18 6.15 18.5 9.23 7.18 12.3	Pass Pass Pass Pass Pass Pass Pass Pass	1.2e-003inH2O 9.0e-003inH2O 1.2e-002inH2O 9.0e-003inH2O 6.0e-003inH2O 5.8e-003inH2O 5.8e-003inH2O	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	1024700 21067	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD21067					
Calibrated Span =	150 inH20					
Calibration Tolera	ance = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	0.000inH2O	0.0975inH2O	0	Pass	5.8e-003inH2O	
37.5000 inH2O	37.498inH2O	0.0975inH2O	2.05	Pass	5.8e-003inH2O	
75.0000 inH2O	75.004inH2O	0.0975inH2O	4.1	Pass	6.0e-003inH2O	
112.5000 inH2O	112.502inH2O	0.0975inH2O	2.05	Pass	9.0e-003inH2O	
150.0000 inH2O	150.002inH2O	0.0975inH2O	2.05	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	150.000inH2O	0.0975inH2O	0	Pass	1.2e-002inH2O	
112.5000 inH2O	112.519inH2O	0.0975inH2O	19.5	Pass	9.0e-003inH2O	
75.0000 inH2O	75.021inH2O	0.0975inH2O	21.5	Pass	6.0e-003inH2O	
37.5000 inH2O	37.515inH2O	0.0975inH2O	15.4	Pass	5.8e-003inH2O	
0.0000 inH2O	0.000inH2O	0.0975inH2O	0	Pass	5.8e-003inH2O	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	1024701 21108	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	l By:	

**Approved By:** 

Standards	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD21108					
Calibrated Span =	150 inH2O					
Calibration Tolera	nce = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	0.000inH2O	0.0975inH2O	0	Pass	5.8e-003inH2O	
37.5000 inH2O	37.483inH2O	0.0975inH2O	17.4	Pass	5.8e-003inH2O	
75.0000 inH2O	74.996inH2O	0.0975inH2O	4.1	Pass	6.0e-003inH2O	
112.5000 inH2O	112.502inH2O	0.0975inH2O	2.05	Pass	9.0e-003inH2O	
150.0000 inH2O	150.006inH2O	0.0975inH2O	6.15	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	150.016inH2O	0.0975inH2O	16.4	Pass	1.2e-002inH2O	
112.5000 inH2O	112.513inH2O	0.0975inH2O	13.3	Pass	9.0e-003inH2O	
75.0000 inH2O	74.996inH2O	0.0975inH2O	4.1	Pass	6.0e-003inH2O	
37.5000 inH2O	37.498inH2O	0.0975inH2O	2.05	Pass	5.8e-003inH2O	
0.0000 inH2O	0.015inH2O	0.0975inH2O	15.4	Pass	5.8e-003inH2O	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	1344511 21122	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~150 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Calibrated By:** 

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD21122					
Calibrated Span =	150 inH20					
Calibration Tolera	ance = 0.0975 inH20					
Upscale Tests						
0.0000 inH2O	-0.008inH2O	0.0975inH2O	8.21	Pass	5.8e-003inH2O	
37.5000 inH2O	37.489inH2O	0.0975inH2O	11.3	Pass	5.8e-003inH2O	
75.0000 inH2O	74.985inH2O	0.0975inH2O	15.4	Pass	6.0e-003inH2O	
112.5000 inH2O	112.492inH2O	0.0975inH2O	8.21	Pass	9.0e-003inH2O	
150.0000 inH2O	150.001inH2O	0.0975inH2O	1.03	Pass	1.2e-002inH2O	
Downscale Tests						
150.0000 inH2O	150.001inH2O	0.0975inH2O	1.03	Pass	1.2e-002inH2O	
112.5000 inH2O	112.510inH2O	0.0975inH2O	10.3	Pass	9.0e-003inH2O	
75.0000 inH2O	75.000inH2O	0.0975inH2O	0	Pass	6.0e-003inH2O	
37.5000 inH2O	37.489inH2O	0.0975inH2O	11.3	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.026inH2O	0.0975inH2O	26.7	Pass	5.8e-003inH2O	



### **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1764571 21128	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Condi	.TIONS Numidity, 158Ph Bar	ometric Pressure	• 1/ 22DGTA			
10mperature: 220, 11	anitarcy. 49 sian, bar	omeerie riessuie	. 11.2210111			
Transmitter Calibra	tion Range= 3000 ps	ia				
Transmitter Accurac	y= 1.95 psia					
******** AS FOUN	ID/AS LEFT *******	* *				
Upscale Pressur	e Tests (DIGITAL) -					
14.2200 psi	14.279psi	1.9500psi	3.03	Pass	2.2e-003psi	
513.1850 psi	513.222psi	1.9500psi	1.9	Pass	7.7e-002psi	
1012.6680 psi	1012.740psi	1.9500psi	3.69	Pass	1.5e-001psi	
2011.6340 psi	2011.904psi	1.9500psi	13.8	Pass	3.0e-001psi	
3010.6000 psi	3010.801psi	1.9500psi	10.3	Pass	4.5e-001psi	
Downscale Press	ure Tests (DIGITAL)					
3010.6000 psi	3010.778psi	1.9500psi	9.13	Pass	4.5e-001psi	
2011.6340 psi	2011.979psi	1.9500psi	17.7	Pass	3.0e-001psi	
1012.6680 psi	1012.973psi	1.9500psi	15.6	Pass	1.5e-001psi	
513.1850 psi	513.431psi	1.9500psi	12.6	Pass	7.7e-002psi	
14.2200 psi	14.279psi	1.9500psi	3.03	Pass	2.2e-003psi	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	69293 21289	CAL DUE: DATA TYPE:	11 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~350 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD21289					
Calibrated Span = 3	350 inH2O					
Calibration Tolera	nce = 0.2275 inH20					
Upscale Tests						
0.0000 inH2O	-0.003inH2O	0.2275inH2O	1.32	Pass	5.8e-003inH2O	
87.5000 inH2O	87.492inH2O	0.2275inH2O	3.52	Pass	7.0e-003inH2O	
175.0000 inH2O	174.993inH2O	0.2275inH2O	3.08	Pass	1.4e-002inH2O	
262.5000 inH2O	262.499inH2O	0.2275inH2O	0.44	Pass	2.1e-002inH2O	
350.0000 inH2O	350.009inH2O	0.2275inH2O	3.96	Pass	2.8e-002inH2O	
Downscale Tests						
350.0000 inH2O	350.011inH2O	0.2275inH2O	4.84	Pass	2.8e-002inH2O	
262.5000 inH2O	262.491inH2O	0.2275inH2O	3.96	Pass	2.1e-002inH2O	
175.0000 inH2O	174.982inH2O	0.2275inH2O	7.91	Pass	1.4e-002inH2O	
87.5000 inH2O	87.490inH2O	0.2275inH2O	4.4	Pass	7.0e-003inH2O	
0.0000 inH2O	-0.002inH2O	0.2275inH2O	0.879	Pass	5.8e-003inH2O	



#### **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 12 April 2017
SERIAL NUMBER:	4161	CAL DUE:	12 April 2018
ASSET NUMBER:	21349	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021349					
Probe Calibration	Range = 125 to 1100 Deg = 51.7 to	F 593.3 Deg C				
AS FOUND/AS LEFT F	120113					
Besistance Value a	at Temp = 120 1385 Ohms					
125.1080 F	125.1000 01mmb	0.5000E	17 2	Pass	1 2e-001F	
Resistance Value a	154.37333 Ohms	0.00001	17.2	1 455	1.20 0011	
287.4720 F	287 555F	0 5000F	16.6	Pass	1 2e-001F	
Resistance Value a	at Temp = 187.67017 Ohms		1010			
449.9220 F	450.039F	0.5000F	23.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.01583 Ohms					
612.4310 F	612.403F	0.5000F	5.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.4395 Ohms					
774.9110 F	774.787F	0.5000F	24.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 281.98367 Ohms					
937.4660 F	937.426F	0.5000F	8	Pass	1.2e-001F	
Resistance Value a	at Temp = 311.5945 Ohms					
1099.9630 F	1100.041F	0.5000F	15.6	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	at Temp = 120.1385 Ohms					
51.7270 c	51.679c	0.2780c	17.3	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.37333 Ohms					
141.9290 c	141.975c	0.2780c	16.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.67017 Ohms					
232.1790 c	232.244c	0.2780c	23.4	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.01583 Ohms					
322.4620 c	322.446c	0.2780c	5.76	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.4395 Ohms					
412.7280 c	412.660c	0.2780c	24.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 281.98367 Ohms					
503.0360 c	503.014c	0.2780c	7.91	Pass	6.4e-002c	
Resistance Value a	at Temp = 311.5945 Ohms					
593.3130 c	593.356c	0.2780c	15.5	Pass	6.4e-002c	
As Left Coefficien	its:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen
where T = Deg C and Rt = Resistance at Temp
T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B)
Ro= 100.12746
Alpha= 0.003839796
Delta= 1.48025902381
A= 0.00389663492679
B= -5.68389267857e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### REPORT OF CALIBRATION

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 10 April 2017
SERIAL NUMBER:	4137	CAL DUE:	10 April 2018
ASSET NUMBER:	21414	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14016	Rosemount Aerospace 162CE SPRT	4211	8/19/2016	8/19/2017		

Standard Reading	<b><u>UUT Reading</u></b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021414					
Probe Calibration 3	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.227 Ohms					
125.1290 F	125.155F	0.5000F	5.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.35733 Ohms					
287.5700 F	287.565F	0.5000F	1	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.59883 Ohms					
450.0740 F	450.034F	0.5000F	8	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.942 Ohms					
612.5820 F	612.519F	0.5000F	12.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.41833 Ohms					
775.1300 F	775.185F	0.5000F	11	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.9865 Ohms					
937.7220 F	937.826F	0.5000F	20.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.58633 Ohms					
1100.1840 F	1100.105F	0.5000F	15.8	Pass	1.2e-001F	
************Degree	es C***********					
Resistance Value a	t Temp = 120.227 Ohms					
51.7380 c	51.753c	0.2780c	5.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.35733 Ohms					
141.9830 c	141.981c	0.2780c	0.719	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.59883 Ohms					
232.2630 c	232.241c	0.2780c	7.91	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.942 Ohms					
322.5460 c	322.510c	0.2780c	12.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.41833 Ohms					
412.8500 c	412.881c	0.2780c	11.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.9865 Ohms					
503.1790 c	503.237c	0.2780c	20.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.58633 Ohms					
593.4350 c	593.392c	0.2780c	15.5	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C an$	d Rt = Resistance at Tem	ıp				

 $T = [-RoA + Sqrt(Ro^{2}A^{2}-4Ro^{*}B(Ro-Rt))]/(2*Ro^{*}B)$ 

Ro= 100.24408 Alpha= 0.003825194

Test Results

Delta= 1.44262104341

A= 0.0038803770536

B= -5.51830535952e-007



### REPORTOFCALIBRATION

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UNIT UNDER TEST:	Power Meter, Digital	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	399850 21461	CAL DUE: DATA TYPE:	11 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Nexus 1250/1252/1500: CAL VER 60Hz 0 - 03/28/17 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

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Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as left.

Elibrated By:

**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
14001	Fluke 5520A Multi-Function Calibrator	8635015	3/14/2017	3/14/2018		
14002	Rotek MSB100 Power and Energy Standard	173	2/25/2017	2/25/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AC VOLTAGE TESTS - 6	OHz					
Phase A -						
100.000 V	100.0080V	0.08000V	10	Pass	1.6e-002V	3.81
120.000 V	120.0070V	0.09600V	7.29	Pass	1.9e-002V	3.87
240.000 V	240.0110V	0.19200V	5.73	Pass	3.7e-002V	
Phase B -						
100.000 V	99.9920V	0.08000V	10	Pass	1.6e-002V	3.81
120.000 V	119.9870V	0.09600V	13.5	Pass	1.9e-002V	3.87
240.000 V	240.0040V	0.19200V	2.08	Pass	3.7e-002V	
Phase C -						
100.000 V	99.9910V	0.08000V	11.3	Pass	1.6e-002V	3.81
120.000 V	119.9890V	0.09600V	11.5	Pass	1.9e-002V	3.87
240.000 V	239.9940V	0.19200V	3.13	Pass	3.7e-002V	
AC CURRENT TESTS - 6	OHz					
Phase A - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase B - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase C - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase A - 2.5A Range						
2.50060 A	2.5004A	0.00200A	10	Pass	6.5e-004A	3.11
Phase B - 2.5A Range						
2.50060 A	2.5004A	0.00200A	10	Pass	6.5e-004A	3.11
Phase C - 2.5A Range						
2.50060 A	2.5004A	0.00200A	10	Pass	6.5e-004A	3.11
Phase A - 5A Range						
5.00180 A	5.0017A	0.00400A	2.5	Pass	1.3e-003A	3.11
Phase B - 5A Range						
5.00180 A	5.0017A	0.00400A	2.5	Pass	1.3e-003A	3.11
Phase C - 5A Range						
5.00190 A	5.0017A	0.00400A	5	Pass	1.3e-003A	3.11
AC WATT TESTS - 60Hz	- PF 1.0					
Phase A - 1A Range						
120.03090 W	120.0330W	0.09600W	2.19	Pass	7.6e-003W	
Phase B - 1A Range						
120.03060 W	120.0077W	0.09600W	23.9	Pass	7.6e-003W	
Phase C - 1A Range						
120.03080 W	120.0152W	0.09600W	16.3	Pass	7.6e-003W	

Phase A - 2.5A Range

Date Printed: May 11, 2017

Test Results						
<u>Standard Reading</u> 300.07220 W	<u>UUT Reading</u> 300.0566W	<u>Test Tol</u> 0.24000W	<u>% Tol Error</u> 6.5	<u>PASS/FAIL</u> Pass	Expanded Unc. 3.5e-002W	<u>TUR</u>
Phase B - 2.5A Range 300.07260 W	300.0303W	0.24010W	17.6	Pass	3.5e-002W	
Phase C - 2.5A Range 300.07280 W	300.0247W	0.24000W	20	Pass	3.5e-002W	
Phase A - 5A Range 600.22640 W	600.1278W	0.48000W	20.5	Pass	1.4e-001W	
Phase B - 5A Range 600.22310 W	600.0789W	0.48000W	30	Pass	1.4e-001W	
Phase C - 5A Range 600.22440 W	600.0768W	0.48000W	30.7	Pass	1.4e-001W	
AC WATT TESTS - 60Hz	- PF 0.75 Lead/La	.g				
Phase A - 0.75 Lag 450.32880 W	450.2323W	0.36000W	26.8	Pass	9.0e+002W	
Phase B - 0.75 Lag 450.32560 W	450.1639W	0.36000W	44.9	Pass	8.7e-003W	
Phase C - 0.75 Lag 450.33070 W	450.2446W	0.36000W	23.9	Pass	8.7e-003W	
Phase A - 0.75 Lead 450.03200 W	449.9171W	0.36000W	31.9	Pass	9.0e+002W	
Phase B - 0.75 Lead 450.03130 W	449.8398W	0.36000W	53.2	Pass	8.7e-003W	
Phase C - 0.75 Lead 450.03160 W	449.7627W	0.36000W	74.7	Pass	8.7e-003W	



### REPORTOFCALIBRATION

McHalePerformance of

UNIT UNDER TEST:	Power Meter, Digital	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER: ASSET NUMBER:	399854 21466	CAL DUE: DATA TYPE:	12 May 2018 FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Nexus 1250/1252/1500: CAL VER 60Hz 0 - 03/28/17 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as found and as left.

Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14001	Fluke 5520A Multi-Function Calibrator	8635015	3/14/2017	3/14/2018	
14002	Rotek MSB100 Power and Energy Standard	173	2/25/2017	2/25/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AC VOLTAGE TESTS - 6	OHz					
Phase A -	00.0040\/	0.000001/	7 5	Dees	1.0-0001/	0.04
100.000 V	99.99400	0.08000	7.5	Pass	1.6e-002V	3.81
120.000 V	119.99000	0.09600V	10.4	Pass	1.9e-002V	3.87
240.000 V	239.99200	0.192000	4.17	Pass	3.7e-002v	
100 000 V	00 00701/	0.000001/	2 75	Deee	1.60.002)/	2.04
120.000 V	99.9970V	0.00000	3.75	Pass	1.00-002V	3.01 2.07
240 000 V	119.99007	0.090000	10.4	Pass	1.9e-002V	3.07
240.000 V	239.9950 V	0.192000	2.0	Pass	3.7e-002v	
100 000 V	00.0770\/	0.09000\/	20.7	Dooo	1.60.002\/	2 01
120.000 V	99.97700	0.000000	20.7	Fass	1.00-0021	3.01 2.07
240,000 V	119.9040V	0.096007	37.5	Pass	1.90-0020	3.07
240.000 V	239.97700	0.192000	12	Pass	3.7e-002V	
AC CURRENT TESTS - 6	0Hz					
Phase A - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase B - 1A Range						
1.00030 A	1.0002A	0.00100A	10	Pass	2.6e-004A	3.89
Phase C - 1A Range						
1.00030 A	1.0007A	0.00100A	40	Pass	2.6e-004A	3.89
Phase A - 2.5A Range						
2.50060 A	2.5012A	0.00200A	30	Pass	6.5e-004A	3.11
Phase B - 2.5A Range						
2.50060 A	2.5012A	0.00200A	30	Pass	6.5e-004A	3.11
Phase C - 2.5A Range						
2.50060 A	2.5020A	0.00200A	70	Pass	6.5e-004A	3.11
Phase A - 5A Range						
5.00190 A	5.0024A	0.00400A	12.5	Pass	1.3e-003A	3.11
Phase B - 5A Range						
5.00200 A	5.0028A	0.00400A	20	Pass	1.3e-003A	3.11
Phase C - 5A Range						
5.00200 A	5.0055A	0.00400A	87.5	Pass	1.3e-003A	3.11
AC WATT TESTS - 60Hz	- PF 1.0					
Phase A - IA Range			10.0	-		
120.03240 W	120.0225W	0.09600W	10.3	Pass	7.6e-003W	
Dhace D 17 Decem						
rnase в - IA Kange	120 0409\4/	0.00600144	0.70	Deee	7.60 00004	
120.03140 10	120.0408W	0.0960077	9.79	Pass	7.0e-003W	
Dhace ( - 11 Dones						
120 03200 W	120 0220\\/	0.0060014	0	Paga	7 60 00014	
120.00200 ##	120.032000	0.0900000	U	F 055	1.08-00300	

Phase A - 2.5A Range

Test Results						
Standard Reading 300.07300 W	<u>UUT Reading</u> 300.0741W	<u>Test Tol</u> 0.24000W	<u>% Tol Error</u> 0.458	<u>PASS/FAIL</u> Pass	Expanded Unc. 3.5e-002W	<u>TUR</u>
Phase B - 2.5A Range 300.07470 W	300.1107W	0.24010W	15	Pass	3.5e-002W	
Phase C - 2.5A Range 300.07490 W	300.1400W	0.24000W	27.1	Pass	3.5e-002W	
Phase A - 5A Range 600.20660 W	600.1381W	0.48000W	14.3	Pass	1.4e-001W	
Phase B - 5A Range 600.21250 W	600.2002W	0.48000W	2.56	Pass	1.4e-001W	
Phase C - 5A Range 600.21390 W	600.3634W	0.48000W	31.1	Pass	1.4e-001W	
AC WATT TESTS - 60Hz	- PF 0.75 Lead/La	g				
Phase A - 0.75 Lag 450.34160 W	450.1850W	0.36000W	43.5	Pass	9.0e+002W	
Phase B - 0.75 Lag 450.33830 W	450.3588W	0.36000W	5.69	Pass	8.7e-003W	
Phase C - 0.75 Lag 450.34160 W	450.5301W	0.36000W	52.4	Pass	8.7e-003W	
Phase A - 0.75 Lead 450.03400 W	450.0212W	0.36000W	3.56	Pass	9.0e+002W	
Phase B - 0.75 Lead 450.03270 W	449.9375W	0.36000W	26.4	Pass	8.7e-003W	
Phase C - 0.75 Lead 450.03710 W	450.0108W	0.36000W	7.31	Pass	8.7e-003W	



#### **REPORTOFCALIBRATION**

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 12 April 2017
SERIAL NUMBER:	6744	CAL DUE:	12 April 2018
ASSET NUMBER:	21481	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Calibrated By:** 

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021481					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 t	o 593.3 Deg (	2			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.05 Ohms					
125.1080 F	125.007F	0.5000F	20.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.36267 Ohms					
287.4720 F	287.566F	0.5000F	18.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 187.7125 Ohms					
449.9220 F	450.058F	0.5000F	27.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.08533 Ohms					
612.4310 F	612.404F	0.5000F	5.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.51867 Ohms					
774.9110 F	774.789F	0.5000F	24.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.042 Ohms					
937.4660 F	937.374F	0.5000F	18.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 311.63633 Ohms					
1099.9630 F	1100.074F	0.5000F	22.2	Pass	1.2e-001F	
************Degre	ees C************					
Resistance Value a	at Temp = 120.05 Ohms					
51.7270 c	51.671c	0.2780c	20.1	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.36267 Ohms					
141.9290 c	141.981c	0.2780c	18.7	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.7125 Ohms					
232.1790 c	232.254c	0.2780c	27	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.08533 Ohms					
322.4620 c	322.447c	0.2780c	5.4	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.51867 Ohms					
412.7280 c	412.660c	0.2780c	24.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.042 Ohms					
503.0360 c	502.986c	0.2780c	18	Pass	6.4e-002c	
Resistance Value a	at Temp = 311.63633 Ohms					
593.3130 c	593.375c	0.2780c	22.3	Pass	6.4e-002c	
As Left Coefficier	nts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.99129 Alpha= 0.00385424 Delta= 1.50993046414 A= 0.00391243634392 B= -5.81963439211e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



Coster Road Knoxville, IN 37934 865 588 2654

# REPORTOFCALIBRATIO

UNIT UNDER TEST:	Input Card, 20 Channel, Type K	TEST RESULT: CAL DATE:	PASS 13 December 2016
SERIAL NUMBER:	US37236738	CAL DUE:	13 December 2017
ASSET NUMBER:	21565	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Agilent 34901A TYPE K T/C (1 year) 1 - 01/30/14 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 °C 31 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found and as left.

Vint Shophis

Calibrated

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10219	Agilent 34970A Data Logger	US37042760	11/22/2016	2/22/2017	
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
0.00 status Type K T/C	0.0status		0	Pass		
32 °F	32°F	1.8°F	22.1	Pass	6.2e-001°F	
150.0 °F	150.5°F	1.80°F	28.4	Pass	2.3e-001°F	
1050.0 °F	1050.6°F	1.80°F	31.1	Pass	3.7e-001°F	3.85
Channel 201 Test						
<b>100.0 °F</b> Channel 202 Test	100.7°F	1.80°F	40.6	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 203 Test	100.7°F	1.80°F	40.2	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 204 Test	100.7°F	1.80°F	36.4	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 205 Test	100.6°F	1.80°F	33.7	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 206 Test	100.6°F	1.80°F	32.6	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 207 Test	100.5°F	1.80°F	28.6	Pass	2.3e-001°F	
100.0 °F Channel 208 Test	100.6°F	1.80°F	31.2	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 209 Test	100.6°F	1.80°F	32.3	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 210 Test	100.6°F	1.80°F	33.8	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 211 Test	100.6°F	1.80°F	32.6	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 212 Test	100.5°F	1.80°F	29.8	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 213 Test	100.5°F	1.80°F	26.6	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 214 Test	100.5°F	1.80°F	29.7	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 215 Test	100.5°F	1.80°F	28.2	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 216 Test	100.5°F	1.80°F	26.4	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 217 Test	100.4°F	1.80°F	24.7	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 218 Test	100.4°F	1.80°F	22.7	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 219 Test	100.5°F	1.80°F	25.1	Pass	2.3e-001°F	
<b>100.0 °F</b> Channel 220 Test	100.5°F	1.80°F	25.3	Pass	2.3e-001°F	
100.0 °F	100.5°F	1.80°F	25.2	Pass	2.3e-001°F	



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER:	7235	CAL DUE:	14 April 2018
ASSET NUMBER:	21615	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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1	<b>ب</b>	4 A	-
A	2210~	1 June 1	
$-\mathcal{Y}$	Calibrated By	y:	

**Approved By:** 

Standards Used				
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021615					
Probe Calibration	Range = 125 to 1100 Dec	ſ F				
	= 51.7 t	o 593.3 Deg (	C			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.33767 Ohms	5				
125.0950 F	125.046F	0.5000F	9.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.56317 Ohms					
287.4450 F	287.549F	0.5000F	20.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 187.84033 Ohms	;				
449.8770 F	449.850F	0.5000F	5.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.24783 Ohms	5				
612.3720 F	612.334F	0.5000F	7.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 251.74767 Ohms					
774.8290 F	774.817F	0.5000F	2.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.35967 Ohms	1				
937.3810 F	937.405F	0.5000F	4.8	Pass	1.2e-001F	
Resistance Value a	at Temp = 312.03883 Ohms	5				
1099.8610 F	1099.860F	0.5000F	0.2	Pass	1.2e-001F	
************Degre	ees C************					
Resistance Value a	at Temp = 120.33767 Ohms					
51.7200 c	51.692c	0.2780c	10.1	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.56317 Ohms	;				
141.9140 c	141.971c	0.2780c	20.5	Pass	6.4e-002c	
Resistance Value a	at Temp = 187.84033 Ohms	5				
232.1540 c	232.139c	0.2780c	5.4	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.24783 Ohms					
322.4290 c	322.408c	0.2780c	7.55	Pass	6.4e-002c	
Resistance Value a	at Temp = 251.74767 Ohms					
412.6830 c	412.676c	0.2780c	2.52	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.35967 Ohms			_		
502.9890 c	503.003c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	at Temp = 312.03883 Ohms			_		
593.2560 C	593.256c	0.2780c	0	Pass	6.4e-002c	
Ne Toft Coofficion	te.					
Equation Head- Cal	londar-Van Duson					

Equation Used= Callendar-Van Dusen
where T = Deg C and Rt = Resistance at Temp
T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B)
Ro= 100.33204
Alpha= 0.003830516
Delta= 1.44893939824
A= 0.00388601785548
B= -5.550185548e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



### **REPORTOFCALIBRATION**

McHalePerformance of

UNIT UNDER TEST:	RTD, Digital, 4-Wire, 24"	TEST RESULT: CAL DATE:	PASS 17 April 2017
SERIAL NUMBER:	07260	CAL DUE:	17 April 2018
ASSET NUMBER:	21653	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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$\neg \neg$	Calibrated F	Bv:	

**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
--------------------	-----------------------------	-----------------	--------------------	-----------	---------------	------------
Probe ID Number	= TT021653					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	o 593.3 Deg (	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.39033 Ohms					
125.1000 F	125.074F	0.5000F	5.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.71633 Ohms					
287.4490 F	287.424F	0.5000F	5	Pass	1.2e-001F	
Resistance Value a	t Temp = 188.133 Ohms					
449.8780 F	449.987F	0.5000F	21.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.5635 Ohms					
612.3650 F	612.392F	0.5000F	5.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 252.03517 Ohms					
774.8320 F	774.768F	0.5000F	12.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.574 Ohms					
937.3620 F	937.253F	0.5000F	21.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 312.1955 Ohms					
1099.8560 F	1099.944F	0.5000F	17.6	Pass	1.2e-001F	
************Degre	es C***********					
Resistance Value a	t Temp = 120.39033 Ohms					
51.7220 c	51.708c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.71633 Ohms					
141.9160 c	141.902c	0.2780c	5.04	Pass	6.4e-002c	
Resistance Value a	t Temp = 188.133 Ohms					
232.1540 c	232.215c	0.2780c	21.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.5635 Ohms					
322.4250 c	322.440c	0.2780c	5.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 252.03517 Ohms					
412.6850 c	412.649c	0.2780c	12.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.574 Ohms					
502.9790 c	502.919c	0.2780c	21.6	Pass	6.4e-002c	
Resistance Value a	t Temp = 312.1955 Ohms					
593.2540 c	593.302c	0.2780c	17.3	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen
where T = Deg C and Rt = Resistance at Temp
T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B)
Ro= 100.28179
Alpha= 0.003849752
Delta= 1.51663379498
A= 0.00390813863986
B= -5.8386639855e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



Coster Boad Knoxville, IN 37934 865 588 2654

## **REPORTOFCALIBRATION**

McHalePerformance same

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 21 April 2017
SERIAL NUMBER:	21735	CAL DUE:	21 April 2018
ASSET NUMBER:		DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RH Cal 3 pt 1 - 09/08/2016 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

Grant St

Calibrated By:

**Approved By:** 

Standards Used								
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>				
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017				
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017				
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017				

Test Results							
Standard Read	ding	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Tes	st					
Test Point:	11.3% RH	I					
11.5000 %RH		12.658%RH	2.0000%RH	57.9	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH	I					
33.0000 %RH		33.295%RH	2.0000%RH	14.7	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0%	RH					
75.0000 %RH		74.907%RH	2.0000%RH	4.63	Pass	1.0e+000%RH	2.00



Doster Road Knoxville, IN 37934 805 588 2054

## **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 18 April 2017
SERIAL NUMBER:		CAL DUE:	18 April 2018
ASSET NUMBER:	21740	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Digital RH Cal 3 pt	<b>TEMPERATURE:</b>	21.00 °C
PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	1 - 09/08/2016 Jessica Trent McHale & Associates	HUMIDITY:	30 %
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~99 %

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

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**Approved By:** 

Standards Used							
<u>Asset #</u>	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			

Test Results							
Standard Read	ding <u>U</u>	JUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Test						
Test Point:	11.3% RH						
12.0000 %RH		11.766%RH	2.0000%RH	11.7	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH						
33.0000 %RH		32.978%RH	2.0000%RH	1.1	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0% RH	I					
76.0000 %RH		75.363%RH	2.0000%RH	31.9	Pass	1.0e+000%RH	2.00



Coster Boad Knoxville, IN 37934 865 588 2654

## REPORTOFCALIBRATION

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 21 April 2017
SERIAL NUMBER:	21741	CAL DUE:	21 April 2018
ASSET NUMBER:		DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Digital RH Cal 3 pt 1 - 09/08/2016 Grant Shropshire McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used							
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017			

Test Results							
Standard Read	ding	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Tes	t					
Test Point:	11.3% RH	[					
11.5000 %RH		11.299%RH	2.0000%RH	10.1	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH	I					
33.0000 %RH		33.399%RH	2.0000%RH	19.9	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0%	RH					
75.0000 %RH		74.715%RH	2.0000%RH	14.2	Pass	1.0e+000%RH	2.00



0 Doster Road - Knoxville, TN 37934 - 865 588 2654

## **REPORTOFCALIBRATION**

McHalePerformance same

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 21 April 2017
SERIAL NUMBER:		CAL DUE:	21 April 2018
ASSET NUMBER:	21742	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Digital RH Cal 3 pt	<b>TEMPERATURE:</b>	21.00 °C
PROCEDURE REV.:	1 - 09/08/2016	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille TN 37912		0~99 %
		CAL UNITS.	/0

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

Calibrated By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results							
Standard Read	ling <u>UUT Read</u>	ing <u>Test Tol</u>	<u>% Tol Err</u>	or <u>PASS/FA</u>	IL Expanded Unc.	<u>TUR</u>	
Relative Hum	idity Test						
Test Point:	11.3% RH						
12.0000 %RH	12.101%F	2.0000%RH	5.04	Pass	1.0e+000%RH	2.00	
Test Point:	33.0% RH						
33.0000 %RH	33.515%F	2.0000%RH	25.7	Pass	1.0e+000%RH	2.00	
Test Point:	75.3.0% RH						
76.0000 %RH	75.112%F	2.0000%RH	44.4	Pass	1.0e+000%RH	2.00	



Doster Road Knoxville IN 37934 - 866 588 2664

## **REPORTOFCALIBRATION**

McHalePerformance same

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 21 April 2017
SERIAL NUMBER:		CAL DUE:	21 April 2018
ASSET NUMBER:	21746	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Digital RH Cal 3 pt	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 09/08/2016	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates		
	4700 Coster Rd. Knowille TN 37912	CAL RANGE:	0~99 %
		CAL UNITS.	70

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

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**REMARKS:** Operating within tolerance as found and as left.

Calibrated By:

**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017		
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017		
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017		

Test Results						
Standard Read	ling <u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Test					
Test Point:	11.3% RH					
12.0000 %RH	11.463%RH	2.0000%RH	26.9	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH					
33.0000 %RH	33.023%RH	2.0000%RH	1.14	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0% RH					
76.0000 %RH	75.884%RH	2.0000%RH	5.82	Pass	1.0e+000%RH	2.00



# **REPORTOFCALIBRATION**

McHalePerformance same

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 18 April 2017
SERIAL NUMBER:	DAVE-010916-012	CAL DUE:	18 April 2018
ASSET NUMBER:	21749	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME:	Digital RH Cal 3 pt	<b>TEMPERATURE:</b>	21.00 °C
PROCEDURE REV.:	1 - 09/08/2016	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
COSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~99 %

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results							
Standard Read	ling	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Test	5					
Test Point:	11.3% RH						
12.0000 %RH		11.548%RH	2.0000%RH	22.6	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH						
33.0000 %RH		32.440%RH	2.0000%RH	28	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0% H	RH					
76.0000 %RH		75.243%RH	2.0000%RH	37.9	Pass	1.0e+000%RH	2.00



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER:	1469714	CAL DUE:	15 May 2018
ASSET NUMBER:	21897	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	0~1500
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	UUT Reading itions	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Temperature: 22C, 2	Humidity: 45%Rh, Bar	cometric Pressure	e: 14.196PSIA			
Transmitter Calibr	ation Range= 1500 ps	ia				
Transmitter Accura	cy= 0.975 psia					
***** AS FOU	ND/AS LEFT ********	**				
Upscale Pressu	re Tests (DIGITAL) -					
14.1960 psi	14.144psi	0.9750psi	5.33	Pass	2.2e-003psi	
313.3670 psi	313.321psi	0.9750psi	4.72	Pass	4.7e-002psi	
812.8510 psi	812.952psi	0.9750psi	10.4	Pass	1.2e-001psi	
1212.4370 psi	1212.631psi	0.9750psi	19.9	Pass	1.8e-001psi	
1512.1270 psi	1512.433psi	0.9750psi	31.4	Pass	2.3e-001psi	
Downscale Pres	sure Tests (DIGITAL)					
1512.1270 psi	1512.455psi	0.9750psi	33.6	Pass	2.3e-001psi	
1212.4370 psi	1212.620psi	0.9750psi	18.8	Pass	1.8e-001psi	
812.8510 psi	812.938psi	0.9750psi	8.92	Pass	1.2e-001psi	
313.3670 psi	313.456psi	0.9750psi	9.13	Pass	4.7e-002psi	
14.1960 psi	14.144psi	0.9750psi	5.33	Pass	2.2e-003psi	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1879144 21900	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Condi	lunidity: 45%Ph Bar	cometria Dressur	- 14 22DGTA			
Temperature: 220, 1	Iumitulty: 45%Mir, Bar	ometric riessure	-• 14.23F51A			
Transmitter Calibra	ation Range= 3000 ps	sia				
Transmitter Accurac	cy= 1.95 psia					
****		- + +				
AS FOUR	ND/AS LEFI *******					
Upscale Pressur	re Tests (DIGITAL) -					
14.2300 psi	14.278psi	1.9500psi	2.46	Pass	2.2e-003psi	
513.1950 psi	512.833psi	1.9500psi	18.6	Pass	7.7e-002psi	
1012.6780 psi	1012.554psi	1.9500psi	6.36	Pass	1.5e-001psi	
2011.6440 psi	2011.455psi	1.9500psi	9.69	Pass	3.0e-001psi	
3010.6100 psi	3010.537psi	1.9500psi	3.74	Pass	4.5e-001psi	
Downscale Press	sure Tests (DIGITAL)					
3010.6100 psi	3010.493psi	1.9500psi	6	Pass	4.5e-001psi	
2011.6440 psi	2011.755psi	1.9500psi	5.69	Pass	3.0e-001psi	
1012.6780 psi	1012.897psi	1.9500psi	11.2	Pass	1.5e-001psi	
513.1950 psi	513.080psi	1.9500psi	5.9	Pass	7.7e-002psi	
14.2300 psi	14.278psi	1.9500psi	2.46	Pass	2.2e-003psi	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1164345 22102	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Calibrated By:** 

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Cond	ltlons Humidity: 45%Rh Bay	cometric Pressure	• 14 23PSTA			
10mperature: 220, 1	namiaicy. 45 min, bai		. 11.20101M			
Transmitter Calibra	ation Range= 3000 ps	sia				
Transmitter Accurac	cy= 1.95 psia					
****	אר /אפ דרריי *******	* * *				
A5 1001	ND/AS LEFT					
Upscale Pressu	re Tests (DIGITAL) -					
14.2300 psi	14.278psi	1.9500psi	2.46	Pass	2.2e-003psi	
513.1950 psi	513.484psi	1.9500psi	14.8	Pass	7.7e-002psi	
1012.6780 psi	1012.958psi	1.9500psi	14.4	Pass	1.5e-001psi	
2011.6440 psi	2011.804psi	1.9500psi	8.21	Pass	3.0e-001psi	
3010.6100 psi	3010.586psi	1.9500psi	1.23	Pass	4.5e-001psi	
Downscale Press	sure Tests (DIGITAL)					
3010.6100 psi	3010 631psi	1 9500nsi	1 08	Pass	4.5e-001psi	
2011 6440 psi	2012 172nsi	1.9500psi	27.1	Pass	3.0e-001psi	
1012 6780 psi	1013 084psi	1.9500psi	20.8	Pass	1 5e-001psi	
513.1950 psi	513 589psi	1.9500psi	20.0	Pass	7 7e-002psi	
14.2300 psi	14 278psi	1.9500psi	2 46	Pass	2 2e-003psi	
	<u>=</u> . opoi		<b>_</b> .+0	1 450	c 000p0i	



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1701576 22105	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Temperature: 22C, 2	Humidity: 45%Rh, Bar	cometric Pressure	e: 14.22PSIA			
Transmitter Calibr	ation Range= 3000 ps	ia				
Transmitter Accura	cy= 1.95 psia					
******** AS FOU	ND/AS LEFT ********	**				
Upscale Pressu	re Tests (DIGITAL) -					
14.2200 psi	14.404psi	1.9500psi	9.44	Pass	2.2e-003psi	
513.1850 psi	513.618psi	1.9500psi	22.2	Pass	7.7e-002psi	
1012.6680 psi	1013.052psi	1.9500psi	19.7	Pass	1.5e-001psi	
2011.6340 psi	2011.855psi	1.9500psi	11.3	Pass	3.0e-001psi	
3010.6000 psi	3010.853psi	1.9500psi	13	Pass	4.5e-001psi	
Downscale Pres	sure Tests (DIGITAL)					
3010.6000 psi	3010.831psi	1.9500psi	11.8	Pass	4.5e-001psi	
2011.6340 psi	2011.994psi	1.9500psi	18.5	Pass	3.0e-001psi	
1012.6680 psi	1013.714psi	1.9500psi	53.6	Pass	1.5e-001psi	
513.1850 psi	513.618psi	1.9500psi	22.2	Pass	7.7e-002psi	
14.2200 psi	14.278psi	1.9500psi	2.97	Pass	2.2e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER: ASSET NUMBER:	1332066 22122	CAL DUE: DATA TYPE:	12 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA22122					
Calibrated Span =	800 PSI					
Calibration Tolera	ance = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.060psi	0.5200psi	11.5	Pass	7.3e-003psi	
200.0000 psi	200.032psi	0.5200psi	6.15	Pass	1.6e-002psi	
400.0000 psi	400.011psi	0.5200psi	2.12	Pass	3.2e-002psi	
600.0000 psi	600.016psi	0.5200psi	3.08	Pass	4.8e-002psi	
800.0000 psi	800.021psi	0.5200psi	4.04	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.021psi	0.5200psi	4.04	Pass	6.4e-002psi	
600.0000 psi	600.016psi	0.5200psi	3.08	Pass	4.8e-002psi	
400.0000 psi	400.011psi	0.5200psi	2.12	Pass	3.2e-002psi	
200.0000 psi	200.032psi	0.5200psi	6.15	Pass	1.6e-002psi	
15.0000 psi	15.006psi	0.5200psi	1.15	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT:	PASS 31 March 2017
SERIAL NUMBER: ASSET NUMBER:	1824521 23082	CAL DATE: CAL DUE: DATA TYPE:	31 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

**Calibrated By:** 

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag	= PTD23082					
Calibrated Span =	25 inH20					
Calibration Tolera	ance = 0.025 inH20					
Upscale Tests						
0.0000 inH2O	-0.006inH2O	0.0250inH2O	24	Pass	5.8e-003inH2O	
6.2500 inH2O	6.250inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
12.5000 inH2O	12.498inH2O	0.0250inH2O	8	Pass	5.8e-003inH2O	
18.7500 inH2O	18.746inH2O	0.0250inH2O	16	Pass	5.8e-003inH2O	
25.0000 inH2O	25.000inH2O	0.0250inH2O	0	Pass	5.8e-003inH2O	
Downscale Tests						
25.0000 inH2O	25.001inH2O	0.0250inH2O	4	Pass	5.8e-003inH2O	
18.7500 inH2O	18.745inH2O	0.0250inH2O	20	Pass	5.8e-003inH2O	
12.5000 inH2O	12.495inH2O	0.0250inH2O	20	Pass	5.8e-003inH2O	
6.2500 inH2O	6.246inH2O	0.0250inH2O	16	Pass	5.8e-003inH2O	
0.0000 inH2O	-0.006inH2O	0.0250inH2O	24	Pass	5.8e-003inH2O	



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**REPORTOFCALIBRATION** 

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UNIT UNDER TEST:	Input Card, 20 Channel, Type K	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER:	US37238146	CAL DUE:	16 May 2018
ASSET NUMBER:	23858	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Agilent 34901A TYPE K T/C (1 year) 1 - 01/30/14 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

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Calibrated By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10133	Agilent 34970A Data Logger	US37028610	5/4/2017	8/2/2017	
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
SELF TEST				_		
	0.0status		0	Pass		
Type K T/C	0005		04.0	Data	0.0. 00405	
32 F	32°F	1.8°F	24.9	Pass	6.2e-001°F	
150.0 °F	150.5°F	1.80°F	30.3	Pass	2.3e-001°F	0.05
1050.0 F	1050.6°F	1.80°F	32.1	Pass	3.7e-001°F	3.85
100.0°E	00.0°E	1.00%	5.00	Data	0.0- 004°F	
Channel 102 Teat	99.9°F	1.80°F	5.33	Pass	2.3e-001°F	
	100 1%	1 00%	0.47	Deee	2.2° 0018E	
Channel 102 mart	100.1°F	1.00 F	3.17	Pass	2.3e-001 F	
	400.0%	4.00%	0.00	Deee	0.0- 004°F	
Channel 104 Teat	100.2 F	1.00 F	0.33	Pass	2.3e-001°F	
	100.2%	1 00%	14.0	Deee	2.2° 0018E	
Champel 105 Mart	100.3°F	1.80°F	14.8	Pass	2.3e-001°F	
	100 4°E	1 000	20.7	Deee	2.20 001°E	
Obannal 106 Toat	100.4°F	1.00 F	22.7	Pass	2.3e-001°F	
		1 00%	0F 7	Deee	2.2° 0018E	
Channel 107 Teat	100.5 F	1.00 F	25.7	Pass	2.3e-001°F	
		1 00%	26.2	Deee	2.2° 0018E	
Channel 109 Teat	100.5 F	1.00 F	20.2	Pass	2.3e-001°F	
	100 5°E	1 200 5	28.0	Dooo	2.30.001°E	
Channel 100 Test	100.5 F	1.00 F	20.9	Pass	2.3e-001 F	
100.0 °F	100 6°E	1 2005	20.7	Pacc	2.30.001°E	
Channel 110 Test	100.01	1.00 1	50.7	F 855	2.38-0011	
100.0 °F	100 6°E	1 80°E	32.4	Pacc	2.30.001°E	
Channel 111 Test	100.01	1.00 1	52.4	F 855	2.38-0011	
100.0 °F	100 6°E	1 80°E	247	Pacc	2.30.001°E	
Channel 112 Test	100.01	1.00 1	54.7	F 855	2.38-0011	
100.0 °F	100 7°E	1 80°E	26.6	Pacc	2.30.001°E	
Channel 113 Test	100.7	1.00 1	30.0	F 855	2.38-0011	
100.0 °F	100 6°E	1 80°E	26.1	Pacc	2 3e-001°E	
Channel 114 Test	100.01	1.00 1	50.1	1 855	2.00 001 1	
100.0 °F	100 6°E	1 80°E	35 1	Pass	2 3e-001°E	
Channel 115 Test	100.01	1.00 1	55.1	1 455	2.00 001 1	
100.0 °F	100 6°E	1 80°E	34.6	Pass	2 3e-001°E	
Channel 116 Test	100.01	1.00 1	04.0	1 455	2.00 001 1	
100.0 °F	100 6°E	1 80°E	32.2	Pass	2 3e-001°E	
Channel 117 Test	100.01	1.00 1	52.2	1 455	2.00 001 1	
100.0 °F	100 5°E	1 80°F	30.1	Pass	2 3e-001°F	
Channel 118 Test	100.01	1.00 1	00.1	1 465	2.00 001 1	
100.0 °F	100 6°E	1 80°F	31.8	Pass	2 3e-001°F	
Channel 119 Test	100.01	1.00 1	01.0	. 400	2.00 001 1	
100.0 °F	100 6°F	1 80°⋿	35.2	Pass	2.3e-001°F	
Channel 120 Test	100.01	1.00 1	00.2	1 400	2.00 001 1	
100.0 °F	100.6°F	1 80°F	33.0	Pass	2.3e-001°F	
	100.01	1.00 1	55.5	1 435	2.00 001 1	



#### **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 26 April 2017
SERIAL NUMBER:	4373	CAL DUE:	26 April 2018
ASSET NUMBER:	23897	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	45 %
CALIBRATED BY:	Jessica Irent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left with new coefficients.

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**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT023897					
Probe Calibration	Range = 20 to 200 Deg F	1				
	= -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	t Temp = 97.47653 Ohms					
20.4130 F	20.403F	0.2590F	3.86	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.94833 Ohms					
50.3650 F	50.376F	0.2590F	4.25	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.38767 Ohms					
80.3220 F	80.336F	0.2590F	5.41	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.80633 Ohms					
110.3400 F	110.336F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	t Temp = 123.19383 Ohms					
140.3640 F	140.329F	0.2590F	13.5	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.578 Ohms					
170.4160 F	170.446F	0.2590F	11.6	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.90583 Ohms					
200.4420 F	200.436F	0.2590F	2.32	Pass	3.4e-002F	
************Degre	es C***********					
Resistance Value a	t Temp = 97.47653 Ohms					
-6.4370 c	-6.443c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.94833 Ohms					
10.2030 c	10.209c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.38767 Ohms					
26.8460 c	26.853c	0.1440c	4.86	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.80633 Ohms					
43.5220 c	43.520c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.19383 Ohms					
60.2030 c	60.183c	0.1440c	13.9	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.578 Ohms					
76.8980 c	76.914c	0.1440c	11.1	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.90583 Ohms					
93.5790 c	93.576c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficien	ts:					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.98402 Alpha= 0.003835997 Delta= 1.38628573318 A= 0.00388917487914 B= -5.31778791363e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 April 2017
SERIAL NUMBER:	9383	CAL DUE:	13 April 2018
ASSET NUMBER:	23899	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	1 - 01/05/06 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	Bv:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	<u>Expanded Unc.</u>	<u>TUR</u>
Probe ID Number	= TT023899					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 t	o 593.3 Deg (	C			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.2415 Ohms					
125.1020 F	125.036F	0.5000F	13.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.5075 Ohms					
287.4470 F	287.572F	0.5000F	25	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.799 Ohms					
449.8780 F	449.872F	0.5000F	1.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.19317 Ohms					
612.3750 F	612.306F	0.5000F	13.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.68167 Ohms					
774.8490 F	774.844F	0.5000F	1	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.24433 Ohms					
937.3750 F	937.385F	0.5000F	2	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.87017 Ohms					
1099.8570 F	1099.868F	0.5000F	2.2	Pass	1.2e-001F	
************Degre	es C************					
Resistance Value a	t Temp = 120.2415 Ohms					
51.7230 c	51.687c	0.2780c	12.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.5075 Ohms					
141.9150 c	141.985c	0.2780c	25.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.799 Ohms					
232.1540 c	232.151c	0.2780c	1.08	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.19317 Ohms					
322.4300 c	322.392c	0.2780c	13.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.68167 Ohms					
412.6940 c	412.691c	0.2780c	1.08	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.24433 Ohms					
502.9860 c	502.991c	0.2780c	1.8	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.87017 Ohms					
593.2540 c	593.260c	0.2780c	2.16	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where T = Deg C an	d Rt = Resistance at Te	np				

 $T = [-RoA + Sqrt(Ro^{2}A^{2}-4Ro^{*}B(Ro-Rt))]/(2*Ro^{*}B)$ 

Ro= 100.21076 Alpha= 0.003839887

Delta= 1.47649419571

A= 0.00389658270868

B= -5.66957086768e-007



Coster Road Knoxville, IN 37934 866 588 2664

**REPORTOFCALIBRATION** 

McHalePerformance surr

UNIT UNDER TEST:	Input Card, 20 Channel, Type K	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER:	US37002262	CAL DUE:	16 May 2018
ASSET NUMBER:	23970	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Agilent 34901A TYPE K T/C (1 year) 1 - 01/30/14 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

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Calibrated By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10133	Agilent 34970A Data Logger	US37028610	5/4/2017	8/2/2017	
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
SELF TEST	0. Octobus		0	Dees		
	0.0status		0	Pass		
32 °F	30°E	1 0°⊏	2 92	Pacc	6.20.001°E	
150.0 °F	150 2°E	1.01	0.67	Pass	0.20-001 F	
1050.0 °F	1050.2 P	1.80°F	9.07	Pass	2.3e-001 F	3 85
1000.0 1	1030.2 1	1.00 1	10.2	1 835	5.76-0011	5.05
Channel 301 Test						
100.0 °F	99.0°F	1.80°F	56.7	Pass	2.3e-001°F	
Channel 302 Test						
100.0 °F	99.2°F	1.80°F	43.7	Pass	2.3e-001°F	
Channel 303 Test						
100.0 °F	99.4°F	1.80°F	31.4	Pass	2.3e-001°F	
Channel 304 Test						
100.0 °F	99.6°F	1.80°F	22.4	Pass	2.3e-001°F	
Channel 305 Test						
100.0 °F	99.9°F	1.80°F	7.67	Pass	2.3e-001°F	
Channel 306 Test						
100.0 °F	100.0°F	1.80°F	2.72	Pass	2.3e-001°F	
Channel 307 Test						
100.0 °F	100.2°F	1.80°F	9.22	Pass	2.3e-001°F	
Channel 308 Test						
100.0 °F	100.1°F	1.80°F	5.72	Pass	2.3e-001°F	
Channel 309 Test						
100.0 °F	100.2°F	1.80°F	10.2	Pass	2.3e-001°F	
Channel 310 Test				_	<b>.</b>	
100.0 °F	100.2°F	1.80°F	12.2	Pass	2.3e-001°F	
Channel 311 Test		4.0005	4.00	Data	0.0.00405	
100.0 °F	100.0°F	1.80°F	1.83	Pass	2.3e-001°F	
100 0 °F	100 0°E	1 000	1.00	Deee	2.20.001°E	
Channel 212 Teat	100.0°F	1.00 F	1.33	Pass	2.3e-001°F	
	00 0°E	1 2005	5 56	Dooo	2.30.001°E	
Channel 314 Test	55.5 T	1.00 1	5.50	Fd55	2.56-0011	
100.0 °F	99.8°F	1 80°E	11 9	Pass	2 3e-001°E	
Channel 315 Test	55.01	1.00 1	11.5	1 435	2.50 001 1	
100.0 °F	99.7°F	1 80°F	16.3	Pass	2 3e-001°F	
Channel 316 Test	00.1	1.00 1	10.0	1 400	2.00 001 1	
100.0 °F	99.6°F	1.80°F	22.4	Pass	2.3e-001°F	
Channel 317 Test						
100.0 °F	99.6°F	1.80°F	23.3	Pass	2.3e-001°F	
Channel 318 Test						
100.0 °F	99.6°F	1.80°F	23.7	Pass	2.3e-001°F	
Channel 319 Test						
100.0 °F	99.6°F	1.80°F	23.8	Pass	2.3e-001°F	
Channel 320 Test						
100.0 °F	99.6°F	1.80°F	23.9	Pass	2.3e-001°F	



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 17 April 2017
SERIAL NUMBER:	5627	CAL DUE:	17 April 2018
ASSET NUMBER:	23986	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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$\neg \neg$	Calibrated	l By:

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT023986					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.4555 Ohms					
125.1000 F	125.014F	0.5000F	17.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.76383 Ohms					
287.4490 F	287.581F	0.5000F	26.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 188.0955 Ohms					
449.8780 F	449.901F	0.5000F	4.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.526 Ohms					
612.3650 F	612.337F	0.5000F	5.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 252.02983 Ohms					
774.8320 F	774.764F	0.5000F	13.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.636 Ohms					
937.3620 F	937.339F	0.5000F	4.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 312.31383 Ohms					
1099.8560 F	1099.906F	0.5000F	10	Pass	1.2e-001F	
***********Degre	es C*********					
Resistance Value a	t Temp = 120.4555 Ohms					
51.7220 c	51.675c	0.2780c	16.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.76383 Ohms					
141.9160 c	141.990c	0.2780c	26.6	Pass	6.4e-002c	
Resistance Value a	t Temp = 188.0955 Ohms					
232.1540 c	232.167c	0.2780c	4.68	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.526 Ohms					
322.4250 c	322.409c	0.2780c	5.76	Pass	6.4e-002c	
Resistance Value a	t Temp = 252.02983 Ohms					
412.6850 c	412.647c	0.2780c	13.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.636 Ohms					
502.9790 c	502.966c	0.2780c	4.68	Pass	6.4e-002c	
Resistance Value a	t Temp = 312.31383 Ohms					
593.2540 c	593.281c	0.2780c	9.71	Pass	6.4e-002c	
	h					
AS LEIT COETTICIEN	lls:					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.40882 Alpha= 0.003836265 Delta= 1.47466389578 A= 0.0038928370149 B= -5.65720149015e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 April 2017
SERIAL NUMBER:	6434	CAL DUE:	14 April 2018
ASSET NUMBER:	24022	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018		
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
--------------------	-------------------------	-----------------	--------------------	-----------	---------------	------------
Probe ID Number	= TT024022					
Probe Calibration	Range = 125 to 1100 Deg	F				
	= 51.7 to	593.3 Deg C	2			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.3175 Ohms					
125.0950 F	125.168F	0.5000F	14.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.57083 Ohms					
287.4450 F	287.337F	0.5000F	21.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.97133 Ohms					
449.8770 F	449.849F	0.5000F	5.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 220.45317 Ohms					
612.3720 F	612.399F	0.5000F	5.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.994 Ohms					
774.8290 F	774.874F	0.5000F	9	Pass	1.2e-001F	
Resistance Value a	t Temp = 282.62267 Ohms					
937.3810 F	937.423F	0.5000F	8.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 312.29533 Ohms					
1099.8610 F	1099.809F	0.5000F	10.4	Pass	1.2e-001F	
***********Degre	es C***********					
Resistance Value a	t Temp = 120.3175 Ohms					
51.7200 c	51.760c	0.2780c	14.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.57083 Ohms					
141.9140 c	141.854c	0.2780c	21.6	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.97133 Ohms					
232.1540 c	232.138c	0.2780c	5.76	Pass	6.4e-002c	
Resistance Value a	t Temp = 220.45317 Ohms					
322.4290 c	322.444c	0.2780c	5.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.994 Ohms					
412.6830 c	412.708c	0.2780c	8.99	Pass	6.4e-002c	
Resistance Value a	t Temp = 282.62267 Ohms					
502.9890 c	503.013c	0.2780c	8.63	Pass	6.4e-002c	
Resistance Value a	t Temp = 312.29533 Ohms					
593.2560 c	593.227c	0.2780c	10.4	Pass	6.4e-002c	
As Left Coefficien	ts:					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.22137 Alpha= 0.003846631 Delta= 1.47373473852 A= 0.00390332013731 B= -5.66891373099e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



## REPORTOFCALIBRATION

McHalePerformance of

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 April 2017
SERIAL NUMBER:	6521	CAL DUE:	13 April 2018
ASSET NUMBER:	24272	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025	
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018	

Standard Reading	<b><u>UUT Reading</u></b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT024272					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	C			
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 120.33783 Ohms					
125.1020 F	124.969F	0.5000F	26.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 154.7915 Ohms					
287.4470 F	287.653F	0.5000F	41.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 188.19117 Ohms					
449.8780 F	449.910F	0.5000F	6.4	Pass	1.2e-001F	
Resistance Value a	at Temp = 220.663 Ohms					
612.3750 F	612.339F	0.5000F	7.2	Pass	1.2e-001F	
Resistance Value a	at Temp = 252.166 Ohms					
774.8490 F	774.744F	0.5000F	21	Pass	1.2e-001F	
Resistance Value a	at Temp = 282.73817 Ohms					
937.3750 F	937.327F	0.5000F	9.6	Pass	1.2e-001F	
Resistance Value a	at Temp = 312.34967 Ohms					
1099.8570 F	1099.940F	0.5000F	16.6	Pass	1.2e-001F	
************Degre	ees C************					
Resistance Value a	at Temp = 120.33783 Ohms					
51.7230 c	51.649c	0.2780c	26.6	Pass	6.4e-002c	
Resistance Value a	at Temp = 154.7915 Ohms					
141.9150 c	142.030c	0.2780c	41.4	Pass	6.4e-002c	
Resistance Value a	at Temp = 188.19117 Ohms					
232.1540 c	232.172c	0.2780c	6.47	Pass	6.4e-002c	
Resistance Value a	at Temp = 220.663 Ohms					
322.4300 c	322.411c	0.2780c	6.83	Pass	6.4e-002c	
Resistance Value a	at Temp = 252.166 Ohms					
412.6940 c	412.636c	0.2780c	20.9	Pass	6.4e-002c	
Resistance Value a	at Temp = 282.73817 Ohms					
502.9860 c	502.960c	0.2780c	9.35	Pass	6.4e-002c	
Resistance Value a	at Temp = 312.34967 Ohms					
593.2540 c	593.300c	0.2780c	16.5	Pass	6.4e-002c	
As Left Coefficier	nts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.21442 Alpha= 0.00385926 Delta= 1.53062248644 A= 0.00391833070137 B= -5.90707013703e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



## **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	70223 24360	CAL DUE: DATA TYPE:	11 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~350 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Calibrated By:** 

**Approved By:** 

Standards	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD24360					
Calibrated Span =	350 inH2O					
Calibration Tolera	nce = 0.2275 inH20					
Upscale Tests						
0.0000 inH2O	-0.002inH2O	0.2275inH2O	0.879	Pass	5.8e-003inH2O	
87.5000 inH2O	87.494inH2O	0.2275inH2O	2.64	Pass	7.0e-003inH2O	
175.0000 inH2O	175.000inH2O	0.2275inH2O	0	Pass	1.4e-002inH2O	
262.5000 inH2O	262.501inH2O	0.2275inH2O	0.44	Pass	2.1e-002inH2O	
350.0000 inH2O	349.996inH2O	0.2275inH2O	1.76	Pass	2.8e-002inH2O	
Downscale Tests						
350.0000 inH2O	350.003inH2O	0.2275inH2O	1.32	Pass	2.8e-002inH2O	
262.5000 inH2O	262.493inH2O	0.2275inH2O	3.08	Pass	2.1e-002inH2O	
175.0000 inH2O	174.992inH2O	0.2275inH2O	3.52	Pass	1.4e-002inH2O	
87.5000 inH2O	87.494inH2O	0.2275inH2O	2.64	Pass	7.0e-003inH2O	
0.0000 inH2O	-0.008inH2O	0.2275inH2O	3.52	Pass	5.8e-003inH2O	



## **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER:	70245	CAL DUE:	11 May 2018
ASSET NUMBER:	24363	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~350
	Knoxville, TN 37912	CAL UNITS:	In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards V	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD24363					
Calibrated Span =	350 inH2O					
Calibration Tolera	nce = 0.2275 inH20					
Upscale Tests						
0.0000 inH2O	-0.001inH2O	0.2275inH2O	0.44	Pass	5.8e-003inH2O	
87.5000 inH2O	87.510inH2O	0.2275inH2O	4.4	Pass	7.0e-003inH2O	
175.0000 inH2O	175.015inH2O	0.2275inH2O	6.59	Pass	1.4e-002inH2O	
262.5000 inH2O	262.510inH2O	0.2275inH2O	4.4	Pass	2.1e-002inH2O	
350.0000 inH2O	350.005inH2O	0.2275inH2O	2.2	Pass	2.8e-002inH2O	
Downscale Tests						
350.0000 inH2O	349.999inH2O	0.2275inH2O	0.44	Pass	2.8e-002inH2O	
262.5000 inH2O	262.493inH2O	0.2275inH2O	3.08	Pass	2.1e-002inH2O	
175.0000 inH2O	174.990inH2O	0.2275inH2O	4.4	Pass	1.4e-002inH2O	
87.5000 inH2O	87.491inH2O	0.2275inH2O	3.96	Pass	7.0e-003inH2O	
0.0000 inH2O	0.000inH2O	0.2275inH2O	0	Pass	5.8e-003inH2O	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 11 May 2017
SERIAL NUMBER: ASSET NUMBER:	70231 24365	CAL DUE: DATA TYPE:	11 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~350 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD24365					
Calibrated Span =	350 inH2O					
Calibration Tolera	nce = 0.2275 inH20					
Upscale Tests						
0.0000 inH2O	-0.003inH2O	0.2275inH2O	1.32	Pass	5.8e-003inH2O	
87.5000 inH2O	87.510inH2O	0.2275inH2O	4.4	Pass	7.0e-003inH2O	
175.0000 inH2O	175.021inH2O	0.2275inH2O	9.23	Pass	1.4e-002inH2O	
262.5000 inH2O	262.512inH2O	0.2275inH2O	5.27	Pass	2.1e-002inH2O	
350.0000 inH2O	350.002inH2O	0.2275inH2O	0.879	Pass	2.8e-002inH2O	
Downscale Tests						
350.0000 inH2O	349.995inH2O	0.2275inH2O	2.2	Pass	2.8e-002inH2O	
262.5000 inH2O	262.499inH2O	0.2275inH2O	0.44	Pass	2.1e-002inH2O	
175.0000 inH2O	174.982inH2O	0.2275inH2O	7.91	Pass	1.4e-002inH2O	
87.5000 inH2O	87.488inH2O	0.2275inH2O	5.27	Pass	7.0e-003inH2O	
0.0000 inH2O	-0.005inH2O	0.2275inH2O	2.2	Pass	5.8e-003inH2O	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER: ASSET NUMBER:	1449288 24563	CAL DUE: DATA TYPE:	16 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Cond	itions					
Temperature: 22C, H	Humidity: 45%Rh, Ban	cometric Pressure	e: 14.22PSIA			
Transmitter Calibra	ation Range= 3000 ps	sia				
Transmitter Accurac	cy= 1.95 psia					
********* AS FOUL	ND/AS LEFT *******	* * *				
Upscale Pressu	re Tests (DIGITAL) –					
14.2200 psi	14.258psi	1.9500psi	1.95	Pass	2.2e-003psi	
513.1850 psi	513.625psi	1.9500psi	22.6	Pass	7.7e-002psi	
1012.6680 psi	1013.094psi	1.9500psi	21.8	Pass	1.5e-001psi	
2011.6340 psi	2011.875psi	1.9500psi	12.4	Pass	3.0e-001psi	
3010.6000 psi	3010.500psi	1.9500psi	5.13	Pass	4.5e-001psi	
Downscale Press	sure Tests (DIGITAL)					
3010.6000 psi	3010.500psi	1.9500psi	5.13	Pass	4.5e-001psi	
2011.6340 psi	2012.313psi	1.9500psi	34.8	Pass	3.0e-001psi	
1012.6680 psi	1013.063psi	1.9500psi	20.3	Pass	1.5e-001psi	
513.1850 psi	513.641psi	1.9500psi	23.4	Pass	7.7e-002psi	
14.2200 psi	14.279psi	1.9500psi	3.03	Pass	2.2e-003psi	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER: ASSET NUMBER:	1996930 24574	CAL DUE: DATA TYPE:	12 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA24574					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	
200.0000 psi	200.113psi	0.5200psi	21.7	Pass	1.6e-002psi	
400.0000 psi	400.094psi	0.5200psi	18.1	Pass	3.2e-002psi	
600.0000 psi	600.078psi	0.5200psi	15	Pass	4.8e-002psi	
800.0000 psi	800.016psi	0.5200psi	3.08	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.016psi	0.5200psi	3.08	Pass	6.4e-002psi	
600.0000 psi	600.078psi	0.5200psi	15	Pass	4.8e-002psi	
400.0000 psi	400.070psi	0.5200psi	13.5	Pass	3.2e-002psi	
200.0000 psi	200.109psi	0.5200psi	21	Pass	1.6e-002psi	
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	



## **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 15 May 2017
SERIAL NUMBER: ASSET NUMBER:	1201630 24623	CAL DUE: DATA TYPE:	15 May 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Pressure Transmitter - PSIA/DW M2000 3 - 10/11/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 45 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~3000 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		
7214	Pressurements M2000/3 Hydraulic Dead Weight Tester	13715-1	5/24/2016	5/24/2018		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Environmental Condi	itions					
Temperature: 22C, H	Humidity: 45%Rh, Ba	cometric Pressure	e: 14.18PSIA			
Transmitter Calibra	ation Range= 3000 ps	sia				
Transmitter Accurac	cy= 1.95 psia					
***** AS FOUN	ND/AS LEFT *******	***				
Upscale Pressur	re Tests (DIGITAL) ·					
14.1800 psi	14.144psi	1.9500psi	1.85	Pass	2.2e-003psi	
513.1450 psi	513.259psi	1.9500psi	5.85	Pass	7.7e-002psi	
1012.6280 psi	1013.071psi	1.9500psi	22.7	Pass	1.5e-001psi	
2011.5950 psi	2012.008psi	1.9500psi	21.2	Pass	3.0e-001psi	
3010.5620 psi	3011.211psi	1.9500psi	33.3	Pass	4.5e-001psi	
Downscale Press	sure Tests (DIGITAL)					
3010.5620 psi	3011.110psi	1.9500psi	28.1	Pass	4.5e-001psi	
2011.5950 psi	2012.437psi	1.9500psi	43.2	Pass	3.0e-001psi	
1012.6280 psi	1013.252psi	1.9500psi	32	Pass	1.5e-001psi	
513.1450 psi	513.455psi	1.9500psi	15.9	Pass	7.7e-002psi	
14.1800 psi	14.144psi	1.9500psi	1.85	Pass	2.2e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 25 April 2017
SERIAL NUMBER: ASSET NUMBER:	1393320 24635	CAL DUE: DATA TYPE:	25 April 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

Elibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA24635					
Calibrated Span =	800 PSI					
Calibration Tolera	ance = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.006psi	0.5200psi	1.15	Pass	7.3e-003psi	
200.0000 psi	200.116psi	0.5200psi	22.3	Pass	1.6e-002psi	
400.0000 psi	400.124psi	0.5200psi	23.8	Pass	3.2e-002psi	
600.0000 psi	600.121psi	0.5200psi	23.3	Pass	4.8e-002psi	
800.0000 psi	800.109psi	0.5200psi	21	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.114psi	0.5200psi	21.9	Pass	6.4e-002psi	
600.0000 psi	600.113psi	0.5200psi	21.7	Pass	4.8e-002psi	
400.0000 psi	400.097psi	0.5200psi	18.7	Pass	3.2e-002psi	
200.0000 psi	200.116psi	0.5200psi	22.3	Pass	1.6e-002psi	
15.0000 psi	14.979psi	0.5200psi	4.04	Pass	7.3e-003psi	



oster Road - Knoxville, IN-37934 - aŭs 588 2054

**REPORTOFCALIBRATION** 

McHalePerformance surv

UNIT UNDER TEST:	Input Card, 20 Channel, Type K	TEST RESULT: CAL DATE:	PASS 16 May 2017
SERIAL NUMBER:	US37259960	CAL DUE:	16 May 2018
ASSET NUMBER:	24663	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Agilent 34901A TYPE K T/C (1 year) 1 - 01/30/14 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 45 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Operating within tolerance as found and as left.

NICO (

**Calibrated By:** 

**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10133	Agilent 34970A Data Logger	US37028610	5/4/2017	8/2/2017		
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/5/2016	10/5/2017		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
SELF TEST	0. Oototuo		0	Dava		
	0.0status		0	Pass		
32 °F	32°F	1 8°F	4 56	Pass	6.2e-001°F	
150.0 °F	150.1°F	1.80°F	2.78	Pass	2.3e-001°F	
1050.0 °F	1050.1°F	1.80°F	3.89	Pass	3.7e-001°F	3.85
Channel 201 Test						
100.0 °F	99.7°F	1.80°F	15.2	Pass	2.3e-001°F	
Channel 202 Test						
100.0 °F	99.8°F	1.80°F	10.6	Pass	2.3e-001°F	
Channel 203 Test						
100.0 °F	99.8°F	1.80°F	8.33	Pass	2.3e-001°F	
Channel 204 Test						
100.0 °F	99.9°F	1.80°F	4.17	Pass	2.3e-001°F	
Channel 205 Test						
100.0 °F	100.0°F	1.80°F	2.17	Pass	2.3e-001°F	
Channel 206 Test						
100.0 °F	100.1°F	1.80°F	5.56	Pass	2.3e-001°F	
Channel 207 Test						
100.0 °F	100.0°F	1.80°F	2.28	Pass	2.3e-001°F	
Channel 208 Test						
100.0 °F	100.0°F	1.80°F	1.72	Pass	2.3e-001°F	
Channel 209 Test						
100.0 °F	100.1°F	1.80°F	6.33	Pass	2.3e-001°F	
Channel 210 Test				_		
100.0 °F	100.1°F	1.80°F	4.44	Pass	2.3e-001°F	
Channel 211 Test				_	<b>-</b>	
100.0 °F	100.0°F	1.80°F	0.0556	Pass	2.3e-001°F	
Channel 212 Test		1.0005	0.47	-	0.0-004%	
	100.1°F	1.80°F	3.17	Pass	2.3e-001°F	
100.0°E		4.00%	0.550	Dava	0.04.004%	
Channel 214 Teat	100.0°F	1.80°F	0.556	Pass	2.3e-001°F	
	100.0°E	1 00°E	0.70	Dooo	2.20.001°E	
Channel 215 Test	100.0 F	1.00 F	2.70	F d 5 5	2.38-001 F	
100.0 °F	00 0°E	1 90°E	2.22	Pass	2.30.001°E	
Channel 216 Test	55.5 1	1.00 F	5.55	F 855	2.38-0011	
100.0 °F	00 0°F	1 80°E	3.83	Pass	2 30-001°F	
Channel 217 Test	00.01	1.00 1	0.00	1 435	2.00 001 1	
100.0 °F	99.9°F	1 80°F	6 28	Pass	2.3e-001°F	
Channel 218 Test			0.20		2.00 001 1	
100.0 °F	100.0°F	1,80°F	0.667	Pass	2.3e-001°F	
Channel 219 Test						
100.0 °F	100.1°F	1.80°F	4.44	Pass	2.3e-001°F	
Channel 220 Test						
100.0 °F	100.1°F	1.80°F	5.06	Pass	2.3e-001°F	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Power Meter, Digital	TEST RESULT: CAL DATE:	PASS 12 May 2017
SERIAL NUMBER: ASSET NUMBER:	00400006 25055	CAL DUE: DATA TYPE:	12 May 2018 FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Nexus 1250/1252/1500: CAL VER 60Hz 0 - 03/28/17 Grant Shropshire	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	N/A N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as found and as left.

Grant Shaphin

-Calibrated Bv:

**Approved By:** 

Standards Used							
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
14001	Fluke 5520A Multi-Function Calibrator	8635015	3/14/2017	3/14/2018			
14002	Rotek MSB100 Power and Energy Standard	173	2/25/2017	2/25/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AC VOLTAGE TESTS - 6	DUHZ					
Phase A -	400.00001/	0.000001/	07.5	Dava	4.0- 00014	0.04
100.000 V	100.0220V	0.08000	27.5	Pass	1.6e-002V	3.81
120.000 V	120.0220V	0.09600V	22.9	Pass	1.9e-002V	3.87
240.000 V	240.0280V	0.19200V	14.6	Pass	3.7e-002V	
Phase B -				_		
100.000 V	100.0420V	0.08000V	52.5	Pass	1.6e-002V	3.81
120.000 V	120.0460V	0.09600V	47.9	Pass	1.9e-002V	3.87
240.000 V	240.0300V	0.19200V	15.6	Pass	3.7e-002V	
Phase C -						
100.000 V	100.0230V	0.08000V	28.7	Pass	1.6e-002V	3.81
120.000 V	120.0280V	0.09600V	29.2	Pass	1.9e-002V	3.87
240.000 V	239.9850V	0.19200V	7.81	Pass	3.7e-002V	
AC CURRENT TESTS - 6	50Hz					
Phase A - 1A Range						
1.00030 A	1.0004A	0.00100A	10	Pass	2.6e-004A	3.89
Phase B - 1A Range						
1.00030 A	1.0006A	0.00100A	30	Pass	2.6e-004A	3.89
Phase C - 1A Range						
1.00030 A	1.0003A	0.00100A	0	Pass	2.6e-004A	3.89
Phase A - 2.5A Range	2					
2.50060 A	2.5008A	0.00200A	10	Pass	6.5e-004A	3.11
Phase B - 2.5A Range	2					
2.50060 A	2.5011A	0.00200A	25	Pass	6.5e-004A	3.11
Phase C - 2.5A Range	2					
2.50060 A	2.5011A	0.00200A	25	Pass	6.5e-004A	3.11
Phase A - 5A Range						
5.00180 A	5.0026A	0.00400A	20	Pass	1.3e-003A	3.11
Phase B - 5A Range						
5.00180 A	5.0025A	0.00400A	17.5	Pass	1.3e-003A	3.11
Phase C - 5A Range						
5.00190 A	5.0024A	0.00400A	12.5	Pass	1.3e-003A	3.11
AC WATT TESTS - 60Hz	z - PF 1.0					
Phase A - 1A Range						
120.03190 W	120.0549W	0.09600W	24	Pass	7.6e-003W	
Phase B - 1A Range						
120.03290 W	120.1089W	0.09600W	79.2	Pass	7.6e-003W	
Phase C - 1A Range						
120.03290 W	120.0730W	0.09600W	41.8	Pass	7.6e-003W	

Phase A - 2.5A Range

Date Printed: May 12, 2017

Test Results						
<u>Standard Reading</u> 300.07500 W	<u>UUT Reading</u> 300.1086W	<u>Test Tol</u> 0.24000W	<u>% Tol Error</u> 14	<u>PASS/FAIL</u> Pass	Expanded Unc. 3.5e-002W	<u>TUR</u>
Phase B - 2.5A Range 300.07590 W	300.2050W	0.24010W	53.8	Pass	3.5e-002W	
Phase C - 2.5A Range 300.07500 W	300.1456W	0.24000W	29.4	Pass	3.5e-002W	
Phase A - 5A Range 600.22260 W	600.3083W	0.48000W	17.9	Pass	1.4e-001W	
Phase B - 5A Range 600.22260 W	600.4502W	0.48000W	47.4	Pass	1.4e-001W	
Phase C - 5A Range 600.22190 W	600.3589W	0.48000W	28.5	Pass	1.4e-001W	
AC WATT TESTS - 60Hz	- PF 0.75 Lead/Lag	g				
Phase A - 0.75 Lag 450.32500 W	450.4598W	0.36000W	37.4	Pass	9.0e+002W	
Phase B - 0.75 Lag 450.32600 W	450.5408W	0.36000W	59.7	Pass	8.7e-003W	
Phase C - 0.75 Lag 450.32900 W	450.4090W	0.36000W	22.2	Pass	8.7e-003W	
Phase A - 0.75 Lead 450.10930 W	450.1018W	0.36000W	2.08	Pass	9.0e+002W	
Phase B - 0.75 Lead 450.11110 W	450.2727W	0.36000W	44.9	Pass	8.7e-003W	
Phase C - 0.75 Lead 450.10680 W	450.1933W	0.36000W	24	Pass	8.7e-003W	



## **REPORTOFCALIBRATION**

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UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 11 April 2017
SERIAL NUMBER:	N/A	CAL DUE:	11 April 2018
ASSET NUMBER:	SR317	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	30 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

Grant Shaphin

Calibrated By:

**Approved By:** 

Standards U	Jsed			
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14045	Rosemount Aerospace 162CE SPRT	4025	1/3/2017	1/3/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT0SR317					
Probe Calibration	Range = 125 to 1100 De	eg F				
	= 51.7	to 593.3 Deg (	С			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 120.02417 Ohm	IS				
125.1040 F	125.126F	0.5000F	4.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.10733 Ohm	IS				
287.6000 F	287.615F	0.5000F	3	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.27683 Ohm	IS				
450.0950 F	450.025F	0.5000F	14	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.57067 Ohm	IS				
612.5950 F	612.544F	0.5000F	10.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 250.98067 Ohm	IS				
775.0680 F	775.137F	0.5000F	13.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.4745 Ohms	;				
937.5450 F	937.636F	0.5000F	18.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.02233 Ohm	IS				
1099.9420 F	1099.867F	0.5000F	15	Pass	1.2e-001F	
***********Degre	es C************					
Resistance Value a	t Temp = 120.02417 Ohm	IS				
51.7240 c	51.737c	0.2780c	4.68	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.10733 Ohm	IS				
142.0000 c	142.009c	0.2780c	3.24	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.27683 Ohm	IS				
232.2750 c	232.236c	0.2780c	14	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.57067 Ohm	IS				
322.5530 c	322.524c	0.2780c	10.4	Pass	6.4e-002c	
Resistance Value a	t Temp = 250.98067 Ohm	IS				
412.8160 c	412.854c	0.2780c	13.7	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.4745 Ohms	;				
503.0800 c	503.131c	0.2780c	18.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.02233 Ohm	IS				
593.3010 c	593.259c	0.2780c	15.1	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.0856 Alpha= 0.003823984 Delta= 1.43922277424 A= 0.00387901964861 B= -5.50356486113e-007



McHalePerformance.com

UNIT UNDER TEST:	Agilent 34970A Data Logger	TEST RESULT: CAL DATE:	PASS 24 May 2016
SERIAL NUMBER:	US37030228	CAL DUE:	24 May 2017
ASSET NUMBER:	2018	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Agilent 34970A: RS-232/5520A (1 year) (Auto) 0 - 05/26/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	0.23 °C 40 %
	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale & Associates certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

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**REMARKS:** Instrument passed calibration as found and as left.

1	-	4	A
4	ssion	J	m.
$-\Theta$	 Calibrated 1	Bv:	,

**Approved By:** 

Standards Used							
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/1/2015	10/1/2016			

Test Results						
SELF TEST	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
0.00 status ZERO TESTS	0.0status		0	Pass		
100 mVDC Range						
0.0000 mV	-0.0025mV		62.6	Pass		
0.0000000 V 10 VDC Range	-0.000002V		28.7	Pass		
<b>0.00000 V</b> 100 VDC Range	-0.00000V		7.6	Pass		
<b>0.0000 V</b> 300 VDC Range	-0.0001V		10.5	Pass		
0.000 V 100 Ohm Range, 2-W:	-0.000V		0.444	Pass		
0.0000 Ohm 100 Ohm Range, 4-W:	-0.0002Ohm ire		0.0237	Pass		
0.0000 Ohm 1 kOhm Range, 2-Wi:	0.00000hm		0.625	Pass		
0.000000 kOhm 1 kOhm Range, 4-Wi:	0.000038kOhm		3.74	Pass		
0.000000 kOhm 10 kOhm Range, 2-W:	0.000000kOhm ire		3.8	Pass		
0.00000 kOhm	0.00002kOhm		1.82	Pass		
10 kOhm Range, 4-W	ire					
0.00000 kOhm 100 kOhm Range, 2-0	0.00000kOhm Nire		2.5	Pass		
0.0000 kOhm 100 kOhm Range, 4-0	-0.0002kOhm Wire		9.4	Pass		
0.0000 kOhm 1 MOhm Range, 2-Wi:	-0.0001kOhm re		5	Pass		
0.000000 MOhm 1 MOhm Range, 4-Wi:	0.000000MOhm re		4.55	Pass		
0.000000 MOhm 10 MOhm Range, 2-W:	-0.000000MOhm ire		2.5	Pass		
0.00000 MOhm	-0.00000MOhm		2.48	Pass		
10 MOhm Range, 4-W	ire					
0.00000 MOhm 100 MOhm Range, 2-0	0.00001MOhm Wire		5	Pass		
0.0000 MOhm 100 MOhm Range, 4-0	0.0000MOhm Nire		0	Pass		
0.0000 MOhm 10 mADC Range	0.0000MOhm		0	Pass		
<b>0.00000 mA</b> 100 mADC Range	-0.00005mA		2.31	Pass		
<b>0.00000 mA</b> 1 ADC Range	-0.00012mA		2.46	Pass		
0.000000 A DC VOLTAGE:	-0.000002A		1.75	Pass		
100mV Range						
50.0000 mV	49.9988mV	0.00000650V	18.3	Pass	1.6e-006V	3.25

Test Results						
Standard Reading 100.0000 mV	<u>UUT Reading</u> 99.9990mV	<u>Test Tol</u> 9.0000000001e-006	<u>% Tol Error</u> 10.8	<u>PASS/FAIL</u> Pass	Expanded Unc. 2.3e-006V	<u>TUR</u> 3.00
1V Range						
0.5000000 V	0.5000050V	0.00002700V	18.4	Pass	5.8e-006V	3.60
1.000000 V	1.000013V	0.0000470V	27	Pass	1.0e-005V	3.62
10V Range						
5.00000 V	5.00007V	0.000225V	31.6	Pass	6.2e-005V	2.81
10.00000 V	10.00015V	0.00040000000001V	36.5	Pass	1.1e-004V	2.86
100V Range						
50.0000 V	50.0006V	0.00285V	21.5	Pass	8.2e-004V	2.71
100.0000 V	100.0010V	0.00510V	19.4	Pass	1.5e-003V	2.62
300V Range						
150.0000 V	149.9975V	0.01575V	15.9	Pass	2.2e-003V	
300.0000 V AC VOLTAGE:	299.9983V	0.02250V	7.69	Pass	4.3e-003V	
100mV Range						
100.0000 mV @ 1 kHz	100.0076mV	0.00010000V	7.61	Pass	1.7e-005V	
100.0000 mV @ 50 kHz	100.0682mV	0.00017000V	40.1	Pass	3.3e-005V	3.95
1V Range						
1.000000 V @ 1 kHz	1.000058V	0.0010000V	5.82	Pass	1.6e-004V	
1.000000 V @ 50 kHz	1.000726V	0.0017000V	42.7	Pass	2.7e-004V	
10V Range						
10.00000 V @ 1 kHz	10.00021V	0.01000V	2.14	Pass	1.6e-003V	
10.00000 V @ 50 kHz	10.00381V	0.017000V	22.4	Pass	3.2e-003V	0.74
10.00000 V @ 10 Hz	9.998397	0.0100000	16.1	Pass	2.8e-003V	2.74
100V Range				_		
100.0000 V @ 1 kHz	100.0198V	0.10000V	19.8	Pass	1.6e-002V	
100.0000 V @ 50 kHz	100.0011V	0.17000V	0.653	Pass	2.8e-002V	
300V Range						
300.000 V @ 1 kHz	300.077V	0.4200V	18.4	Pass	4.6e-002V	
300.000 V @ 50 kHz 2-WIRE OHMS:	300.134V	0.7200V	18.6	Pass	7.4e-002V	
100 Ohm Range						
100.0000 Ohm	100.1226Ohm	1.01400Ohm	12.1	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	1.000138kOhm	1.1100Ohm	12.4	Pass	2.3e-002Ohm	
10 kOhm Range						
10.00000 kOhm	10.00024kOhm	2.100Ohm	11.5	Pass	2.3e-0010hm	
100 kOhm Range						
100.0000 kOhm	100.0024kOhm	12.00Ohm	20.2	Pass	2.3e+0000hm	4.00
1 MOhm Range						
1.000000 MOhm	1.000039MOhm	111.00hm	34.7	Pass	2.6e+0010hm	3.26

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10 MOhm Range						
10.00000 MOhm	10.00061MOhm	4100Ohm	14.8	Pass	1.0e+003Ohm	3.04
100 MOhm Range						
<b>100.0000 MOhm</b> 4-WIRE OHMS:	99.5444MOhm	8100000hm	56.2	Pass	4.1e+004Ohm	
100 Ohm Range						
100.0000 Ohm	100.00000hm	0.014000hm	0.179	Pass	3.3e-003Ohm	3.33
1 kOhm Range						
1.000000 kOhm	1.000014kOhm	0.1100Ohm	12.5	Pass	2.3e-002Ohm	3.67
10 kOhm Range						
10.00000 kOhm	10.00013kOhm	1.100Ohm	11.9	Pass	2.3e-0010hm	3.67
100 kOhm Range						
100.0000 kOhm FREOUENCY - Gain Ver	100.0026kOhm	11.00Ohm	23.4	Pass	2.3e+0000hm	3.67
- 100mV Range						
100.0000 Hz @ 10 mV	100.0089Hz	0.10000Hz	8.9	Pass	2.1e-004Hz	
1V Range						
100.0000 kHz @ 1 V DC CURRENT:	100.0001kHz	10.00Hz	1.4	Pass	2.0e-001Hz	
10mA Range						
10.00000 mA	10.00043mA	0.000007000A	6.09	Pass	9.7e-007A	
100mA Range						
100.0000 mA	100.0022mA	0.00005500A	3.95	Pass	9.7e-006A	
1A Range						
1.000000 A AC CURRENT:	0.999909A	0.0011000A	8.28	Pass	1.9e-004A	
10mA Range						
10.00000 mA @ 1 kHz	9.99954mA	0.000014000A	3.32	Pass	4.7e-006A	2.33
100mA Range						
100.0000 mA @ 1 kHz	100.0507mA	0.00060000A	8.45	Pass	4.7e-005A	
1A Range						
1.000000 A @ 1 kHz	1.000086A	0.0014000A	6.16	Pass	4.7e-004A	2.33



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Nexus 1500 Power Meter	TEST RESULT: CAL DATE:	PASS 10 February 2017
SERIAL NUMBER:	180266730	CAL DUE:	10 February 2018
ASSET NUMBER:	10387	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Nexus 1250: CAL VER 1 1 - 06/25/07 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Unit is operating within tolerance as found and as left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14001	Fluke 5520A Multi-Function Calibrator	8635015	2/24/2016	2/23/2017	
14002	Rotek MSB100 Power and Energy Standard	173	3/4/2016	3/4/2017	

Test Results	Test Results					
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
AC VOLTAGE TESTS - 6	UHZ					
100 000 V	00 00201/	0.000001/	10	Deee	1.60.002\/	2.04
120,000 V	99.99200	0.08000	10	Pass	1.6e-002V	3.81
120.000 V	119.9880V	0.09600V	12.5	Pass	1.9e-002V	3.87
240.000 V	239.9770V	0.19200V	12	Pass	3.7e-002V	
Phase B -				_		
100.000 V	99.9810V	0.08000V	23.8	Pass	1.6e-002V	3.81
120.000 V	119.9850V	0.09600V	15.6	Pass	1.9e-002V	3.87
240.000 V	239.9650V	0.19200V	18.2	Pass	3.7e-002V	
Phase C -						
100.000 V	99.9900V	0.08000V	12.5	Pass	1.6e-002V	3.81
120.000 V	119.9850V	0.09600V	15.6	Pass	1.9e-002V	3.87
240.000 V	239.9790V	0.19200V	10.9	Pass	3.7e-002V	
AC CURRENT TESTS - 6	OHz					
Phase A - 1A Range						
1.00020 A	1.0002A	0.00100A	0	Pass	2.6e-004A	3.89
Phase B - 1A Range						
1.00020 A	1.0001A	0.00100A	10	Pass	2.6e-004A	3.89
Phase C - 1A Range						
1.00020 A	1.0001A	0.00100A	10	Pass	2.6e-004A	3.89
Phase A - 2.5A Range						
2.50050 A	2.5004A	0.00200A	5	Pass	6.5e-004A	3.11
Phase B - 2.5A Range						
2.50050 A	2.5004A	0.00200A	5	Pass	6.5e-004A	3.11
Phase C - 2.5A Range						
2.50050 A	2.5004A	0.00200A	5	Pass	6.5e-004A	3.11
Phase A - 5A Range						
5.00130 A	5.0010A	0.00400A	7.5	Pass	1.3e-003A	3.11
Phase B - 5A Range						
5.00130 A	5.0009A	0.00400A	10	Pass	1.3e-003A	3.11
Phase C - 5A Range						
5.00130 A	5.0011A	0.00400A	5	Pass	1.3e-003A	3.11
AC WATT TESTS - 60Hz	- PF 1.0					
Phase A - 1A Range						
120.02500 W	120.0065W	0.09600W	19.3	Pass	7.6e-003W	
Phase B - 1A Range						
120.02510 W	120.0054W	0.09600W	20.5	Pass	7.6e-003W	
Phase C - 1A Range						
120.02490 W	119.9995W	0.09600W	26.5	Pass	7.6e-003W	

Phase A - 2.5A Range

Date Printed: February 10, 2017

Test Results	Test Results					
<u>Standard Reading</u> 300.05720 W	<u>UUT Reading</u> 300.0178W	<u>Test Tol</u> 0.24000W	<u>% Tol Error</u> 16.4	<u>PASS/FAIL</u> Pass	Expanded Unc. 3.5e-002W	<u>TUR</u>
Phase B - 2.5A Range 300.05940 W	300.0005W	0.24000W	24.5	Pass	3.5e-002W	
Phase C - 2.5A Range 300.06130 W	300.0107W	0.24000W	21.1	Pass	3.5e-002W	
Phase A - 5A Range 600.16840 W	600.0420W	0.48000W	26.3	Pass	1.4e-001W	
Phase B - 5A Range 600.17960 W	600.0800W	0.48000W	20.8	Pass	1.4e-001W	
Phase C - 5A Range 600.17700 W	600.0553W	0.48000W	25.4	Pass	1.4e-001W	
AC WATT TESTS - 60Hz	- PF 0.75 Lead/Lag	r				
Phase A - 0.75 Lag 450.25490 W	450.1898W	0.36000W	18.1	Pass	9.0e+002W	
Phase A - 0.75 Lead 450.08880 W	449.9913W	0.36000W	27.1	Pass	9.0e+002W	
Phase B - 0.75 Lag 450.22170 W	450.1490W	0.36000W	20.2	Pass	8.7e-003W	
Phase B - 0.75 Lead 450.11140 W	450.0308W	0.36000W	22.4	Pass	8.7e-003W	
Phase C - 0.75 Lag 450.21300 W	450.1389W	0.36000W	20.6	Pass	8.7e-003W	
Phase C - 0.75 Lead 450.16030 W	450.0790W	0.36000W	22.6	Pass	8.7e-003W	



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	5577	CAL DUE:	09 February 2018
ASSET NUMBER:	15047	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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Calibrated By:

**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	= 11013047 Bange = 20 to 200 Deg F					
11020 04112140101	= -6.7 to	93.3 Deg C				
AS FOUND/AS LEFT F	ESULTS					
Degrees F	= 07 70022  Obma					
20 4060 F	20 411E	0.25005	1.02	Deee	2 40 0025	
Pesistance Value a	20.411F	0.2590F	1.95	Pass	3.4e-002F	
50 3570 E	EO 251E	0.25005	2.22	Dooo	2 40 0025	
Bosistanco Value a	50.35  IF	0.2590F	2.32	F d 5 5	3.4 <del>0</del> -002F	
80 3200 F	80 307E	0.25005	5.02	Pass	3 40 002E	
Pesistance Value a	= 117 30267  Ohms	0.23901	5.02	F 855	3.46-0021	
110 3350 F	110 357E	0 2500E	8 /0	Pass	3 40-002E	
Resistance Value a	T = 123 7305  Obms	0.23301	0.45	1 835	3.46-0021	
140 3530 F	140 356F	0 2590F	1 16	Pass	3 4e-002F	
Resistance Value a	t Temp = 130,11867 Ohms	0.20001	1.10	1 465	0.10 0021	
170.3830 F	170 365F	0 2590F	6 95	Pass	3 4e-002F	
Resistance Value a	t Temp = 136.475 Ohms	0.2000.	0.00		0110 002	
200.4150 F	200.422F	0.2590F	2.7	Pass	3.4e-002F	
*****	es C**********					
Resistance Value a	t. Temp = 97,78033 Ohms					
-6.4410 c	-6.438c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 104.32033 Ohms	0111100	2.00			
10.1980 c	10.195c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.82233 Ohms					
26.8440 c	26.837c	0.1440c	4.86	Pass	1.9e-002c	
Resistance Value a	t Temp = 117.30267 Ohms					
43.5200 c	43.531c	0.1440c	7.64	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.7305 Ohms					
60.1960 c	60.198c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	t Temp = 130.11867 Ohms					
76.8790 c	76.870c	0.1440c	6.25	Pass	1.9e-002c	
Resistance Value a	t Temp = 136.475 Ohms					
93.5640 c	93.568c	0.1440c	2.78	Pass	1.9e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.31678 Alpha= 0.003847372 Delta= 1.94647903101 A= 0.00392226028923 B= -7.48882892251e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	2261	CAL DUE:	09 February 2018
ASSET NUMBER:	16055	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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	Calibrated	By:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT016055					
Probe Calibration	Range = 20 to 200 Deg F					
	= -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT H	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.61817 Ohms					
20.4060 F	20.413F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	at Temp = 104.13283 Ohms					
50.3570 F	50.350F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.617 Ohms					
80.3200 F	80.318F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value a	at Temp = 117.073 Ohms					
110.3350 F	110.329F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.4935 Ohms					
140.3530 F	140.350F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.88483 Ohms					
170.3830 F	170.409F	0.2590F	10	Pass	3.4e-002F	
Resistance Value a	at Temp = 136.224 Ohms					
200.4150 F	200.400F	0.2590F	5.79	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = 97.61817 Ohms					
-6.4410 c	-6.437c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 104.13283 Ohms					
10.1980 c	10.194c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.617 Ohms					
26.8440 c	26.843c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 117.073 Ohms					
43.5200 c	43.516c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.4935 Ohms					
60.1960 c	60.194c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.88483 Ohms					
76.8790 c	76.894c	0.1440c	10.4	Pass	1.9e-002c	
Resistance Value a	at Temp = 136.224 Ohms					
93.5640 c	93.556c	0.1440c	5.56	Pass	1.9e-002c	
De Teft Coefficie						

As Left Coefficients: Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.14408 Alpha= 0.003846639 Delta= 1.74977530987 A= 0.00391394653948 B= -6.73075394819e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	2508	CAL DUE:	09 February 2018
ASSET NUMBER:	20128	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
--------------------	---------------------------	-----------------	--------------------	-----------	---------------	------------
Probe ID Number	= TT020128					
Probe Calibration	Range = $20$ to $200$ Deg	F				
	= -6.7	to 93.3 Deg C				
AS FOUND/AS LEFT F	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.32567 Ohms					
20.4060 F	20.407F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.83383 Ohm	s				
50.3570 F	50.360F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.3035 Ohms					
80.3200 F	80.314F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.748 Ohms					
110.3350 F	110.330F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	t Temp = 123.15517 Ohm	S				
140.3530 F	140.353F	0.2590F	0	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.5285 Ohms					
170.3830 F	170.399F	0.2590F	6.18	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.85483 Ohm	s				
200.4150 F	200.406F	0.2590F	3.47	Pass	3.4e-002F	
************Degre	es C***********					
Resistance Value a	t Temp = 97.32567 Ohms					
-6.4410 c	-6.440c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.83383 Ohm	S				
10.1980 c	10.200c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.3035 Ohms					
26.8440 c	26.841c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.748 Ohms					
43.5200 c	43.517c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.15517 Ohm	S				
60.1960 c	60.196c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.5285 Ohms					
76.8790 c	76.888c	0.1440c	6.25	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.85483 Ohm	S				
93.5640 c	93.559c	0.1440c	3.47	Pass	1.9e-002c	
De Teft Confficie	<b>F</b>					
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Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.84909 Alpha= 0.003849784 Delta= 1.81202991077 A= 0.00391954323758 B= -6.97592375799e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	4050	CAL DUE:	09 February 2018
ASSET NUMBER:	20148	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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Calibrated By:

**Approved By:** 

Standards Used							
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT020148					
Probe Calibration	Range = 20 to 200 Deg	F				
	= -6.7	to 93.3 Deg C				
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.27517 Ohms					
20.4060 F	20.407F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.74833 Ohm	s				
50.3570 F	50.350F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.19533 Ohm	s				
80.3200 F	80.329F	0.2590F	3.47	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.6145 Ohms					
110.3350 F	110.336F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	t Temp = 123.00117 Ohm	S				
140.3530 F	140.352F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.3555 Ohms					
170.3830 F	170.375F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.68 Ohms					
200.4150 F	200.420F	0.2590F	1.93	Pass	3.4e-002F	
************Degre	es C************					
Resistance Value a	t Temp = 97.27517 Ohms					
-6.4410 c	-6.440c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.74833 Ohm	s				
10.1980 c	10.194c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.19533 Ohm	S				
26.8440 c	26.849c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.6145 Ohms					
43.5200 c	43.520c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.00117 Ohm	S				
60.1960 c	60.195c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.3555 Ohms					
76.8790 c	76.875c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.68 Ohms					
93.5640 c	93.566c	0.1440c	1.39	Pass	1.9e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.78539 Alpha= 0.003840568 Delta= 1.60016089415 A= 0.00390202326725 B= -6.14552672491e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Data Logger	TEST RESULT: CAL DATE:	PASS 20 May 2016
SERIAL NUMBER:	MY44058010	CAL DUE:	20 May 2017
ASSET NUMBER:	20365	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Agilent 34970A: RS-232/5520A (1 year) (Auto) 0 - 05/26/04 Jessica Trent	TEMPERATURE: HUMIDITY:	23.00 °C 40 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	N/A
	Knoxville, TN 37912	CAL UNITS:	N/A

McHale & Associates certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as found and as left.

Jussia	JmA	1
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Calibrated By:

**Approved By:** 

Standards Used							
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
14023	Fluke 5520A Multi-Function Calibrator	7825010	10/1/2015	10/1/2016			

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
0.00 status ZERO TESTS	0.0status		0	Pass		
100 mVDC Range						
<b>0.0000 mV</b> 1 VDC Range	-0.0004mV		10	Pass		
<b>0.000000 V</b> 10 VDC Range	-0.00000V		1.86	Pass		
0.00000 V 100 VDC Range	V00000V		2.6	Pass		
0.0000 V 300 VDC Range	0.0000V		4.5	Pass		
0.000 V 100 Ohm Range, 2-Wi	0.000V		1.44	Pass		
0.0000 Ohm 100 Ohm Range, 4-Wi	-0.0003Ohm		0.0253	Pass		
0.0000 Ohm 1 kOhm Range, 2-Wir	-0.0002Ohm		5.02	Pass		
0.000000 kOhm 1 kOhm Range, 4-Wir	-0.000024kOhm		2.4	Pass		
0.000000 kOhm 10 kOhm Bange, 2-Wi	0.000000kOhm		1.3	Pass		
0.00000 kOhm	-0.00003kOhm		2.44	Pass		
10 kOhm Range, 4-Wi	re					
0.00000 kOhm 100 kOhm Range, 2-W	0.00000kOhm		2.7	Pass		
0.0000 kOhm 100 kOhm Range, 4-W	-0.0000kOhm Vire		2	Pass		
0.0000 kOhm 1 MOhm Range, 2-Wir	0.0000kOhm		2.7	Pass		
0.000000 MOhm 1 MOhm Range, 4-Wir	-0.000000MOhm		2.45	Pass		
0.000000 MOhm 10 MOhm Range, 2-Wi	-0.000000MOhm		2.7	Pass		
0.00000 MOhm	-0.00000MOhm		2.67	Pass		
10 MOhm Range, 4-Wi	re					
0.00000 MOhm 100 MOhm Range, 2-W	0.00001MOhm Jire		5.3	Pass		
0.0000 MOhm 100 MOhm Range, 4-W	0.0000MOhm Jire		0	Pass		
0.0000 MOhm 10 mADC Range	0.0000MOhm		0	Pass		
<b>0.00000 mA</b> 100 mADC Range	0.00001mA		0.405	Pass		
<b>0.00000 mA</b> 1 ADC Range	0.00000mA		0	Pass		
0.000000 A DC VOLTAGE:	-0.000000A		0.13	Pass		
100mV Range						
50.0000 mV	49.9981mV	0.0000650V	29.3	Pass	1.6e-006V	3.25

Test Results						
Standard Reading 100.0000 mV	<u>UUT Reading</u> 99.9957mV	<u>Test Tol</u> 0.00000900∨	<u>% Tol Error</u> 48.3	<u>PASS/FAIL</u> Pass	Expanded Unc. 2.3e-006V	<u>TUR</u> 3.00
1V Range						
0.5000000 V	0.4999986V	0.00002700V	5.07	Pass	5.8e-006V	3.60
1.000000 V	0.999998V	0.0000470V	4.32	Pass	1.0e-005V	3.62
10V Range						
5.00000 V	5.00002V	0.000225V	10.3	Pass	6.2e-005V	2.81
10.00000 V	10.00005V	0.00040000000001V	12.3	Pass	1.1e-004V	2.86
100V Range						
50.0000 V	50.0004V	0.00285V	14	Pass	8.2e-004V	2.71
100.0000 V	100.0006V	0.00510V	12.2	Pass	1.5e-003V	2.62
300V Range						
150.0000 V	149.9994V	0.01575V	3.68	Pass	2.2e-003V	
300.0000 V	299.9997V	0.02250V	1.38	Pass	4.3e-003V	
AC VOLTAGE:						
100 0000 mV @ 1 kHz	100.0028mV	0.00010000V	2.83	Pass	1.7e-005V	
100.0000 mV @ 50 kHz	100.0371mV	0.00017000V	21.8	Pass	3.3e-005V	3.95
1V Range						
1.000000 V @ 1 kHz	0.999976V	0.0010000V	2.41	Pass	1.6e-004V	
1.000000 V @ 50 kHz	1.000035V	0.0017000V	2.06	Pass	2.7e-004V	
10V Range						
10.00000 V @ 1 kHz	9.99920V	0.010000V	8.03	Pass	1.6e-003V	
10.00000 V @ 50 kHz	10.00165V	0.017000V	9.69	Pass	3.2e-003V	
10.00000 V @ 10 Hz	9.99808V	0.010000V	19.2	Pass	2.8e-003V	2.74
100V Range						
100.0000 V @ 1 kHz	99.9998V	0.10000V	0.159	Pass	1.6e-002V	
100.0000 V @ 50 kHz	99.9754V	0.17000V	14.5	Pass	2.8e-002V	
300V Range						
300.000 V @ 1 kHz	299.982V	0.4200V	4.4	Pass	4.6e-002V	
<b>300.000 V @ 50 kHz</b> 2-WIRE OHMS:	299.934V	0.7200V	9.22	Pass	7.4e-002V	
100 Ohm Range						
100.0000 Ohm	100.1344Ohm	1.014000hm	13.3	Pass	3.3e-003Ohm	
1 kOhm Range						
1.000000 kOhm	1.000129kOhm	1.1100Ohm	11.6	Pass	2.3e-002Ohm	
10 kOhm Range						
10.00000 kOhm	10.00002kOhm	2.100Ohm	1.05	Pass	2.3e-001Ohm	
100 kOhm Range						
100.0000 kOhm	99.9996kOhm	12.00Ohm	3.45	Pass	2.3e+0000hm	4.00
1 MOhm Range						
1.000000 MOhm	1.000010MOhm	111.00hm	9.01	Pass	2.6e+0010hm	3.26

Sundard Reading         UU Reading         Test Tol         % Tol Error         PASS/FAIL         Expanded Lmc         TUR           10 MOhn Range 100.0000 MOhm         10.00012MOhm         41000hm         2.98         Pass         1.0e-0030hm         3.04           100 HOhm Range 100.0000 MOhm         99.9952MOhm         8100000hm         12.9         Pass         4.1e+0040hm         3.33           100 Hohm Range 100.0000 Ohm         99.99620hm         0.014000hm         27.1         Pass         3.3e-0030hm         3.33           1 kohm Range 1.000000 kohm         0.999992kOhm         0.11000hm         7.38         Pass         2.3e-0020hm         3.67           100 kohm Range 1.000000 kohm         99.9995kOhm         1.1000hm         8.16         Pass         2.3e-0020hm         3.67           100 kohm Range 1.000000 khm         99.9995kOhm         1.1000hm         8.16         Pass         2.3e-0010hm         3.67           100 kohm Range 1.000000 khm         99.9995kOhm         1.000hr         57.3         Pass         2.3e-0010hm         3.67           100 kohm Range 1.000000 mA         10.00012         0.000000ha         2.41         Pass         9.7e-004H         3.67           100 0000 kr ga 1v kr ga 1v         10.00002kHz         1.0000hz <t< th=""><th>Test Results</th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Test Results						
10 Nohm Kange       10.00012MOhm       41000hm       2.98       Pass       1.0e+0030hm       3.04         100 Mohm Range       99.9952MOhm       8100000hm       12.9       Pass       4.1e+0040hm       3.03         100 Mohm Range       99.9952MOhm       8100000hm       27.1       Pass       4.1e+0040hm       3.33         100 Mohm Range       99.9952M0hm       0.014000hm       27.1       Pass       3.3e-0030hm       3.33         1 kohm Range       0.999992K0hm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 kohm Range       0.999992K0hm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 kohm Range       10.0000khm       9.99995K0hm       1.1000hm       8.16       Pass       2.3e-0020hm       3.67         100 kohm Range       100.0000 khm       9.9995K0hm       1.000hm       4.37       Pass       2.3e-0000hm       3.67         100 kohm Range       100.0000 khm       100.00737Hz       0.1000Hz       57.3       Pass       2.1e-004Hz       3.67         100 Kohm Sange       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz       2.0e-001Hz       2.0e-001Hz       2.0e-001Hz       2.0e-001Hz       2	Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
10.00000 MOhm       10.0012MOhm       41000hm       2.98       Pass       1.0e+0030hm       3.04         100       Mohm       99.9952MOhm       8100000hm       12.9       Pass       4.1e+0040hm       3.03         100.0000 Ohm       99.99520hm       0.014000hm       27.1       Pass       3.3e-0030hm       3.33         1 k0hm Range       1.000000 k0hm       0.999992k0hm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 k0hm Range       0.999992k0hm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 k0hm Range       0.999992k0hm       1.1000hm       8.16       Pass       2.3e-0010hm       3.67         10 k0hm Range       10.0000 k0hm       9.99995k0hm       11.000hm       8.16       Pass       2.3e-0010hm       3.67         100 k0hm Range       100.0000 k0hm       9.99995k0hm       11.000hm       4.37       Pass       2.3e-0010hm       3.67         100 k0hm Range       100.0000 k1z @ 10 mV       100.00573Hz       0.1000Hz       57.3       Pass       2.1e-004Hz         100 k0hm Range       100.0000 k1z @ 10 mV       100.0002 k1z       10.001Hz       2.3       Pass       9.7e-006A       10mA Range       100.0000 mA	10 MOhm Range						
100.0000 MOhm kange         99.8952MOhm         8100000hm         12.9         Pass         4.1e+0040hm           44TER ORMS:         100.0000 Ohm         99.99620hm         0.014000hm         27.1         Pass         3.3e-0030hm         3.33           1 k0hm Range         1.000000 k0hm         0.999992k0hm         0.11000hm         7.38         Pass         2.3e-0020hm         3.67           10 k0hm Range         0.999992k0hm         0.11000hm         7.38         Pass         2.3e-0010hm         3.67           10 k0hm Range         0.999991k0hm         1.1000hm         8.16         Pass         2.3e-0010hm         3.67           100 k0hm Range         0.999991k0hm         1.1000hm         8.16         Pass         2.3e-0010hm         3.67           100 k0hm Range         0.999991k0hm         1.1000hm         4.37         Pass         2.3e-0000hm         3.67           100 k0hm Range         10.000573Hz         0.10000Hz         57.3         Pass         2.1e-004Hz           100 0000 Hz@ 10 mV         100.002kHz         10.00Hz         2.3         Pass         2.1e-004Hz           100 0000 mA         10.00016mA         0.000007000A         2.24         Pass         9.7e-006A           100.0000 mA         10.000	10.00000 MOhm	10.00012MOhm	4100Ohm	2.98	Pass	1.0e+003Ohm	3.04
100.0000 MQhm         99.8952M0hm         8100000hm         12.9         Pass         4.1e+0040hm           4-WIRE OBMS:         100 0hm Range         99.99620hm         0.014000hm         27.1         Pass         3.3e-0030hm         3.33           1 kohm Range         1.000000 kOhm         99.9992kOhm         0.11000hm         7.38         Pass         2.3e-0020hm         3.67           10 kohm Range         1.000000 kOhm         9.99991kOhm         1.1000hm         7.38         Pass         2.3e-0010hm         3.67           10 kohm Range         1.000000 kOhm         9.99991kOhm         1.1000hm         8.16         Pass         2.3e-0010hm         3.67           100 kohm Range         100.0000 kOhm         99.9995kOhm         1.1000hm         4.37         Pass         2.3e-0010hm         3.67           100 kohm Range         100.0000 kIz         0.10000Hz         0.10000Hz         Pass         2.3e+0000hm         3.67           100 kohm Range         100.0002 kHz         0.10000Hz         57.3         Pass         2.1e-004Hz           100.0000 kHz @ 1 v         100.0002 kHz         10.00Hz         2.3         Pass         9.7e-007A           100.0000 mA         10.00016mA         0.00000000A         2.61         Pass	100 MOhm Range						
100 Ohm Range       0.01400Ohm       27.1       Pass       3.3e-003Ohm       3.33         1 kOhm Range       0.999992kOhm       0.1100Ohm       7.38       Pass       2.3e-002Ohm       3.67         1 kOhm Range       0.999992kOhm       0.1100Ohm       7.38       Pass       2.3e-002Ohm       3.67         10 kOhm Range       9.99991kOhm       1.100Ohm       8.16       Pass       2.3e-001Ohm       3.67         100 kOhm Range       10.00000 kHm       9.99991kOhm       1.100Ohm       8.16       Pass       2.3e-001Ohm       3.67         100 kOhm Range       10.00000 kHm       9.99995kOhm       1.000Hm       4.37       Pass       2.3e+000Ohm       3.67         100 kOhm Range       10.0000 kHz       0.10000Hz       57.3       Pass       2.1e-004Hz       3.67         100 kObm Range       10.0002kHz       10.00Hz       2.3       Pass       2.1e-004Hz       3.67         11V Range       10.00000 kHz @ 1 v       100.0002kHz       10.00Hz       2.3       Pass       2.1e-004Hz       3.67         100mA Range       10.0000 kA       0.00005500A       2.61       Pass       9.7e-007A       3.67         10A Range       10.00000 mA @ 1999986mA       0.00011000A       19.6 <td><b>100.0000 MOhm</b> 4-WIRE OHMS:</td> <td>99.8952MOhm</td> <td>8100000hm</td> <td>12.9</td> <td>Pass</td> <td>4.1e+004Ohm</td> <td></td>	<b>100.0000 MOhm</b> 4-WIRE OHMS:	99.8952MOhm	8100000hm	12.9	Pass	4.1e+004Ohm	
100.0000 0hm       99.99620hm       0.014000hm       27.1       Pass       3.3e-0030hm       3.33         1 kohm Range       1.000000 kOhm       0.999992kOhm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 kohm Range       1.0000hm       9.99991kOhm       1.1000hm       8.16       Pass       2.3e-0010hm       3.67         10 kohm Range       100.0000 kOhm       99.9995kOhm       11.000hm       8.16       Pass       2.3e-0010hm       3.67         100 kohm Range       100.0000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e-0010hm       3.67         100 kohm Range       100.0002kHz       0.10000Hz       57.3       Pass       2.3e+0000hm       3.67         100 kohm Range       100.0002kHz       0.1000Hz       57.3       Pass       2.1e-004Hz       3.67         100 kohm Range       100.0002kHz       10.00Hz       2.3       Pass       2.9e-001Hz       3.67         100 kohm Range       100.0002kHz       10.00016mA       0.0000500A       2.24       Pass       9.7e-007A       3.67         100 kohm Range       10.00000 A       0.00005500A       2.61       Pass       1.9e-004A       2.33       3.67       3.67	100 Ohm Range						
1 kohm Range         0.999992kOhm         0.11000hm         7.38         Pass         2.3e-002Ohm         3.67           10 kohm Range         10.00000 kOhm         9.99991kOhm         1.100Ohm         8.16         Pass         2.3e-001Ohm         3.67           100 kohm Range         100.0000 kOhm         9.99995kOhm         11.00Ohm         8.16         Pass         2.3e-001Ohm         3.67           100 kohm Range         100.0000 kOhm         99.9995kOhm         11.00Ohm         4.37         Pass         2.3e+000Ohm         3.67           78EQUENCY - Gain Verification         10.000Hz         57.3         Pass         2.3e+000Ohm         3.67           100.0000 Hz @ 10 mV         100.0573Hz         0.1000Hz         57.3         Pass         2.1e-004Hz           100.0000 Hz @ 10 mV         100.002kHz         10.00Hz         2.3         Pass         2.0e-001Hz           DC CURRENT:         100.0002kHz         10.00016mA         0.000007000A         2.24         Pass         9.7e-006A           100.0000 mA         10.00016mA         0.00005500A         2.61         Pass         1.9e-004A           10.00000 A         0.999784A         0.0011000A         19.6         Pass         1.9e-005A           10.00000 mA @ 1 kHz <td>100.0000 Ohm</td> <td>99.9962Ohm</td> <td>0.01400Ohm</td> <td>27.1</td> <td>Pass</td> <td>3.3e-003Ohm</td> <td>3.33</td>	100.0000 Ohm	99.9962Ohm	0.01400Ohm	27.1	Pass	3.3e-003Ohm	3.33
1.00000 kOhm       0.999992kOhm       0.11000hm       7.38       Pass       2.3e-0020hm       3.67         10 kOhm Range       10.0000 kOhm       9.99991kOhm       1.1000hm       8.16       Pass       2.3e-0010hm       3.67         100 kOhm Range       100.0000 kOhm       9.9995kOhm       11.000hm       8.16       Pass       2.3e-0010hm       3.67         100 kOhm Range       100.0000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e+0000hm       3.67         100.0000 kZ @ 10 mV       100.0573Hz       0.10000Hz       57.3       Pass       2.1e-004Hz       3.67         100.0000 kHz @ 10 mV       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz       2.0e-001H	1 kOhm Range						
10 k0hm Range       1.0000 kOhm       9.99991kOhm       1.1000hm       8.16       Pass       2.3e-0010hm       3.67         100 k0hm Range       100.0000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e+0000hm       3.67         100 k00m Kange       100.0000 Hz @ 10 mV       100.0573Hz       0.10000Hz       57.3       Pass       2.1e+004Hz         1V Range       100.0000 Hz @ 10 mV       100.0002 Hz       10.00Hz       2.3       Pass       2.0e+001Hz         1V Range       100.0000 Mz @ 1 V       100.0002 Hz       10.00Hz       2.3       Pass       9.7e+007A         100 CURRENT:       100.0000 mA       0.00016mA       0.00005500A       2.61       Pass       9.7e+006A         100 MA Range       100.0000 mA       99.9986mA       0.0011000A       19.6       Pass       9.7e+006A         100 MA Range       100.0000 mA       9.999784A       0.0011000A       19.6       Pass       1.9e+004A         AC CURRENT:       10.00000 mA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e+006A       2.33         100mA Range       10.00000 mA @ 1 kHz       9.99967mA       0.00060000A       0.551       Pass       4.7e+005A       2.33	1.000000 kOhm	0.999992kOhm	0.1100Ohm	7.38	Pass	2.3e-002Ohm	3.67
10.0000 kOhm       9.99991kOhm       1.1000hm       8.16       Pass       2.3e-0010hm       3.67         100 kohm Range       100.0000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e+0000hm       3.67         100.0000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e+0000hm       3.67         100.0000 kJ@ 10 mV       100.0573Hz       0.10000Hz       57.3       Pass       2.1e-004Hz         1V Range       100.0000 kHz@ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         100 CURENT:       100.0000 mA       10.00016mA       0.000007000A       2.24       Pass       9.7e-007A         100mA Range       100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         10.00000 A       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURENT:       10.00000 A       0.999784A       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 M@ 1 kHz       9.9996mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.996mA       0.00060000A <td>10 kOhm Range</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	10 kOhm Range						
100 k0hm Range         99.9995K0hm         11.000hm         4.37         Pass         2.3e+0000hm         3.67           FREQUENCY - Gain Verification         100/V Range         100.0000 Hz @ 10 mV         100.0573Hz         0.10000Hz         57.3         Pass         2.1e-004Hz         1V           1V Range         100.0000 kHz @ 1 V         100.002kHz         10.00Hz         57.3         Pass         2.1e-004Hz         1V           1V Range         100.0000 kHz @ 1 V         100.0002kHz         10.00Hz         2.3         Pass         2.0e-001Hz         10.001Hz         10.0000 kHz @ 1 V         10.0000 kHz         10.0000 kHz         10.0000 kHz         10.0000 kHz         10.0000 kHz         10.001Hz         2.3         Pass         2.0e-001Hz         10.0000 kHz         10.00000 kHz         10.00000 kHz         10.00000 kHz         10.00000 kHz         10.00000 kHz         10.0000 kHz         10.00000 kHz	10.00000 kOhm	9.99991kOhm	1.100Ohm	8.16	Pass	2.3e-0010hm	3.67
100.000 kOhm       99.9995kOhm       11.000hm       4.37       Pass       2.3e+0000hm       3.67         PFREQUENCY - Gain Verification       100.0000 Hz @ 10 mV       100.0573Hz       0.10000Hz       57.3       Pass       2.1e-004Hz         1V Range       100.0000 kHz @ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         1V Range       10.0000 kHz @ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         100 mA Range       10.00016mA       0.000007000A       2.24       Pass       9.7e-007A         100mA Range       10.00000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range       10.00000 mA       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       100mA Range       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.0014000A       14.5       Pass       4.7e-005A         10A Range       1.000000 A @ 1 kHz       1.000202A       0.0014000A <t< td=""><td>100 kOhm Range</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	100 kOhm Range						
100mV Range         100.0000 Hz @ 10 mV       100.0573Hz       0.1000Hz       57.3       Pass       2.1e-004Hz         1V Range       100.0000 kHz @ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         100.0000 mA       100.0016mA       0.000007000A       2.24       Pass       9.7e-007A         100mA Range       10.0000 mA       10.00016mA       0.00005500A       2.61       Pass       9.7e-006A         100.0000 mA       99.9986mA       0.0011000A       19.6       Pass       9.7e-006A         1A Range       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         10.00000 mA @ 1 kHz       9.99943mA       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         100mA Range       1.000000 A @ 1 kHz       1.000202A       0.0014000A       14.5       Pass       4.7e-005A       2.33	100.0000 kOhm FREQUENCY - Gain Ver	99.9995kOhm rification	11.00Ohm	4.37	Pass	2.3e+000Ohm	3.67
100.000 Hz @ 10 mV       100.0573Hz       0.1000Hz       57.3       Pass       2.1e-004Hz         1V Range 100.0000 kHz @ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         DC CURRENT:       100mA Range 10.0000 mA       10.00016mA       0.00007000A       2.24       Pass       9.7e-007A         100mA Range 100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range 100.0000 A C CURRENT:       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         10 A Range 10.00000 MA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range 100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         100mA Range 100.0000 mA @ 1 kHz       1.000202A       0.0014000A       14.5       Pass       4.7e-005A       2.33	100mV Range						
1V Range       100.0002 kHz @ 1 V       100.0002 kHz       10.00Hz       2.3       Pass       2.0e-001Hz         100mA Range       10.00016mA       0.00007000A       2.24       Pass       9.7e-007A         100mA Range       100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       0.999784A       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         100mA Range       10.00000 mA @ 1 kHz       10.00202A       0.0014000A       14.5       Pass       4.7e-005A       2.33	100.0000 Hz @ 10 mV	100.0573Hz	0.10000Hz	57.3	Pass	2.1e-004Hz	
100.0000 kHz @ 1 V       100.0002kHz       10.00Hz       2.3       Pass       2.0e-001Hz         DC CURRENT:       10.0000 mA       10.00016mA       0.000007000A       2.24       Pass       9.7e-007A         100mA Range       100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         1.000000 mA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         100mA Range       1.000202A       0.0014000A       14.5       Pass       4.7e-005A       2.33	1V Range						
10mA Range       10.00016mA       0.00007000A       2.24       Pass       9.7e-007A         100mA Range       100.0000 mA       99.9986mA       0.0005500A       2.61       Pass       9.7e-006A         1A Range       1.000000 A       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         1.00000 mA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range       1.000000 A @ 1 kHz       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	100.0000 kHz @ 1 V DC CURRENT:	100.0002kHz	10.00Hz	2.3	Pass	2.0e-001Hz	
10.0000 mA       10.00016mA       0.00007000A       2.24       Pass       9.7e-007A         100mA Range       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       0.999784A       0.00014000A       4.1       Pass       4.7e-006A         10.00000 mA @ 1 kHz       9.99943mA       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	10mA Range						
100mA Range 100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range 1.000000 A AC CURRENT:       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         10mA Range 10.00000 mA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range 10.00000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         1A Range 100.0000 mA @ 1 kHz       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	10.00000 mA	10.00016mA	0.000007000A	2.24	Pass	9.7e-007A	
100.0000 mA       99.9986mA       0.00005500A       2.61       Pass       9.7e-006A         1A Range       1.000000 A       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       10mA Range       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	100mA Range						
1A Range       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       100MA Range       10.00000 mA @ 1 kHz       9.99943mA       0.00014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       1000mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	100.0000 mA	99.9986mA	0.00005500A	2.61	Pass	9.7e-006A	
1.000000 A       0.999784A       0.0011000A       19.6       Pass       1.9e-004A         AC CURRENT:       10mA Range       10.00000 mA @ 1 kHz       9.99943mA       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	1A Range						
10mA Range       10.00000 mA @ 1 kHz       9.99943mA       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A       2.33         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	1.000000 A AC CURRENT:	0.999784A	0.0011000A	19.6	Pass	1.9e-004A	
10.00000 mA @ 1 kHz       9.99943mA       0.000014000A       4.1       Pass       4.7e-006A       2.33         100mA Range       100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	10mA Range						
100mA Range         100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range         1.000000 A @ 1 kHz       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	10.00000 mA @ 1 kHz	9.99943mA	0.000014000A	4.1	Pass	4.7e-006A	2.33
100.0000 mA @ 1 kHz       99.9967mA       0.00060000A       0.551       Pass       4.7e-005A         1A Range       1.000202A       0.0014000A       14.5       Pass       4.7e-004A       2.33	100mA Range						
1A Range 1.000000 A @ 1 kHz 1.000202A 0.0014000A 14.5 Pass 4.7e-004A 2.33	100.0000 mA @ 1 kHz	99.9967mA	0.00060000A	0.551	Pass	4.7e-005A	
1.000000 A @ 1 kHz 1.000202A 0.0014000A 14.5 Pass 4.7e-004A 2.33	1A Range						
	1.000000 A @ 1 kHz	1.000202A	0.0014000A	14.5	Pass	4.7e-004A	2.33



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 07 February 2017
SERIAL NUMBER: ASSET NUMBER:	53787 20385	CAL DUE: DATA TYPE:	07 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 35 %
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	10~15 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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Calibrated By:

**Approved By:** 

Standards	Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20385					
Calibrated Span =	5 PSI					
Calibration Tolera	nce = 0.00325 PSI					
Upscale Tests						
10.0000 psi	10.000psi	0.00325psi	0	Pass	9.9e-004psi	
11.2500 psi	11.249psi	0.00325psi	30.8	Pass	1.1e-003psi	3.61
12.5000 psi	12.498psi	0.00325psi	61.5	Pass	1.2e-003psi	3.25
13.7500 psi	13.749psi	0.00325psi	30.8	Pass	1.2e-003psi	2.95
15.0000 psi	14.999psi	0.00325psi	30.8	Pass	1.3e-003psi	2.71
Downscale Tests						
15.0000 psi	14.998psi	0.00325psi	61.5	Pass	1.3e-003psi	2.71
13.7500 psi	13.749psi	0.00325psi	30.8	Pass	1.2e-003psi	2.95
12.5000 psi	12.499psi	0.00325psi	30.8	Pass	1.2e-003psi	3.25
11.2500 psi	11.250psi	0.00325psi	0	Pass	1.1e-003psi	3.61
10.0000 psi	10.000psi	0.00325psi	0	Pass	9.9e-004psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 02 February 2017
SERIAL NUMBER: ASSET NUMBER:	1332074 20508	CAL DUE: DATA TYPE:	02 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price	TEMPERATURE: HUMIDITY:	22.00 •C 39 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~800 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin

Calibrated By:

**Approved By:** 

Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA20508					
Calibrated Span =	800 PSI					
Calibration Tolera	nce = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.114psi	0.5200psi	21.9	Pass	7.3e-003psi	
200.0000 psi	200.005psi	0.5200psi	0.962	Pass	1.6e-002psi	
400.0000 psi	400.092psi	0.5200psi	17.7	Pass	3.2e-002psi	
600.0000 psi	600.178psi	0.5200psi	34.2	Pass	4.8e-002psi	
800.0000 psi	800.318psi	0.5200psi	61.2	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.337psi	0.5200psi	64.8	Pass	6.4e-002psi	
600.0000 psi	600.172psi	0.5200psi	33.1	Pass	4.8e-002psi	
400.0000 psi	400.092psi	0.5200psi	17.7	Pass	3.2e-002psi	
200.0000 psi	199.978psi	0.5200psi	4.23	Pass	1.6e-002psi	
15.0000 psi	14.949psi	0.5200psi	9.81	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 22 February 2017
SERIAL NUMBER:	1146882	CAL DUE:	22 February 2018
ASSET NUMBER:	20538	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 38 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017
20282	Pressurements Limited V1600/3D Dead Weight Tester	N455/2013611	1/7/2016	1/6/2018

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20538					
Calibrated Span =	5 inH2O					
Calibration Tolera	nce = 0.005 inH20					
_						
Upscale Tests						
0.0000 inH2O	0.000inH2O	0.0050inH2O	0	Pass	7.6e-004inH2O	
2.0000 inH2O	1.999inH2O	0.0050inH2O	20	Pass	1.6e-003inH2O	3.29
3.0000 inH2O	3.000inH2O	0.0050inH2O	0	Pass	1.9e-003inH2O	2.73
4.0000 inH2O	3.999inH2O	0.0050inH2O	20	Pass	2.1e-003inH2O	2.45
5.0000 inH2O	5.000inH2O	0.0050inH2O	0	Pass	2.3e-003inH2O	2.27
Downscale Tests						
5.0000 inH2O	5.000inH2O	0.0050inH2O	0	Pass	2.3e-003inH2O	2.27
4.0000 inH2O	3.999inH2O	0.0050inH2O	20	Pass	2.1e-003inH2O	2.45
3.0000 inH2O	2.999inH2O	0.0050inH2O	20	Pass	1.9e-003inH2O	2.73
2.0000 inH2O	1.999inH2O	0.0050inH2O	20	Pass	1.6e-003inH2O	3.29
0.0000 inH2O	-0.001inH2O	0.0050inH2O	20	Pass	7.6e-004inH2O	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 22 February 2017
SERIAL NUMBER:	1339325	CAL DUE:	22 February 2018
ASSET NUMBER:	20606	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 38 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	
20282	Pressurements Limited V1600/3D Dead Weight Tester	N455/2013611	1/7/2016	1/6/2018	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20606					
Calibrated Span =	5 inH2O					
Calibration Tolera	nce = 0.005 inH20					
Upscale Tests						
0.0000 inH2O	0.000inH2O	0.0050inH2O	0	Pass	7.6e-004inH2O	
2.0000 inH2O	1.999inH2O	0.0050inH2O	20	Pass	1.6e-003inH2O	3.29
3.0000 inH2O	3.000inH2O	0.0050inH2O	0	Pass	1.9e-003inH2O	2.73
4.0000 inH2O	3.999inH2O	0.0050inH2O	20	Pass	2.1e-003inH2O	2.45
5.0000 inH2O	4.999inH2O	0.0050inH2O	20	Pass	2.3e-003inH2O	2.27
Downscale Tests						
5.0000 inH2O	4.999inH2O	0.0050inH2O	20	Pass	2.3e-003inH2O	2.27
4.0000 inH2O	4.000inH2O	0.0050inH2O	0	Pass	2.1e-003inH2O	2.45
3.0000 inH2O	3.000inH2O	0.0050inH2O	0	Pass	1.9e-003inH2O	2.73
2.0000 inH2O	2.000inH2O	0.0050inH2O	0	Pass	1.6e-003inH2O	3.29
0.0000 inH2O	0.000inH2O	0.0050inH2O	0	Pass	7.6e-004inH2O	



#### **REPORTOFCALIBRATION**

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 02 February 2017
SERIAL NUMBER:	1015711	CAL DUE:	02 February 2018
ASSET NUMBER:	20783	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Dave Price McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 •C 39 %
	4700 Coster Rd.	CAL RANGE:	0~800
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Grant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTA20783					
Calibrated Span =	800 PSI					
Calibration Tolera	ance = 0.52 PSI					
Upscale Tests						
15.0000 psi	15.033psi	0.5200psi	6.35	Pass	7.3e-003psi	
200.0000 psi	200.015psi	0.5200psi	2.88	Pass	1.6e-002psi	
400.0000 psi	400.034psi	0.5200psi	6.54	Pass	3.2e-002psi	
600.0000 psi	600.011psi	0.5200psi	2.12	Pass	4.8e-002psi	
800.0000 psi	800.015psi	0.5200psi	2.88	Pass	6.4e-002psi	
Downscale Tests						
800.0000 psi	800.015psi	0.5200psi	2.88	Pass	6.4e-002psi	
600.0000 psi	600.011psi	0.5200psi	2.12	Pass	4.8e-002psi	
400.0000 psi	400.015psi	0.5200psi	2.88	Pass	3.2e-002psi	
200.0000 psi	200.031psi	0.5200psi	5.96	Pass	1.6e-002psi	
15.0000 psi	15.044psi	0.5200psi	8.46	Pass	7.3e-003psi	



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER: ASSET NUMBER:	1024081 20875	CAL DUE: DATA TYPE:	14 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD20875					
Calibrated Span =	25 inH2O					
Calibration Tolera	ance = 0.01625 inH20					
Upscale Tests						
0.0000 inH2O	-0.010inH2O	0.01625inH2O	61.5	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.254inH2O	0.01625inH2O	24.6	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.504inH2O	0.01625inH2O	24.6	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.758inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
25.0000 inH2O	25.007inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81
Downscale Tests						
25.0000 inH2O	25.002inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.759inH2O	0.01625inH2O	55.4	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.508inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.249inH2O	0.01625inH2O	6.15	Pass	5.8e-003inH2O	2.81
0.0000 inH2O	-0.007inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 22 February 2017
SERIAL NUMBER:	1894777	CAL DUE:	22 February 2018
ASSET NUMBER:	20895	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 •C 38 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	0~5
	Knoxville, TN 37912	CAL UNITS:	In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Calibrated By:** 

**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	
20282	Pressurements Limited V1600/3D Dead Weight Tester	N455/2013611	1/7/2016	1/6/2018	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20895					
Calibrated Span =	5 inH2O					
Calibration Tolera	nce = 0.005 inH20					
Upscale Tests						
0.0000 inH2O	0.000inH2O	0.0050inH2O	0	Pass	7.6e-004inH2O	
2.0000 inH2O	1.999inH2O	0.0050inH2O	20	Pass	1.6e-003inH2O	3.29
3.0000 inH2O	2.999inH2O	0.0050inH2O	20	Pass	1.9e-003inH2O	2.73
4.0000 inH2O	3.999inH2O	0.0050inH2O	20	Pass	2.1e-003inH2O	2.45
5.0000 inH2O	4.999inH2O	0.0050inH2O	20	Pass	2.3e-003inH2O	2.27
Downscale Tests						
5.0000 inH2O	4.999inH2O	0.0050inH2O	20	Pass	2.3e-003inH2O	2.27
4.0000 inH2O	3.999inH2O	0.0050inH2O	20	Pass	2.1e-003inH2O	2.45
3.0000 inH2O	2.998inH2O	0.0050inH2O	40	Pass	1.9e-003inH2O	2.73
2.0000 inH2O	1.999inH2O	0.0050inH2O	20	Pass	1.6e-003inH2O	3.29
0.0000 inH2O	0.000inH2O	0.0050inH2O	0	Pass	7.6e-004inH2O	



# **REPORT OF CALIBRATION**

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UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER: ASSET NUMBER:	1473856 20896	CAL DUE: DATA TYPE:	14 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards V	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20896					
Calibrated Span =	25 inH2O					
Calibration Tolera	nce = 0.01625 inH20					
Upscale Tests						
0.0000 inH2O	-0.008inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.246inH2O	0.01625inH2O	24.6	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.493inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.747inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
25.0000 inH2O	24.999inH2O	0.01625inH2O	6.15	Pass	5.8e-003inH2O	2.81
Downscale Tests						
25.0000 inH2O	24.997inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.748inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.498inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.243inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81
0.0000 inH2O	-0.007inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER: ASSET NUMBER:	1339339 20904	CAL DUE: DATA TYPE:	14 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Standards U	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	= PTD20904					
Calibrated Span =	25 inH2O					
Calibration Tolera	ance = 0.01625 inH20					
Upscale Tests						
0.0000 inH2O	-0.008inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.248inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.494inH2O	0.01625inH2O	36.9	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.750inH2O	0.01625inH2O	0	Pass	5.8e-003inH2O	2.81
25.0000 inH2O	25.009inH2O	0.01625inH2O	55.4	Pass	5.8e-003inH2O	2.81
Downscale Tests						
25.0000 inH2O	25.003inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.750inH2O	0.01625inH2O	0	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.497inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.241inH2O	0.01625inH2O	55.4	Pass	5.8e-003inH2O	2.81
0.0000 inH2O	-0.005inH2O	0.01625inH2O	30.8	Pass	5.8e-003inH2O	2.81



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER: ASSET NUMBER:	1877017 20921	CAL DUE: DATA TYPE:	14 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards	Standards Used				
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20921					
Calibrated Span =	25 inH2O					
Calibration Tolera	nce = 0.01625 inH20					
Upscale Tests						
0.0000 inH2O	-0.008inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.247inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.498inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.750inH2O	0.01625inH2O	0	Pass	5.8e-003inH2O	2.81
25.0000 inH2O	24.995inH2O	0.01625inH2O	30.8	Pass	5.8e-003inH2O	2.81
Downscale Tests						
25.0000 inH2O	24.996inH2O	0.01625inH2O	24.6	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.748inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.499inH2O	0.01625inH2O	6.15	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.243inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81
0.0000 inH2O	-0.007inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Diff.	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER: ASSET NUMBER:	1812059 20923	CAL DUE: DATA TYPE:	14 February 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital Pressure Transmitter (inH2O@20c) 1 - 06/21/12 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 •C 31 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	0~25 In-H2O

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017	
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTD20923					
Calibrated Span =	25 inH2O					
Calibration Tolera	nce = 0.01625 inH20					
Upscale Tests						
0.0000 inH2O	-0.007inH2O	0.01625inH2O	43.1	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.253inH2O	0.01625inH2O	18.5	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.501inH2O	0.01625inH2O	6.15	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.750inH2O	0.01625inH2O	0	Pass	5.8e-003inH2O	2.81
25.0000 inH2O	25.008inH2O	0.01625inH2O	49.2	Pass	5.8e-003inH2O	2.81
Downscale Tests						
25.0000 inH2O	25.002inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
18.7500 inH2O	18.751inH2O	0.01625inH2O	6.15	Pass	5.8e-003inH2O	2.81
12.5000 inH2O	12.504inH2O	0.01625inH2O	24.6	Pass	5.8e-003inH2O	2.81
6.2500 inH2O	6.248inH2O	0.01625inH2O	12.3	Pass	5.8e-003inH2O	2.81
0.0000 inH2O	-0.005inH2O	0.01625inH2O	30.8	Pass	5.8e-003inH2O	2.81



Coster Boad Knoxville, IN 37934 865 588 2654

# **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 08 February 2017
SERIAL NUMBER:	A1530001	CAL DUE:	08 February 2018
ASSET NUMBER:	21013	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Digital RH Cal 3 pt 1 - 09/08/2016 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 °C 35 %
	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-found and as-left.

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**Approved By:** 

Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results						
Standard Read	ling <u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Test					
Test Point:	11.3% RH					
12.0000 %RH	12.163%RH	2.0000%RH	8.15	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH					
33.0000 %RH	32.728%RH	2.0000%RH	13.6	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0% RH					
76.0000 %RH	76.431%RH	2.0000%RH	21.5	Pass	1.0e+000%RH	2.00



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	6819	CAL DUE:	09 February 2018
ASSET NUMBER:	21179	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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**Approved By:** 

Standards U	Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	= 11021179 Bange = 20 to 200 Deg F					
	= -6.7  t	o 93.3 Deg C				
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.5435 Ohms			_		
20.4060 F	20.414F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 104.03317 Ohms			_		
50.3570 F	50.344F	0.2590F	5.02	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.49983 Ohms			_		
80.3200 F	80.322F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.94017 Ohms			_		
110.3350 F	110.335F	0.2590F	0	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.34883 Ohms	0.05005		_	0 4 0005	
140.3530 F	140.356F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.72617 Ohms	0.05005	4.00	Dees	0.4-0005	
170.3830 F	170.388F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 136.06/83 Ohms	0.05005	4.00	5	0 4 0005	
200.4150 F	200.410F	0.2590F	1.93	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = 97.5435 Ohms					
-6.4410 c	-6.437c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 104.03317 Ohms					
10.1980 c	10.191c	0.1440c	4.86	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.49983 Ohms					
26.8440 c	26.846c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.94017 Ohms					
43.5200 c	43.519c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.34883 Ohms					
60.1960 c	60.198c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.72617 Ohms					
76.8790 c	76.882c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 136.06783 Ohms					
93.5640 c	93.561c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficier	nts:					
Equation Used= Cal	llendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.05969 Alpha= 0.003842433 Delta= 1.57145046111 A= 0.0039028149311 B= -6.03819310964e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	4058	CAL DUE:	09 February 2018
ASSET NUMBER:	21309	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left with new coefficients.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021309					
Probe Calibration	Range = 20 to 200 Deg	F				
	= -6./	to 93.3 Deg C				
AS FOUND/AS LEFT F	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.3745 Ohms					
20.4060 F	20.410F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.90683 Ohm	S				
50.3570 F	50.358F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.39483 Ohm	s				
80.3200 F	80.300F	0.2590F	7.72	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.86367 Ohm	S				
110.3350 F	110.351F	0.2590F	6.18	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.28 Ohms					
140.3530 F	140.357F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.657 Ohms					
170.3830 F	170.380F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 135.99333 Ohm	S				
200.4150 F	200.414F	0.2590F	0.386	Pass	3.4e-002F	
***********Degre	ees C************					
Resistance Value a	at Temp = 97.3745 Ohms					
-6.4410 c	-6.439c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.90683 Ohm	S				
10.1980 c	10.199c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.39483 Ohm	S				
26.8440 c	26.833c	0.1440c	7.64	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.86367 Ohm	s				
43.5200 c	43.528c	0.1440c	5.56	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.28 Ohms					
60.1960 c	60.198c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.657 Ohms					
76.8790 c	76.878c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 135.99333 Ohm	S				
93.5640 c	93.563c	0.1440c	0.694	Pass	1.9e-002c	
As Left Coefficier	nts:					
HUUATION USAd= ('a	LANGER-VER LINGOR					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.90759 Alpha= 0.003855431 Delta= 2.0028845986 A= 0.00393265083371 B= -7.72198337085e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



#### REPORTOFCALIBRATION

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 February 2017
SERIAL NUMBER:	4041	CAL DUE:	13 February 2018
ASSET NUMBER:	21317	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

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**REMARKS:** Instrument passed calibration as left with new coefficients.

Drant Shaphin Calibrated By:

**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
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Probe Calibration	Range = 20 to 200 Deg F = -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT 1	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.41917 Ohms					
20.4160 F	20.423F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.92933 Ohms					
50.3710 F	50.366F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.41433 Ohms					
80.3640 F	80.356F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.8655 Ohms					
110.3520 F	110.353F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.284 Ohms					
140.3560 F	140.364F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.67317 Ohms					
170.3990 F	170.404F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 136.0225 Ohms					
200.4280 F	200.423F	0.2590F	1.93	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = 97.41917 Ohms					
-6.4350 c	-6.432c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.92933 Ohms					
10.2060 c	10.203c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.41433 Ohms					
26.8690 c	26.864c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.8655 Ohms					
43.5290 c	43.530c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.284 Ohms					
60.1980 c	60.202c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.67317 Ohms					
76.8890 c	76.891c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 136.0225 Ohms					
93.5710 c	93.568c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficien	nts:					
Fountion Hood- Co	llondar-Van Ducon					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.9405 Alpha= 0.003854412 Delta= 1.65678427143 A= 0.00391827129177 B= -6.3859291772e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	6751	CAL DUE:	09 February 2018
ASSET NUMBER:	21475	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:

**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

<u>Standard Reading</u>	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 = -	Deg F 6.7 to 93.3 Deg C				
AS FOUND/AS LEFT H	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.51617	Ohms				
20.4060 F	20.402F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.99617	Ohms				
50.3570 F	50.361F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.44683	Ohms				
80.3200 F	80.325F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.8775	Ohms				
110.3350 F	110.338F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.27583	Ohms				
140.3530 F	140.343F	0.2590F	3.86	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.651 C	hms				
170.3830 F	170.382F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	at Temp = 135.99517	Ohms				
200.4150 F	200.419F	0.2590F	1.54	Pass	3.4e-002F	
************Degre	ees C*************					
Resistance Value a	at Temp = 97.51617	Ohms				
-6.4410 c	-6.444c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.99617	Ohms				
10.1980 c	10.200c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.44683	Ohms				
26.8440 c	26.847c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.8775	Ohms				
43.5200 c	43.521c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.27583	Ohms				
60.1960 c	60.190c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.651 C	hms				
76.8790 c	76.879c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	at Temp = 135.99517	Ohms				
93.5640 c	93.566c	0.1440c	1.39	Pass	1.9e-002c	
As Left Coefficier	nts:					

As here coefficients. Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.02844 Alpha= 0.003839369 Delta= 1.42933528857 A= 0.00389424645598 B= -5.48774559753e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	07268	CAL DUE:	09 February 2018
ASSET NUMBER:	21631	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021631					
Probe Calibration Ra	nge = 20 to 200 Deg F					
	= -6.7 to	93.3 Deg C				
AS FOUND/AS LEFT RES	ULTS					
Degrees F						
Resistance Value at	Temp = 97.652 Ohms					
20.4060 F	20.395F	0.2590F	4.25	Pass	3.4e-002F	
Resistance Value at	Temp = 104.15617 Ohms					
50.3570 F	50.377F	0.2590F	7.72	Pass	3.4e-002F	
Resistance Value at	Temp = 110.61617 Ohms					
80.3200 F	80.312F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value at	Temp = 117.06283 Ohms					
110.3350 F	110.343F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value at	Temp = 123.4685 Ohms					
140.3530 F	140.342F	0.2590F	4.25	Pass	3.4e-002F	
Resistance Value at	Temp = 129.84833 Ohms					
170.3830 F	170.380F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value at	Temp = 136.19433 Ohms					
200.4150 F	200.420F	0.2590F	1.93	Pass	3.4e-002F	
*************Degrees	; C*****					
Resistance Value at	Temp = 97.652 Ohms					
-6.4410 c	-6.447c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value at	Temp = 104.15617 Ohms					
10.1980 c	10.209c	0.1440c	7.64	Pass	1.9e-002c	
Resistance Value at	Temp = 110.61617 Ohms					
26.8440 c	26.840c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value at	Temp = 117.06283 Ohms					
43.5200 c	43.524c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value at	Temp = 123.4685 Ohms					
60.1960 c	60.190c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value at	Temp = 129.84833 Ohms					
76.8790 c	76.878c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value at	Temp = 136.19433 Ohms					
93.5640 c	93.567c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficients	3:					

As Left Coefficients: Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.17353 Alpha= 0.003839126 Delta= 1.5973862071 A= 0.0039004516692 B= -6.13256691972e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER:	07262	CAL DUE:	14 February 2018
ASSET NUMBER:	21635	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025		
14016	Rosemount Aerospace 162CE SPRT	4211	8/19/2016	8/19/2017		

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021635					
Probe Calibration	Range = $125$ to $1100$ Deg	F				
	= 51.7 to	593.3 Deg (	C			
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 119.98717 Ohms					
125.1070 F	125.046F	0.5000F	12.2	Pass	1.2e-001F	
Resistance Value a	t Temp = 154.176 Ohms					
287.4490 F	287.508F	0.5000F	11.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 187.44217 Ohms					
449.8480 F	449.936F	0.5000F	17.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 219.76433 Ohms					
612.2640 F	612.220F	0.5000F	8.8	Pass	1.2e-001F	
Resistance Value a	t Temp = 251.20883 Ohms					
774.7370 F	774.694F	0.5000F	8.6	Pass	1.2e-001F	
Resistance Value a	t Temp = 281.73667 Ohms					
937.2310 F	937.164F	0.5000F	13.4	Pass	1.2e-001F	
Resistance Value a	t Temp = 311.3725 Ohms					
1099.7020 F	1099.769F	0.5000F	13.4	Pass	1.2e-001F	
************Degre	es C************					
Resistance Value a	t Temp = 119.98717 Ohms					
51.7260 c	51.692c	0.2780c	12.2	Pass	6.4e-002c	
Resistance Value a	t Temp = 154.176 Ohms					
141.9160 c	141.949c	0.2780c	11.9	Pass	6.4e-002c	
Resistance Value a	t Temp = 187.44217 Ohms					
232.1370 c	232.187c	0.2780c	18	Pass	6.4e-002c	
Resistance Value a	t Temp = 219.76433 Ohms					
322.3690 c	322.344c	0.2780c	8.99	Pass	6.4e-002c	
Resistance Value a	t Temp = 251.20883 Ohms					
412.6320 c	412.608c	0.2780c	8.63	Pass	6.4e-002c	
Resistance Value a	t Temp = 281.73667 Ohms					
502.9060 c	502.869c	0.2780c	13.3	Pass	6.4e-002c	
Resistance Value a	t Temp = 311.3725 Ohms					
593.1680 c	593.205c	0.2780c	13.3	Pass	6.4e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.99387 Alpha= 0.003840838 Delta= 1.46378152426 A= 0.00389705947702 B= -5.62214770206e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	07246	CAL DUE:	09 February 2018
ASSET NUMBER:	21655	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	MCHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT021655					
Probe Calibration	Range = 20 to 200 Deg 1	F				
	= -6.7	to 93.3 Deg C				
AS FOUND/AS LEFT 1	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.39533 Ohms					
20.4060 F	20.405F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.89333 Ohm:	5				
50.3570 F	50.356F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.3605 Ohms					
80.3200 F	80.327F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.7995 Ohms					
110.3350 F	110.331F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.20733 Ohm:	3				
140.3530 F	140.353F	0.2590F	0	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.58117 Ohms	5				
170.3830 F	170.380F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value	at Temp = 135.92183 Ohms	5				
200.4150 F	200.417F	0.2590F	0.772	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = 97.39533 Ohms					
-6.4410 c	-6.442c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.89333 Ohma	5				
10.1980 c	10.198c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.3605 Ohms					
26.8440 c	26.849c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.7995 Ohms					
43.5200 c	43.517c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.20733 Ohms	5				
60.1960 c	60.196c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.58117 Ohms	5				
76.8790 c	76.878c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	at Temp = 135.92183 Ohm:	5				
93.5640 c	93.565c	0.1440c	0.694	Pass	1.9e-002c	
As Left Coefficien	nts:					

As here coefficients. Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.91511 Alpha= 0.003847502 Delta= 1.64481403329 A= 0.00391078625283 B= -6.32842528271e-007

\*\*\*\*\* End of Report \*\*\*\*\*



Doster Road Knoxville, IN 37934 805 588 2054

## **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	C1230032	CAL DUE:	09 February 2018
ASSET NUMBER:	22677	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital RH Cal 3 pt 1 - 09/08/2016 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 °C 31 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-found and as-left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results	Test Results						
Standard Read	ling <u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>	
Relative Hum	idity Test						
Test Point:	11.3% RH						
12.0000 %RH	11.912%RH	2.0000%RH	4.4	Pass	1.0e+000%RH	2.00	
Test Point:	33.0% RH						
33.0000 %RH	33.421%RH	2.0000%RH	21	Pass	1.0e+000%RH	2.00	
Test Point:	75.3.0% RH						
76.0000 %RH	76.590%RH	2.0000%RH	29.5	Pass	1.0e+000%RH	2.00	

\*\*\*\*\* End of Report \*\*\*\*\*



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## **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 08 February 2017
SERIAL NUMBER:	D4150049	CAL DUE:	08 February 2018
ASSET NUMBER:	22690	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital RH Cal 3 pt 1 - 09/08/2016 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	22.00 °C 35 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-left.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results							
Standard Read	ding	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Tes	t					
Test Point:	11.3% RH						
11.5000 %RH		11.710%RH	2.0000%RH	10.5	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH						
33.0000 %RH		32.990%RH	2.0000%RH	0.5	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0%	RH					
75.0000 %RH		75.013%RH	2.0000%RH	0.65	Pass	1.0e+000%RH	2.00

\*\*\*\*\* End of Report \*\*\*\*\*



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## **REPORTOFCALIBRATION**

McHalePerformance com

UNIT UNDER TEST:	Humidity Sensor, Digital	TEST RESULT: CAL DATE:	PASS 08 February 2017
SERIAL NUMBER:	C2820115	CAL DUE:	08 February 2018
ASSET NUMBER:	23830	DATA TYPE:	FOUND-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Digital RH Cal 3 pt 1 - 09/08/2016 Jessica Trent	TEMPERATURE: HUMIDITY:	22.00 °C 35 %
COSTOMER:	4700 Coster Rd.	CAL RANGE:	0~99
	Knoxville, TN 37912	CAL UNITS:	%

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as-found and as-left.

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Calibrated By:

**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
20000	McHale LiCl - 11.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20001	McHale MgCl2 - 33.0% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	
20003	McHale NaCl - 75.3% Saturated Salt Solution	N/A	1/6/2017	7/6/2017	

Test Results						
Standard Read	ling <u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Relative Hum	idity Test					
Test Point:	11.3% RH					
12.0000 %RH	11.235%RH	2.0000%RH	38.3	Pass	1.0e+000%RH	2.00
Test Point:	33.0% RH					
33.0000 %RH	32.735%RH	2.0000%RH	13.3	Pass	1.0e+000%RH	2.00
Test Point:	75.3.0% RH					
76.0000 %RH	76.566%RH	2.0000%RH	28.3	Pass	1.0e+000%RH	2.00

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	4390	CAL DUE:	09 February 2018
ASSET NUMBER:	23964	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 Deg	F				
	= -6.7	to 93.3 Deg C				
AS FOUND/AS LEFT 1	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.6855 Ohms					
20.4060 F	20.426F	0.2590F	7.72	Pass	3.4e-002F	
Resistance Value a	at Temp = 104.251 Ohms					
50.3570 F	50.328F	0.2590F	11.2	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.7865 Ohms	3				
80.3200 F	80.312F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 117.28383 Ohm	ıs				
110.3350 F	110.343F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.7315 Ohms	3				
140.3530 F	140.367F	0.2590F	5.41	Pass	3.4e-002F	
Resistance Value a	at Temp = 130.13033 Ohm	เร				
170.3830 F	170.389F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	at Temp = 136.4795 Ohms	3				
200.4150 F	200.404F	0.2590F	4.25	Pass	3.4e-002F	
***********Degre	ees C************					
Resistance Value a	at Temp = 97.6855 Ohms					
-6.4410 c	-6.430c	0.1440c	7.64	Pass	1.9e-002c	
Resistance Value a	at Temp = 104.251 Ohms					
10.1980 c	10.182c	0.1440c	11.1	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.7865 Ohms	3				
26.8440 c	26.840c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 117.28383 Ohm	ıs				
43.5200 c	43.524c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.7315 Ohms	3				
60.1960 c	60.204c	0.1440c	5.56	Pass	1.9e-002c	
Resistance Value a	at Temp = 130.13033 Ohm	เร				
76.8790 c	76.883c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 136.4795 Ohms	3				
93.5640 c	93.558c	0.1440c	4.17	Pass	1.9e-002c	
As Left Coefficien	nts:					
Equation Used= Ca	llendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.23245 Alpha= 0.003859728 Delta= 2.24356029955 A= 0.00394632332508 B= -8.65953250788e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	4417	CAL DUE:	09 February 2018
ASSET NUMBER:	23967	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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$\overline{\mathbf{v}}$	Calibrate	d By:

**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	<u>UUT Reading</u> = TT023967	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 Deg F = $-6.7$ t	, :o 93.3 Deg C				
AS FOUND/AS LEFT 1	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.38617 Ohms					
20.4060 F	20.398F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	at Temp = 103.89583 Ohms					
50.3570 F	50.372F	0.2590F	5.79	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.36033 Ohms					
80.3200 F	80.302F	0.2590F	6.95	Pass	3.4e-002F	
Resistance Value a	at Temp = 116.8165 Ohms					
110.3350 F	110.360F	0.2590F	9.65	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.22333 Ohms					
140.3530 F	140.356F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 129.593 Ohms					
170.3830 F	170.346F	0.2590F	14.3	Pass	3.4e-002F	
Resistance Value a	at Temp = 135.9475 Ohms					
200.4150 F	200.434F	0.2590F	7.34	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = $97.38617$ Ohms					
-6.4410 c	-6.445c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 103.89583 Ohms					
10.1980 c	10.207c	0.1440c	6.25	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.36033 Ohms					
26.8440 c	26.834c	0.1440c	6.94	Pass	1.9e-002c	
Resistance Value a	at Temp = 116.8165 Ohms					
43.5200 c	43.533c	0.1440c	9.03	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.22333 Ohms					
60.1960 c	60.198c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 129.593 Ohms					
76.8790 c	76.859c	0.1440c	13.9	Pass	1.9e-002c	
Resistance Value a	at Temp = $135.9475$ Ohms					
93.5640 c	93.575c	0.1440c	7.64	Pass	1.9e-002c	
As Left Coefficien	nts:					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.91009 Alpha= 0.0038505 Delta= 1.68049763866 A= 0.00391520756158 B= -6.47075615768e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	5641	CAL DUE:	09 February 2018
ASSET NUMBER:	24008	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:	

**Approved By:** 

Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT024008					
Probe Calibration	Range = 20 to 200 Deg H	7				
	= -6.7 t	to 93.3 Deg C				
AS FOUND/AS LEFT F	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.58933 Ohms					
20.4060 F	20.404F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value a	t Temp = 104.10967 Ohms	3				
50.3570 F	50.364F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.58967 Ohms	5				
80.3200 F	80.311F	0.2590F	3.47	Pass	3.4e-002F	
Resistance Value a	t Temp = 117.04967 Ohms	5				
110.3350 F	110.340F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	t Temp = 123.46717 Ohms	5				
140.3530 F	140.346F	0.2590F	2.7	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.85583 Ohms	5				
170.3830 F	170.394F	0.2590F	4.25	Pass	3.4e-002F	
Resistance Value a	t Temp = 136.20017 Ohms	5				
200.4150 F	200.410F	0.2590F	1.93	Pass	3.4e-002F	
************Degre	es C***********					
Resistance Value a	t Temp = 97.58933 Ohms					
-6.4410 c	-6.442c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	t Temp = 104.10967 Ohms	3				
10.1980 c	10.202c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.58967 Ohms	3				
26.8440 c	26.839c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	t Temp = 117.04967 Ohms	3				
43.5200 c	43.522c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	t Temp = 123.46717 Ohms	3				
60.1960 c	60.192c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.85583 Ohms	3				
76.8790 c	76.885c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value a	t Temp = 136.20017 Ohms	3				
93.5640 c	93.561c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.1174 Alpha= 0.003847708 Delta= 1.75974048162 A= 0.00391541767529 B= -6.77096752906e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## REPORTOFCALIBRATION

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 13 February 2017
SERIAL NUMBER:	5616	CAL DUE:	13 February 2018
ASSET NUMBER:	24018	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Grant Shropshire		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Calibrated By:

**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

<u>Standard Reading</u>	UUT Reading = TT024018	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 Deg I = $-6.7$ t	F to 93.3 Deg C				
AS FOUND/AS LEFT :	RESULTS					
Degrees F						
Resistance Value	at Temp = 97.37867 Ohms					
20.4160 F	20.422F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value	at Temp = 103.88133 Ohms	S				
50.3710 F	50.360F	0.2590F	4.25	Pass	3.4e-002F	
Resistance Value	at Temp = 110.36267 Ohms	S				
80.3640 F	80.369F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value	at Temp = 116.801 Ohms					
110.3520 F	110.349F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value	at Temp = 123.20833 Ohms	S				
140.3560 F	140.355F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value	at Temp = 129.589 Ohms					
170.3990 F	170.408F	0.2590F	3.47	Pass	3.4e-002F	
Resistance Value	at Temp = 135.92467 Ohms	S				
200.4280 F	200.423F	0.2590F	1.93	Pass	3.4e-002F	
************Degr	ees C***********					
Resistance Value	at Temp = 97.37867 Ohms					
-6.4350 c	-6.432c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value	at Temp = 103.88133 Ohms	S				
10.2060 c	10.200c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value	at Temp = 110.36267 Ohms	S				
26.8690 c	26.872c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value	at Temp = 116.801 Ohms					
43.5290 c	43.527c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value	at Temp = 123.20833 Ohms	S				
60.1980 c	60.197c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value	at Temp = $129.589$ Ohms					
76.8890 c	76.894c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value	at Temp = 135.92467 Ohm:	S				
93.5710 c	93.568c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficies	nts:					
Equation Hoods Co	llondar Van Ducon					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.89776 Alpha= 0.003850022 Delta= 1.71670308917 A= 0.00391611544661 B= -6.60934466078e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	5616	CAL DUE:	09 February 2018
ASSET NUMBER:	24030	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:	

**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT024030					
Probe Calibration	Range = 20 to 200 Deg F	,				
	= -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.11333 Ohms					
20.4060 F	20.411F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.54533 Ohms					
50.3570 F	50.341F	0.2590F	6.18	Pass	3.4e-002F	
Resistance Value a	t Temp = 109.961 Ohms					
80.3200 F	80.337F	0.2590F	6.56	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.34533 Ohms					
110.3350 F	110.331F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	t Temp = 122.70367 Ohms					
140.3530 F	140.347F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.03683 Ohms					
170.3830 F	170.389F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.33517 Ohms					
200.4150 F	200.413F	0.2590F	0.772	Pass	3.4e-002F	
************Degre	es C************					
Resistance Value a	t Temp = 97.11333 Ohms					
-6.4410 c	-6.438c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.54533 Ohms					
10.1980 c	10.189c	0.1440c	6.25	Pass	1.9e-002c	
Resistance Value a	t Temp = 109.961 Ohms					
26.8440 c	26.854c	0.1440c	6.94	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.34533 Ohms					
43.5200 c	43.517c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 122.70367 Ohms					
60.1960 c	60.193c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.03683 Ohms					
76.8790 c	76.883c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.33517 Ohms					
93.5640 c	93.563c	0.1440c	0.694	Pass	1.9e-002c	
As Left Coefficien	ts:					

As Left Coefficients: Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.60743 Alpha= 0.00383006 Delta= 1.45062820618 A= 0.00388561993067 B= -5.55599306738e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	4350	CAL DUE:	09 February 2018
ASSET NUMBER:	24047	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:

**Approved By:** 

Standards Used				
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT024047					
Probe Calibration	Range = 20 to 200 Deg F					
	= -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT R	ESULTS					
Degrees F						
Resistance Value a	t Temp = 97.413 Ohms					
20.4060 F	20.402F	0.2590F	1.54	Pass	3.4e-002F	
Resistance Value a	t Temp = 103.841 Ohms					
50.3570 F	50.365F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value a	t Temp = 110.24167 Ohms					
80.3200 F	80.319F	0.2590F	0.386	Pass	3.4e-002F	
Resistance Value a	t Temp = 116.63033 Ohms					
110.3350 F	110.337F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value a	t Temp = 122.99033 Ohms					
140.3530 F	140.341F	0.2590F	4.63	Pass	3.4e-002F	
Resistance Value a	t Temp = 129.335 Ohms					
170.3830 F	170.393F	0.2590F	3.86	Pass	3.4e-002F	
Resistance Value a	t Temp = 135.64717 Ohms					
200.4150 F	200.413F	0.2590F	0.772	Pass	3.4e-002F	
***********Degre	es C**********					
Resistance Value a	t Temp = 97.413 Ohms					
-6.4410 c	-6.443c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	t Temp = 103.841 Ohms					
10.1980 c	10.203c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	t Temp = 110.24167 Ohms					
26.8440 c	26.844c	0.1440c	0	Pass	1.9e-002c	
Resistance Value a	t Temp = 116.63033 Ohms					
43.5200 c	43.521c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value a	t Temp = 122.99033 Ohms					
60.1960 c	60.189c	0.1440c	4.86	Pass	1.9e-002c	
Resistance Value a	t Temp = 129.335 Ohms					
76.8790 c	76.885c	0.1440c	4.17	Pass	1.9e-002c	
Resistance Value a	t Temp = 135.64717 Ohms					
93.5640 c	93.563c	0.1440c	0.694	Pass	1.9e-002c	
As Left Coefficien	ts:					

As here coefficients. Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 99.90421 Alpha= 0.003820908 Delta= 1.20693916633 A= 0.00386702403516 B= -4.61160351615e-007

\*\*\*\*\* End of Report \*\*\*\*\*



ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1 ACCREDITED by NVLAP (an ILAC MRA signatory)



NVLAP Lab Code: 200625-0

# Calibration Certificate No.37132

Instrument:	Sound Level Meter		
Model:	SC310		
Manufacturer:	Cesva		
Serial number:	T229771_24125		
Tested with:	Microphone C-130 s/n 10467 Preamplifier PA13 s/n 2391		
Type (class):	1		
Customer:	McHale Performance		
Tel/Fax:	865-588-2654 x119 /		

 Date Calibrated:10/11/2016 Cal Due: 10/11/2017

 Status:
 Received
 Sent

 In tolerance:
 X
 X

 Out of tolerance:
 See comments:
 See comments:

 Contains non-accredited tests:
 Yes X
 No

 Calibration service:
 Basic X
 Standard

 Address:
 4700 Coster Rd
 Knoxville, TN 37912

Tested in accordance with the following procedures and standards: Calibration of Sound Level Meters, Scantek Inc., Rev. 6/22/2012 SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

	Barriela	- 144	6-1 P.4	Traceability evidence	Col Due	
Instrument - Manufacturer	Description	S/N Cal. Date		Cal. Lab / Accreditation	1 Cal. Due	
483B-Norsonic	SME Cal Unit	31061	Jul 27, 2016	Scantek, Inc./ NVLAP	Jul 27, 2017	
DS-360-SRS	Function Generator	88077	Sep 15, 2016	ACR Env./ A2LA	Sep 15, 2018	
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Sep 15, 2016	ACR Env./ A2LA	Sep 15, 2017	
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016	
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.		
1251-Norsonic	Calibrator	30878	Nov 10, 2015	Scantek, Inc./ NVLAP	Nov 10, 2016	
4226-Brüel&Kjær	Multifunction calibrator	2305103	Jul 25, 2016	Scantek, Inc./ NVLAP	Jul 25, 2017	

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

#### **Environmental conditions:**

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
21.4	101.20	41.6

Calibrated by:	Jeremy Gotwalt	Authorized signatory:	Valentin Buzduga
Signature	and Balance	Signature	11/
Date	10/12/14	Date	10/12/2016

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Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT <sup>2,3</sup>	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.3
ACOUSTICAL TEST OF A FREQUENCY WEIGHTING - IEC 61672-3 ED.2.0 CLAUSE 12	Passed	0.3
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED 2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ JEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.2
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.3
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.1
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.1
FILTER TEST 1/10CTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/30CTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (\*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.

Compliance with any standard cannot be claimed based solely on the periodic tests.

#### Tests made with the following attachments to the instrument:

Microphone: Cesva C-130 s/n 10467	for acoustical test
Preamplifier: Cesva PA13 s/n 2391 f	or all tests
Other: line adaptor ADP005 (18pF) for	electrical tests
Accompanying acoustical calibrator:	Cesva C8006 s/n 48461_24356
Windscreen: Cesva PVM-05	

Measured Data: in Test Report # 37132 of two sections totaling 11 pages.

Place of Calibration: Scantek, Inc.	
6430 Dobbin Road, Suite C	Ph/Fax: 410-290-7726/ -9167
Columbia, MD 21045 USA	callab@scantekinc.com

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory. This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.

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## Summary of Test Report No.:37132

#### Cesva Type: SC310 Serial no: T229771\_24125

Customer: Address: Contact Person: Phone No.: eMail: McHale Performance 4700 Coster Rd, Knoxville, TN 37912 Jessica Trent 865-588-2654 x119 jessica.trent@mchaleperformance.com

Cesva	Type: C-130	Serial no:	10467	Sens:dB
Cesva	Type: PA13	Serial no:	2391	
Cesva	Type: CB006	Serial no:	48461_24356	Level:93.76dB
Cesva	Type: PVM-05			
	Cesva Cesva Cesva Cesva	Cesva Type: C-130 Cesva Type: PA13 Cesva Type: CB006 Cesva Type: PVM-05	Cesva Type: C-130 Serial no: Cesva Type: PA13 Serial no: Cesva Type: CB006 Serial no: Cesva Type: PVM-05	Cesva         Type: C-130         Serial no: 10467           Cesva         Type: PA13         Serial no: 2391           Cesva         Type: CB006         Serial no: 48461_24356           Cesva         Type: PVM-05

#### Measurement Results:

Indication at the calibration check frequency - IEC61672-3 Ed.2 Clause 10	Passed
Self-generated noise - IEC 61672-3 Ed.2 Clause 11	Passed
Acoustical test of a frequency weighting - IEC 61672-3 Ed.2.0 Clause 12	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.2.0 Clause 14	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.2 Clause 16	Passed
Toneburst response - IEC 61672-3 Ed.2.0 Clause 18	Passed
Peak C sound level - IEC 61672-3 Ed.2.0 Clause 19	Passed
Overload indication - IEC 61672-3 Ed 2.0 Clause 20	Passed
Hinh level stability test - IEC 61672-3 Ed 2.0 Clause 21	Passed
Long term stability test - IEC 61672-3 Ed.2.0 Clause 15	Passed
Filter Test 1/1octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed
Filter Test 1/3octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed

Environmental conditions: Pressure: Temperature: 101.20 21.4 Date of calibration: 10/11/2016 Date of issue: 10/12/2016 Supervisor: Valentin Buzduga Measurements performed by:

Jeremy Gotwalt

Software version:

Relative humidity: 41.6

> Scantek, Inc. 6430 Dobbin Rd., Suite C, Columbia, MD 21045 Ph: 410-290-7726 eMail: callab@scantekinc.com

## Summers of Tost Report No. 11122

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## Test Report No.:37132

Manufacturer: Instrument type: Serial no: Customer: Department: Order No: Contact Person: Address: Cesva SC310 T229771\_24125 McHale Performance

Jessica Trent 4700 Coster Rd, Knoxville, TN 37912

Environmental conditions:Pressure:101.20Temperature:21.4Relative humidity:41.6

Supervisor Engineer Date: Valentin Buzduga Jeremy Gotwalt 10/11/2016

## Measurement Results:

Indication at the calibration check frequency - IEC61672-3 Ed.2 Clause 10

```
Reference Calibrator: WSC4 - NOR1251-30878
Reference calibrator level: 114.06
Before calibration:
  Environmental corrections: 0.00
 Other corrections: -0.1
 Notional level: 113.96
Reference calibrator level before calibration: 114.0
After calibration:
  Environmental corrections: 0.00
  Other corrections: -0.1
  Notional level: 113.96
Reference calibrator level after calibration: 114.0
Associated Calibrator: Cesva - CB006 - 48461 24356
Associated calibrator level: 93.76
Initial level check:
  Environmental corrections: 0.00
  Other corrections: -0.1
  Notional level: 93.66
Indicated level: 93.7
Final level statement:
  Environmental corrections after calibration: 0.00
  Other corrections: -0.1
 Notional level: 93.66
Indicated level after calibration: 93.7
This value shall be used for adjusting the sound level meter in the future.
Test Passed
```

#### Self-generated noise - IEC 61672-3 Ed.2 Clause 11

Network	Level	Max	Uncert.	Result	Comment
	(dB)	(dB)	(dB)		
A	13.7	14.4	0.3	P	Equivalent capacity
C	17.8	16.8	0.3	N	Equivalent capacity
Test Passed					

#### Acoustical test of a frequency weighting - IEC 61672-3 Ed.2.0 Clause 12

A-Weighted	results: free	field	response	3			
Frequency	Response	T	ol.	Uncert.	Result		
	(dB)	(dB)	(dB)	(dB)			
125 Hz	0.0	1.0	-1.0	0.2	P		
1 kHz	0.0	0.7	-0.7	0.1	P		
4 kHz	0.0	1.0	-1.0	0.2	P		
8 kHz	-0.4	1.5	-2.5	0.4	P		
Test Passed							
The overall	frequency re	sponse	of the a	sound leve	1 meter,	typical	wind

Acoustical test of a frequency weighting - IEC 61672-3 Ed.2.0 Clause 12 Test Passed The overall frequency response of the sound level meter, typical wind screen response and microphone response has shown to conform with the requirements in IEC 61672-3 for a class 1 sound level meter. Frequency response test using multi frequency calibrator. Sources for correction data: Calibrator levels and uncertainty: Scantek - SCL Microphone field corrections and uncertainty: Case reflections and uncertainty: Wind screen corrections and uncertainty: Tabular information Calibrator = WSC4 at 94dB txtMFCL125 = 94.07txtMFCLU125 = 0.11 txtSU125 = 0.20 txtM125 1 - 78.3 txtM125 2 = 78.2txtM125 3 = 78.2txtMFCL1k = 94.07txtMFCLU1k = 0.11txtSU1k = 0.15 txtMlk 1 = 94.2 txtMlk 2 = 94.2 txtM1k 3 = 94.2 txtMFCL4k = 94.02txtMFCL04k = 0.11 txtSU4k = 0.40 txtM4k 1 =94.1 94.1  $txtM4k_2 =$ 94.1 txtM4k =txtMFCL8k = 93.88 txtMFCLU8k = 0.14 txtSU8k = 0.50 txtM8k 1 = 89.4 txtM8k 1 = $txtM8k_2 =$ 89.4 89.4  $txtM8k_3 =$ txtSLM125 = 78.23 txtNC125 = 16.1 txtSLMU125 = 0.2txtMic125 = 0.0 txtMicU125 = 0.05 txtCR125 =txtCRU125 txtWS125 = txtWSU125 = 94.2 txtSLM1k = txtNClk = 0 txtSLMU1k = 0.1 txtMFCL1k = 94.07txtMFCLU1k = 0.11 txtMiclk = 0.1 txtMicUlk = 0.1 txtCR1k = txtCRU1k =

Acoustical test of a frequency weighting - IEC 61672-3 Ed.2.0 Clause 12

94.02 txtMFCL4k = txtMFCLU4k = 0.11 txtMic4k = 1.2 txtMicU4k = 0.2 txtCR4k = txtCRU4k = txtWS4k = txtWSU4k = txtSLM8k = 89.4 txtNC8k = 1.1 txtSLMU8k = 0.1 txtMFCL8k = 93.88 txtMFCLU8k = 0.14 txtMic8k = 3.2 txtMicU8k = 0.4 txtCR8k = txtCRU8k = txtWS8k = txtWSU8k =

#### Frequency weightings: A Network - IEC 61672-3 Ed.2.0 Clause 13

Freq	Ref.	Meas.	T	ol.	Uncert.	Dev.	Result
(Hz)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	
63.1	85.0	85.0	1.0	-1.0	0.2	0.0	P
125.9	85.0	85.0	1.0	-1.0	0.2	0.0	P
251.2	85.0	85.0	1.0	-1.0	0.2	0.0	P
501.2	85.0	85.0	1.0	-1.0	0.2	0.0	P
1000.0	85.0	85.0	0.7	-0.7	0.2	0.0	P
1995.3	85.0	85.0	1.0	-1.0	0.2	0.0	P
3981.1	85.0	85.0	1.0	-1.0	0.2	0.0	P
7943.3	85.0	84.9	1.5	-2.5	0.2	-0.1	P
15848.9	85.0	80.0	2.5	-16.0	0.2	-5.0	P
Part Decend							

Test Passed

#### Frequency weightings: C Network - IEC 61672-3 Ed.2.0 Clause 13

Freq	Ref. Level	Meas. Value	Т	01.	Uncert.	Dev.	Result
(Hz)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	
63.1	85.0	84.9	1.0	-1.0	0.2	-0.1	P
125.9	85.0	85.0	1.0	-1.0	0.2	0.0	P
251.2	85.0	85.0	1.0	-1.0	0.2	0.0	P
501.2	85.0	85.1	1.0	-1.0	0.2	0.1	P
1000.0	85.0	85.0	0.7	-0.7	0.2	0.0	P
1995.3	85.0	85.1	1.0	-1.0	0.2	0.1	P
3981.1	85.0	85.1	1.0	-1.0	0.2	0.1	P
7943.3	85.0	85.0	1.5	-2.5	0.2	0.0	P
15848.9	85.0	80.0	2.5	-16.0	0.2	-5.0	P
Test Passed							

## Frequency weightings: Z Network - IEC 61672-3 Ed.2.0 Clause 13

Freq	Ref.	Meas.	Т	01.	Uncert.	Dev.	Result
(Hz)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	
63.1	85.0	85.0	1.0	-1.0	0.2	0.0	P
125.9	85.0	85.0	1.0	-1.0	0.2	0.0	P
251.2	85.0	85.0	1.0	-1.0	0.2	0.0	P
501.2	85.0	85.1	1.0	-1.0	0.2	0.1	P
1000.0	85.0	85.1	0.7	-0.7	0.2	0.1	P
1995.3	85.0	85.0	1.0	-1.0	0.2	0.0	P
3981.1	85.0	85.0	1.0	-1.0	0.2	0.0	P
7943.3	85.0	85.0	1.5	-2.5	0.2	0.0	P
15848.9	85.0	84.9	2.5	-16.0	0.2	-0.1	P
Test Passed							

### Frequency and time weightings at 1 kHz IEC 61672-3 Ed.2.0 Clause 14

Weigh	ntings	Ref.	Measured	T	01.	Uncert.	Dev.	Result
Time	Netw	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	
Fast	A	94.0	94.0	0.1	-0.1	0.2	0.0	P
Fast	C	94.0	94.1	0.1	-0.1	0.2	0.1	P
Fast	Z	94.0	94.1	0.1	-0.1	0.2	0.1	P
Fast	Flat	94.0	94.1	0.1	-0.1	0.2	0.1	P
Slow	A	94.0	94.0	0.1	-0.1	0.2	0.0	P
Leg	A	94.0	94.0	0.1	-0.1	0.2	0.0	P
SEL	A	104.0	104.0	0.1	-0.1	0.2	0.0	P
Test	Passed							

#### Level linearity on the reference level range - IEC 61672-3 Ed.2 Clause 16

Ref.	Measured	T	ol.	Uncert.	Dev.	Result			
(dB)	(dB)	(dB)	(dB)	(dB)	(dB)				
Full scale	setting: 13	BOdB	24.0.5						
The follow	ing measurem	ments a	re SPL	measurement	s				
Measured a	t 31.5 Hz								
84.0	84.0	0.8	-0.8	0.25	0.0	P			
89.0	89.0	0.8	-0.8	0.25	0.0	P			
90.6	90.6	0.8	-0.8	0.25	0.0	P			
91.6	91.6	0.8	-0.8	0.25	0.0	P			
92.6	92.6	0.8	-0.8	0.25	0.0	P			
93.6	93.6	0.8	-0.8	0.25	0.0	P			
94.6	94.6	0.8	-0.8	0.25	0.0	P			
84.0	84.0	0.8	-0.8	0.25	0.0	P			
79.0	79.0	0.8	-0.8	0.25	0.0	P			
74.0	74.1	0.8	-0.8	0.25	0.1	P			
69.0	69.1	0.8	-0.8	0.25	0.1	P			
64.0	64.1	0.8	-0.8	0.25	0.1	P			
59.0	59.1	0.8	-0.8	0.25	0.1	P			
54.0	54.1	0.8	-0.8	0.25	0.1	P			
49.0	49.1	0.8	-0.8	0.25	0.1	P			
44.0	44.1	0.8	-0.8	0.25	0.1	P			
38.0	38.1	0.8	-0.8	0.25	0.1	P			
Level	linea Ref.	rity on the Measured	e refere	ence 1	evel range - Uncert.	IEC 616 Dev.	72-3 Ed.2 Result	Clause	16
--------	---------------	-------------------------	----------	--------	-------------------------	-----------------	---------------------	--------	----
(	dB)	(dB)	(dB)	(dB)	(dB)	(dB)			
3	7.0	37.1	0.8	-0.8	0.25	0.1	P		
3	6.0	36.1	0.8	-0.8	0.25	0.1	P		
3	5.0	35.1	0.8	-0.8	0.25	0.1	P		
3	4.0	34.1	0.8	-0.8	0.25	0.1	P		
Measur	ed at	1 kHz							
9	4.0	94.0	0.8	-0.8	0.25	0.0	P		
9	9.0	99.0	0.8	-0.8	0.25	0.0	P		
10	4.0	104.1	0.8	-0.8	0.25	0.1	P		
10	9.0	109.1	0.8	-0.8	0.25	0.1	P		
11	4.0	114.1	0.8	-0.8	0.25	0.1	P		
11	9.0	119.0	0.8	-0.8	0.25	0.0	P		
12	4.0	124.0	0.8	-0.8	0.25	0.0	P		
13	0.0	130.0	0.8	-0.8	0.25	0.0	P		
13	1.0	131.0	0.8	-0.8	0.25	0.0	P		
13	2.0	132.0	0.8	-0.8	0.25	0.0	P		
13	3.0	133.0	0.8	-0.8	0.25	0.0	P		
13	4.0	134.0	0.8	-0.8	0.25	0.0	P		
9	4.0	94.0	0.8	-0.8	0.25	0.0	P		
8	9.0	89.0	0.8	-0.8	0.25	0.0	p		
8	4.0	84.0	0.8	-0.8	0.25	0.0	P		
7	9.0	79.0	0.8	-0.8	0.25	0.0	p		
7	4.0	74.0	0.8	-0.8	0.25	0.0	P		
6	9.0	69.0	0.8	-0.8	0.25	0.0	P		
6	4.0	64.0	0.8	-0.8	0.25	0.0	P		
5	9.0	59.0	0.8	-0.8	0.25	0.0	P		
5	4.0	54.0	0.8	-0.8	0.25	0.0	p		
4	9.0	49.0	0.8	-0.8	0.25	0.0	p		
4	4.0	44 0	0.8	-0.8	0.25	0.0	P		
3	8.0	38.0	0.8	-0.8	0.25	0.0	P		
3	7.0	37.0	0.8	-0.8	0.25	0.0	P		
3	6.0	36.0	0.8	-0.8	0.25	0.0	P		
3	5.0	35.1	0.8	-0.8	0.25	0.1	P		
3	4.0	34.1	0.8	-0.8	0.25	0.1	P		
Measur	ed at	8 kHz		4.0					
9	4.0	94.0	0.8	-0.8	0.25	0.0	P		
9	9.0	99.0	0.8	-0.8	0.25	0.0	P		
10	4.0	104.0	0.8	-0.8	0.25	0.0	P		
10	9.0	109.0	0.8	-0.8	0.25	0.0	P		
11	4.0	114.0	0.8	-0.8	0.25	0.0	P		
11	9.0	118.9	0.8	-0.8	0.25	-0.1	P		
12	4.0	124.0	0.8	-0.8	0.25	0.0	P		
12	8.9	128.8	0.8	-0.8	0.25	-0.1	P		
12	9.9	129.8	0.8	-0.8	0.25	-0.1	P		
13	0.9	130.8	0.8	-0.8	0.25	-0.1	P		
13	1.9	131.8	0.8	-0.8	0.25	-0.1	p		
13	2.9	132.8	0.8	-0.8	0.25	-0.1	P		
9	4.0	94.0	0.8	-0.8	0.25	0.0	P		
8	9.0	89.0	0.8	-0.8	0.25	0.0	P		
8	4.0	84.0	0.8	-0.8	0,25	0.0	P		
7	9.0	78.9	0.8	-0.8	0.25	-0.1	P		
7	4.0	73.9	0.8	-0.8	0.25	-0.1	P		
6	9.0	68.9	0.8	-0.8	0.25	-0.1	P		
6	4.0	64.0	0.8	-0.8	0.25	0.0	P		
5	9.0	58.9	0.8	-0.8	0,25	-0.1	P		
5	4.0	53.9	0.8	-0.8	0.25	-0.1	P		
4	9.0	48.9	0.8	-0.8	0.25	-0.1	P		
4	4.0	44.0	0.8	-0.8	0.25	0.0	P		

Level	l linea Ref.	rity on the Measured	referent	ence le	vel range - Uncert.	IEC 616 Dev.	72-3 Ed.2 Résult	Clause	16
	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)			
	38.0	38.0	0.8	-0.8	0.25	0.0	Р		
	37.0	37.0	0.8	-0.8	0.25	0.0	P		
	36.0	36.0	0.8	-0.8	0.25	0.0	P		
	35.0	35.0	0.8	-0.8	0.25	0.0	P		
	34.0	34.0	0.8	-0.8	0.25	0.0	P		
Test	Passed								

## Toneburst response - IEC 61672-3 Ed.2.0 Clause 18

Burst	t type	Ref.	Measured	T	01.	Uncert.	Dev.	Result
		(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	
Fast	200 mSec	127.0	127.0	0.5	-0.5	0.3	0.0	P
Fast	2.0 mSec	110.0	110.0	1.0	-1.5	0.3	0.0	P
Fast	0.25 mSec	101.0	100.9	1.0	-3.0	0.3	-0.1	P
Slow	200 mSec	120.6	120.6	0.5	-0.5	0.3	0.0	P
Slow	2.0 mSec	101.0	101.0	1.0	-3.0	0.3	0.0	P
SEL	200 mSec	121.0	121.0	0.5	-0.5	0.3	0.0	Р
SEL	2.0 mSec	101.0	101.0	1.0	-1.5	0.3	0.0	P
SEL	0.25 mSec	92.0	91.9	1.0	-3.0	0.3	-0.1	P
Test	Passed							

## Peak C sound level - IEC 61672-3 Ed.2.0 Clause 19

Pulse	Pulse	Ref.	Ref.	Measured	Tol.	Uncert.	Dev.	Result
Type	Freq.	RMS	Peak	Value			1.101	
	(Hz)	(dB)	(dB)	(dB)	(+/-dB)	(dB)	(aB)	
1 cycle	8 k	119.0	122.4	121.5	2.0	0.35	-0.9	P
Pos 1/2 cycle	e 500	122.0	124.4	124.3	1.0	0.35	-0.1	P
Neg 1/2 cycle	e 500	122.0	124.4	124.3	1.0	0.35	-0.1	P
Test Passed								

### Overload indication - IEC 61672-3 Ed.2.0 Clause 20

	Measured	Tol.	Uncert.	Result
	(dB)	(+/-dB)	(dB)	
Level difference of positive and negative puls	es: 0.1	1.5	0.25	P
Positive 1/2 cycle 4 kHz. Overload occurred at	: 139.7			
Negative 1/2 cycle 4 kHz. Overload occurred at	: 139.8			
Test Passed				

## High level stability test - IEC 61672-3 Ed.2.0 Clause 21

Test signal:	Sine wa	ve at 1	kHz		
Initial	Final	Diff.	Tol.	Uncert.	Result
level	level		value		
(dB)	(dB)	(dB)	(dB)	(dB)	
129.0	129.0	0.0	0.1	0.1	P
Test Passed					

### Long term stability test - IEC 61672-3 Ed.2.0 Clause 15

Test	signal:	Sine wave	at 1 kHz			
Time	inteval	StartLevel	StopLevel	Difference	Tolerence	Result
( mr	n:SS)	(dB)	(dB)	(dB)	(dB)	
42	2:31	94.0	94.0	0.0	0.1	P
Test	Passed					

### Filter Test 1/1octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3

Test 1/1 oc	tave filter	X= 3 fexact=	7943.282H	z class 1	
Nominal	Measured	LoLim	HiLim	Result	
f[Hz]	L[dB]	[dB]	[dB]	[P/F]	
501.187	38.6	0.0	58.0	P	
1000.00	48.2	0.0	67.0	P	
1995.26	73.1	0.0	86.0	P	
3981.07	103.9	0.0	110.5	P	
5623.41	125.1	123.0	126.0	P	
6130.56	127.5	126.7	128.3	Р	
6683.44	128.0	127.4	128.3	P	
7286.18	128.0	127.6	128.3	P	
7943.28	128.0	127.7	128.3	P	
8659.64	128.0	127.6	128.3	P	
9440.61	128.0	127.4	128.3	P	
10292.0	127.8	126.7	128.3	P	
11220.2	125.1	123.0	126.0	P	
15848.9	91.5	0.0	110.5	P	
31622.8	14.9	0.0	86.0	P	
63095.7	16.0	0.0	67.0	P	
125893	24.5	0.0	58.0	P	
Test 1/1 oct	tave filter	X= 4 fexact=	15848.932	Hz class 3	1
Nominal	Measured	LoLim	HiLim	Result	
f[H2]	L[dB]	[dB]	[dB]	[P/F]	
1000.00	42.2	0.0	58.0	P	
1995.26	57.8	0.0	67.0	P	
3981.07	82.0	0.0	86.0	P	
7943.28	110.1	0.0	110.5	P	
11220.2	125.1	123.0	126.0	P	
12232.1	127.0	126.7	128.3	P	
13335.2	127.8	127.4	128.3	P	
14537.8	128.0	127.6	128.3	P	
15848.9	128.0	127.7	128.3	P	
17278.3	128.0	127.6	128.3	P	
18836.5	128.0	127.4	128.3	P	

Filter Test	1/loctave:	Relative	attenuation	-	IEC	61260,	Clause	4.4	£	¥5.3
20535.3	128.0	126.7	128.3		p					
22387.2	125.3	123.0	126.0		P					
31622.8	33.1	0.0	110.5		P					
63095.7	18.3	0.0	86.0		P					
125893	26.1	0.0	67.0		P					
200000	24.7	0.0	58.0		P					
Test Passed										

# Filter Test 1/3octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3

Test 1/3 oc	tave filter X=	12 fexa	ct=15848.9321	Hz class	1
Nominal	Measured	LoLim	HiLim	Result	
f[Hz]	L[dB]	[dB]	(dB)	[P/F]	
2939.37	38.5	0.0	58.0	6	
5190.16	54.2	0.0	67.0	P.	
8422.54	76.5	0.0	86.0	P	
12244.5	104.7	0.0	110.5	P	
14125.4	125.0	123.0	126.0	P	
14574.3	127.5	126.7	128.3	P	
15012.0	127.9	127.4	128.3	P	
15437.2	128.0	127.6	128.3	P	
15848.9	128.0	127.7	128.3	P	
16271.7	128.0	127.6	128.3	5	
16732.6	128.0	127.4	128.3	P	
17235.0	127.9	126.7	128.3	P	
17782.8	125.0	123.0	126.0	P	
20514.4	83.5	0.0	110.5	P	
29823.4	18.6	0.0	86.0	p	
48397.1	11.7	0.0	67.0	P	
85456.6	12.5	0.0	58.0	P	
Test 1/3 oc	tave filter X=	13 fexa	ct=19952.623	dz class	1
Nominal	Measured	LoLim	HiLim	Result	
f[Hz]	L[dB]	[dB]	[dB]	[P/F]	
3700.45	43.2	0.0	58.0	P	
6534.02	62.0	0.0	67.0	P	
10603.4	83.7	0.0	86.0	P	
15414.9	109.2	0.0	110.5	P	
17782.8	126.0	123.0	126.0	P	
18348.0	127.1	126.7	128.3	P	
18898.9	127.9	127.4	128.3	P	
19434.2	128.0	127.6	128.3	P	
19952.6	128.0	127.7	128.3	P	
20484.8	128.0	127.6	128.3	P	
21065.1	128.0	127.4	128.3	Р	
21697.6	128.0	126.7	128.3	P	
22387.2	125.0	123.0	126.0	P	
25826.2	59.7	0.0	110.5	P	
37545.4	14.2	0.0	86.0	P	
60928.4	15.7	0.0	67.0	P	
107584	15.2	0.0	58.0	P	
Test Passed					
SC310.ini					

JD6







Scantek, Inc. 6430 Dobbin Road, Suite C Columbia, MD 21045

# Test Report No.: 37132 Part 2

Instrument:	Sound Level Meter
Manufacturer:	Cesva
Model:	SC310
Serial no:	T229771
ID no:	24125
Tested with:	Microphone C-130 sn: 10467
Customer:	McHale Performance
Date:	10/11/2016

Type:

### Input level: 94 dB

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		A weighting		Toleran						
Frequency [Hz]	Measured pressure response [dB re 20µPa]	Estimated Free Field response [dB re 20µPa]	Reference level [dB re 20µPa]	Result	ту	pe 1	Ту	pe 2	Expanded uncertainty (cov. fact. 2) [dB]	
31.5	55.7	55.7	54.8	Passed	1.5	-1.5	3.0	-3.0	0.17	
63	68.1	68.1	68.0	Passed	1.0	-1.0	2.0	-2.0	0.16	
125	78.0	78.0	78.1	Passed	1.0	-1.0	1.5	-1.5	0.16	
250	85.5	85.5	85.6	Passed	1.0	-1.0	1.5	-1.5	0.16	
500	90.9	90.9	91.0	Passed	1.0	-1.0	1.5	-1.5	0.16	
1000	94.2	94.2	94.2	Passed	1.0	-1.0	1.5	-1.5	0.16	
2000	95.5	95.5	95.4	Passed	1.0	-1.0	2.0	-2.0	0.16	
4000	95.2	95.2	95.2	Passed	1.0	-1.0	3.0	-3.0	0.30	
8000	93.5	93.5	93.1	Passed	1.5	-3.0	5.0	-5.0	0.91	
12500	88.4	88.4	89.9	Passed	3.0	-6.0	5.0	-99.0	2.4	
16000	82.7	82.7	87.6	Passed	3.0	-99.0	5.0	-99.0	1.2	

Tested by: JG

Document stored as: Z:\Calibration Lab\2016 Certs\SC310 McHale 37132-T229771\_24125.xlsx

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# Test Regard No. 192

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# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 14 February 2017
SERIAL NUMBER:	6425	CAL DUE:	14 February 2018
ASSET NUMBER:	24223	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	125~1100 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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$\mathcal{D}$	 Calibrate	ed By:	-

**Approved By:** 

Standards U	Jsed			
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10290	Fluke 9173 Metrology Well w/ built-in Ref. Readout	B54045	4/1/2015	3/29/2025
14016	Rosemount Aerospace 162CE SPRT	4211	8/19/2016	8/19/2017

Standard Deading	LIUT Deading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	TU
Probe ID Number	= TT024223				-	
Probe Calibration Ran	ige = 125 to 1100 Deg	F				
	= 51.7 to	593.3 Deg (	C			
AS FOUND/AS LEFT RESU	ILTS					
Degrees F						
Resistance Value at I	emp = 120.012 Ohms					
125.1070 F	124.947F	0.5000F	32	Pass	1.2e-001F	
Resistance Value at T	emp = 154.23783 Ohms					
287.4490 F	287.646F	0.5000F	39.4	Pass	1.2e-001F	
Resistance Value at T	emp = 187.47917 Ohms					
449.8480 F	450.027F	0.5000F	35.8	Pass	1.2e-001F	
Resistance Value at T	emp = 219.74583 Ohms					
612.2640 F	612.113F	0.5000F	30.2	Pass	1.2e-001F	
Resistance Value at I	emp = 251.17467 Ohms					
774.7370 F	774.597F	0.5000F	28	Pass	1.2e-001F	
Resistance Value at I	emp = 281.71017 Ohms					
937.2310 F	937.215F	0.5000F	3.2	Pass	1.2e-001F	
Resistance Value at I	emp = 311.319 Ohms					
1099.7020 F	1099.792F	0.5000F	18	Pass	1.2e-001F	
***********Degrees	C*****					
Resistance Value at T	emp = 120.012 Ohms					
51.7260 c	51.637c	0.2780c	32	Pass	6.4e-002c	
Resistance Value at T	emp = 154.23783 Ohms					
141.9160 c	142.025c	0.2780c	39.2	Pass	6.4e-002c	
Resistance Value at T	emp = 187.47917 Ohms					
232.1370 c	232.237c	0.2780c	36	Pass	6.4e-002c	
Resistance Value at T	emp = 219.74583 Ohms					
322.3690 c	322.285c	0.2780c	30.2	Pass	6.4e-002c	
Resistance Value at T	emp = 251.17467 Ohms					
412.6320 c	412.554c	0.2780c	28.1	Pass	6.4e-002c	
Resistance Value at T	emp = 281.71017 Ohms					
502.9060 c	502.897c	0.2780c	3.24	Pass	6.4e-002c	
Resistance Value at I	'emp = 311.319 Ohms					
593.1680 c	593.218c	0.2780c	18	Pass	6.4e-002c	

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.04609 Alpha= 0.003837541 Delta= 1.46722909063 A= 0.00389384651792 B= -5.63055179168e-007

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	6528	CAL DUE:	09 February 2018
ASSET NUMBER:	24279 Digital PTD		
PROCEDURE NAME: PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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<u> </u>	Calibrated	By:	•

**Approved By:** 

Standards U	Jsed			
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe ID Number	= TT024279					
Probe Calibration	Range = 20 to 200 Deg	F				
	= -6.7	to 93.3 Deg C				
AS FOUND/AS LEFT H	RESULTS					
Degrees F						
Resistance Value a	at Temp = 97.79017 Ohms					
20.4060 F	20.415F	0.2590F	3.47	Pass	3.4e-002F	
Resistance Value a	at Temp = 104.288 Ohms					
50.3570 F	50.344F	0.2590F	5.02	Pass	3.4e-002F	
Resistance Value a	at Temp = 110.76233 Ohm	S				
80.3200 F	80.315F	0.2590F	1.93	Pass	3.4e-002F	
Resistance Value a	at Temp = 117.2155 Ohms					
110.3350 F	110.341F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	at Temp = 123.63317 Ohm	S				
140.3530 F	140.356F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value a	at Temp = 130.02183 Ohm	S				
170.3830 F	170.389F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value a	at Temp = 136.37467 Ohm	s				
200.4150 F	200.409F	0.2590F	2.32	Pass	3.4e-002F	
************Degre	ees C************					
Resistance Value a	at Temp = 97.79017 Ohms					
-6.4410 c	-6.436c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value a	at Temp = 104.288 Ohms					
10.1980 c	10.191c	0.1440c	4.86	Pass	1.9e-002c	
Resistance Value a	at Temp = 110.76233 Ohm	S				
26.8440 c	26.842c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 117.2155 Ohms					
43.5200 c	43.523c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value a	at Temp = 123.63317 Ohm	s				
60.1960 c	60.198c	0.1440c	1.39	Pass	1.9e-002c	
Resistance Value a	at Temp = 130.02183 Ohm	s				
76.8790 c	76.883c	0.1440c	2.78	Pass	1.9e-002c	
Resistance Value a	at Temp = 136.37467 Ohm	s				
93.5640 c	93.561c	0.1440c	2.08	Pass	1.9e-002c	
As Left Coefficier	its:					
Equation Used= Cal	llendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.30922 Alpha= 0.003839081 Delta= 1.54063891255 A= 0.00389822737577 B= -5.91463757704e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1 ACCREDITED by NVLAP (an ILAC MRA signatory)



NVLAP Lab Code: 200625-0

# Calibration Certificate No.37131

nstrument:	<b>Acoustical Calibrator</b>
Nodel:	CB006
Manufacturer:	Cesva
erial number:	48461
lass (IEC 60942):	1
arometer type:	
arometer s/n:	
D number:	24356
ustomer:	McHale Performance
el/Fax:	865-588-2654 x119 /

Status:	Received	Sent
In tolerance:		Х
Out of tolerance:	X	
See comments:	x	

Address: 4700 Coster Rd Knoxville, TN 37912

Tested in accordance with the following procedures and standards: Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument Manufactures	Decemention	e Ini	Cal Date	Traceability evidence	C-1 P
instrument - manufacturer	Description	5/14	Cal. Date	Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31061	Jul 27, 2016	Scantek, Inc./ NVLAP	Jul 27, 2017
DS-360-SRS	Function Generator	88077	Sep 15, 2016	ACR Env./ A2LA	Sep 15, 2018
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Sep 15, 2016	ACR Env./ A2LA	Sep 15, 2017
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016
140-Norsonic	Real Time Analyzer	1403978	Mar 17, 2016	Scantek, Inc. / NVLAP	Mar 17, 2017
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	
4192-Brüel&Kjær	Microphone	2854675	Nov 11, 2015	Scantek, Inc. / NVLAP	Nov 11, 2016
1203-Norsonic	Preamplifier	92268	Oct 14, 2015	Scantek, Inc./ NVLAP	Oct 14, 2016

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Jeremy Gotwalt	Authorized signatory:	Valentin Buzduga
Signature	and them	Signature	A
Date	10 10/7/16	Date	10/12/2016

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory. This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.

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Page 1 of 2

#### Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES <sup>1</sup> FROM STANDARDS REFERENCED IN PROCEDURES:	MET2	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X	1992	
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI \$1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI \$1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI \$1.40:2005 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	X		
ANSI \$1.40:2005 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI 51.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (\*) are not covered by the current NVLAP accreditation.

### Main measured parameters <sup>3</sup>:

Measured <sup>4</sup> /Acceptable <sup>5</sup>	Measured <sup>4</sup> /Acceptable <sup>5</sup>	Measured <sup>4</sup> /Acceptable Level <sup>5</sup>
Tone frequency (Hz):	Total Harmonic Distortion (%):	(dB):
1000.03 ± 1.0/1000.0 ± 10.0	0.20 ± 0.10/ < 3	93.76 ± 0.12/94.0 ± 0.4

<sup>3</sup> The stated level is valid at measurement conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

### **Environmental conditions:**

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
21.7 ± 1.0	100.76 ± 0.000	58.6 ± 2.0

### Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type:		
Other:		

#### Adjustments: Unit was adjusted for level.

Comments: As received, the instrument produced sound pressure level below the lower limit of the admissible range. The level was adjusted to the maximum value possible. After adjustment, the instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.

Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 37131 of two pages.

Place of Calibration: Scantek, Inc. 6430 Dobbin Road, Suite C Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167 callab@scantekinc.com

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory. This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.

Document stored as: Z:\Calibration Lab\Cal 2016\CesvaCB006\_48461\_M2.doc

# Test Report No.:37131

Manufacturer: Type: Serial no: Cesva CB006 48461

Customer: McHale Performance Department: Address: 4700 Coster Rd, Knoxville, TN 37912 Order No: Contact Person: Jessica Trent Phone No.: 865-588-2654 x119 eMail: jessica.trent@mchaleperformance.com

Measurement Results:

Level: P. (dB) 1: 93.62	Stab : Frequency: (dB) (Hz) 0.02 1000.03	F. Stab : (%) 0.00	Distortion: (% TD) 0.20
Result (Average): Expanded Uncertainty:	0.00	0.00	
Degree of Freedom: Coverage Factor: The stated levels are relative to 20µPa.	0.00		

The stated level is valid at measurement conditions. Reference microphone: 4134-982459. Volume correction: 0.000 dB Records:Z:\Calibration Lab\Cal 2016\CesvaCB006 48461 M1.nmf

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

As received data.

Environmental conditions: Pressure: Temperature: 100.760 ± 0.020 kPa 21.7 ± 1.0 °C

Relative humidity: 58.6 ± 2.0 %RH

Date of calibration: 10/7/2016 Date of issue: 10/7/2016

Supervisor : Valentin Buzduga Measurements performed by:

Jeremy Conwalt

Scantek, Inc. 6430 Dobbin Rd., Suite C, Columbia, MD 21045 Ph: 410-290-7726 eMail: callab@scantekinc.com

# Test Report No.:37131

Manufacturer:	
Type:	
Serial no:	

Cesva CB006 48461

Customer: McHale Performance Department: Address: 4700 Coster Rd, Knoxville, TN 37912 Order No: Contact Person: Jessica Trent Phone No.: 865-588-2654 x119 eMall: jessica.trent@mchaleperformance.com

Measurement Results:

	Level:	P. Stab :	Frequency:	F. Stab :	Distortion:
	(dB)	(dB)	(Hz)	(8)	(% TD)
1:	93.76	0.01	1000.03	0.00	0.20
2:	93.75	0.01	1000.04	0.00	0.20
3:	93.77	0.02	1000.03	0.00	0.20
Result (Average):	93.76	0.01	1000.03	0.00	0.20
Expanded Uncertainty:	0.12	0.02	1.00	0.01	0.10
Degree of Freedom:	>100	>100	>100	>100	>100
Coverage Factor:	2.00	2.00	2.00	2.00	2.00
The stated levels are re	lative to 20	)pPa.			

The stated level is valid at measurement conditions. Reference microphone: 4134-982459. Volume correction: 0.000 dB Records:Z:\Calibration Lab\Cal 2016\CesvaCB006\_48461\_M2.nmf

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-6/02.

After adjustment data.

Environmental conditions: Pressure: Temperature: 100.760 ± 0.020 kPa 21.7 ± 1.0 °C

Relative humidity: 58.6 ± 2.0 %RH

Date of calibration: 10/7/2016 Date of issue: 10/7/2016

Supervisor : Valentin Buzduga Measurements performed by:

Jeremy Gotwalt

Scantek, Inc. 6430 Dobbin Rd., Suite C, Columbia, MD 21045 Ph: 410-290-7726 eMail: callab@scantekinc.com

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# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	Press. Transmitter, Abs.	TEST RESULT: CAL DATE:	PASS 03 March 2017
SERIAL NUMBER:	1317188	CAL DUE:	03 March 2018
ASSET NUMBER:	51593	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMED:	Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent Medale & Associates	TEMPERATURE: HUMIDITY:	21.00 •C 30 %
COSTOMER.	4700 Coster Rd.	CAL RANGE:	10~15
	Knoxville, TN 37912	CAL UNITS:	psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards	Used			
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA51593					
Calibrated Span =	5 PSI					
Calibration Tolera	nce = 0.00325 PSI					
Upscale Tests						
10.0000 psi	10.000psi	0.00325psi	0	Pass	9.9e-004psi	
11.2500 psi	11.249psi	0.00325psi	30.8	Pass	1.1e-003psi	3.61
12.5000 psi	12.500psi	0.00325psi	0	Pass	1.2e-003psi	3.25
13.7500 psi	13.751psi	0.00325psi	30.8	Pass	1.2e-003psi	2.95
15.0000 psi	15.000psi	0.00325psi	0	Pass	1.3e-003psi	2.71
Downscale Tests						
15.0000 psi	15.000psi	0.00325psi	0	Pass	1.3e-003psi	2.71
13.7500 psi	13.750psi	0.00325psi	0	Pass	1.2e-003psi	2.95
12.5000 psi	12.500psi	0.00325psi	0	Pass	1.2e-003psi	3.25
11.2500 psi	11.249psi	0.00325psi	30.8	Pass	1.1e-003psi	3.61
10.0000 psi	10.000psi	0.00325psi	0	Pass	9.9e-004psi	

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST: SERIAL NUMBER: ASSET NUMBER: PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Press. Transmitter, Abs. 51604 Digital Pressure Transmitter (PSI) 0 - 08/25/09 Jessica Trent	TEST RESULT: CAL DATE: CAL DUE: DATA TYPE: TEMPERATURE: HUMIDITY:	PASS 03 March 2017 03 March 2018 AS-LEFT 21.00 •C 30 %
		CAL RANGE: CAL UNITS:	10~15 psia

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**REMARKS:** Instrument passed calibration as left.

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**Approved By:** 

Standards V	Standards Used					
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
14025	DH Instruments PPC4 Pressure Controller/Calibrator	217	7/11/2016	7/11/2017		
14052	DH Instruments RPM4 Pressure Controller/Calibrator	1067	7/9/2016	7/9/2017		

Test Results						
Standard Reading	<u>UUT Reading</u>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Transmitter Tag =	PTA51604					
Calibrated Span = 3	5 PSI					
Calibration Tolera	nce = 0.00325 PSI					
Upscale Tests						
10.0000 psi	9.999psi	0.00325psi	30.8	Pass	9.9e-004psi	
11.2500 psi	11.249psi	0.00325psi	30.8	Pass	1.1e-003psi	3.61
12.5000 psi	12.500psi	0.00325psi	0	Pass	1.2e-003psi	3.25
13.7500 psi	13.750psi	0.00325psi	0	Pass	1.2e-003psi	2.95
15.0000 psi	15.001psi	0.00325psi	30.8	Pass	1.3e-003psi	2.71
Downscale Tests						
15.0000 psi	15.001psi	0.00325psi	30.8	Pass	1.3e-003psi	2.71
13.7500 psi	13.751psi	0.00325psi	30.8	Pass	1.2e-003psi	2.95
12.5000 psi	12.501psi	0.00325psi	30.8	Pass	1.2e-003psi	3.25
11.2500 psi	11.250psi	0.00325psi	0	Pass	1.1e-003psi	3.61
10.0000 psi	9.999psi	0.00325psi	30.8	Pass	9.9e-004psi	

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	100013	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Used			
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= 100013					
Probe Calibration 3	Range = -20 to 120 De	g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 88.8145 Ohms					
-19.4830 F	-19.488F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 96.46017 Ohm	S				
15.4290 F	15.439F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 104.06217 Oh	ms				
50.3790 F	50.376F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 111.62483 Oh	ms				
85.3510 F	85.344F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 119.15117 Oh	ms		_		
120.3530 F	120.357F	0.1000F	4	Pass	3.4e-002F	2.94
************Degre	es C************					
Resistance Value a	t Temp = 88.8145 Ohms					
-28.6020 c	-28.604c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 96.46017 Ohm	S				
-9.2060 c	-9.201c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 104.06217 Oh	ms				
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 111.62483 Oh	ms				
29.6390 c	29.635c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 119.15117 Oh	ms		_		
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal.	lendar-Van Dusen					
where $T = Deg C an$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(R)]	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.06943						
Alpha= 0.003853598						
Delta= 1.581206345	68					
A= 0.003914531	33611					

\*\*\*\*\* End of Report \*\*\*\*\*

-6.09333361131e-007

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# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Digital, 4-Wire	TEST RESULT: CAL DATE:	PASS 09 February 2017
SERIAL NUMBER:	2241	CAL DUE:	09 February 2018
ASSET NUMBER:	160025	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Digital RTD	TEMPERATURE:	22.00 °C
PROCEDURE REV.:	1 - 01/05/06	HUMIDITY:	31 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	20~200 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrated	By:

**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Standard Reading	UUT Reading = TT160025	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
Probe Calibration	Range = 20 to 200 Deg F = -6.7 t	o 93.3 Deg C				
AS FOUND/AS LEFT	RESULTS					
Degrees F						
Resistance Value	at Temp = 97.443 Ohms					
20.4060 F	20.404F	0.2590F	0.772	Pass	3.4e-002F	
Resistance Value	at Temp = 104.07383 Ohms					
50.3570 F	50.357F	0.2590F	0	Pass	3.4e-002F	
Resistance Value	at Temp = 110.6755 Ohms					
80.3200 F	80.328F	0.2590F	3.09	Pass	3.4e-002F	
Resistance Value	at Temp = 117.25167 Ohms					
110.3350 F	110.335F	0.2590F	0	Pass	3.4e-002F	
Resistance Value	at Temp = 123.7955 Ohms					
140.3530 F	140.347F	0.2590F	2.32	Pass	3.4e-002F	
Resistance Value	at Temp = 130.3105 Ohms					
170.3830 F	170.380F	0.2590F	1.16	Pass	3.4e-002F	
Resistance Value	at Temp = 136.79333 Ohms					
200.4150 F	200.419F	0.2590F	1.54	Pass	3.4e-002F	
*************Degr	ees C************					
Resistance Value	at Temp = 97.443 Ohms					
-6.4410 c	-6.442c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value	at Temp = 104.07383 Ohms					
10.1980 c	10.198c	0.1440c	0	Pass	1.9e-002c	
Resistance Value	at Temp = $110.6755$ Ohms					
26.8440 c	26.849c	0.1440c	3.47	Pass	1.9e-002c	
Resistance Value	at Temp = 117.25167 Ohms					
43.5200 c	43.520c	0.1440c	0	Pass	1.9e-002c	
Resistance Value	at Temp = 123.7955 Ohms					
60.1960 c	60.193c	0.1440c	2.08	Pass	1.9e-002c	
Resistance Value	at Temp = 130.3105 Ohms					
76.8790 c	76.878c	0.1440c	0.694	Pass	1.9e-002c	
Resistance Value	at Temp = 136.79333 Ohms					
93.5640 c	93.566c	0.1440c	1.39	Pass	1.9e-002c	
As Left Coefficie	nts:					
Equation Used= Ca	llendar-Van Dusen					

Equation Used= Callendar-Van Dusen where T = Deg C and Rt = Resistance at Temp T = [-RoA + Sqrt(Ro^2\*A^2-4Ro\*B(Ro-Rt))]/(2\*Ro\*B) Ro= 100.01409 Alpha= 0.003926417 Delta= 1.52911931646 A= 0.00398645660079 B= -6.00396007917e-007

\*\*\*\*\* End of Report \*\*\*\*\*

Test Results



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	300012	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrate	d By:

**Approved By:** 

Standards U	Jsed			
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= 300012					
Probe Calibration H	Range = -20 to 120 Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.75483 Ohms					
-19.4830 F	-19.489F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.39817 Ohms					
15.4290 F	15.440F	0.1000F	11	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.9965 Ohms					
50.3790 F	50.381F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.55 Ohms	0 40005		_	0 4 0005	
85.3510 F	85.336F	0.1000F	15	Pass	3.4e-002F	2.94
120 3530 E	120.2605	S 0 1000F	7	Deee	2 40 0025	2.04
120.33301	120.300F	0.1000F	7	Pass	3.40-002F	2.94
*****	S (************					
Resistance Value at	t Temp = 88.75483 Ohms					
-28.6020 c	-28.605c	0.0560c	5 36	Pass	1.9e-002c	2 95
Resistance Value at	t Temp = 96.39817 Ohms		0.00			2.00
-9.2060 c	-9.200c	0.0560c	10.7	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.9965 Ohms					
10.2100 c	10.212c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.55 Ohms					
29.6390 c	29.631c	0.0560c	14.3	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.07067 Ohm	S				
49.0850 c	49.089c	0.0560c	7.14	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 100.00526						
Alpha= 0.003851438						
Delta= 1.6427468015	59					

A= 0.00391470737456

B= -6.32693745602e-007

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A 300018	CAL DUE:	06 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= 300018					
Probe Calibration R	Range = $-20$ to $120$ Deg	g F				
	= -28.9	9 to 48.9 Deg	C			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	: Temp = 88.755 Ohms					
-19.4830 F	-19.486F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 96.39433 Ohms	3				
15.4290 F	15.436F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 103.99183 Ohr	ns	_	_		
50.3790 F	50.377F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 111.54917 Ohr	ns 0.40005	_	_	0 4 0005	
85.3510 F	85.346	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	1'emp = 119.06933 Ohr	ns 0.4000F	2	Deee	2 4- 0025	2.04
120.33301	120.330F	0.1000F	3	Pass	3.40-002F	2.94
***********Degree	es C***********					
Resistance Value at	: Temp = 88.755 Ohms					
-28.6020 c	-28.604c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 96.39433 Ohms	5				
-9.2060 c	-9.202c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	. Temp = 103.99183 Ohr	ns				
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 111.54917 Ohr	ns				
29.6390 c	29.636c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 119.06933 Ohr	ns				
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at 1	ľemp				
T = [-RoA + Sqrt(Rc	o^2*A^2-4Ro*B(Ro-Rt))]	]/(2*Ro*B)				
Ro= 100.00173						
Alpha= 0.00385333						
Delta= 1.5847023412	23					
A= 0.0039143938	31073					

\*\*\*\*\* End of Report \*\*\*\*\*

-6.10638107254e-007

B=



# REPORT OF CALIBRATION

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT007	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT007					
Probe Calibration H	Range = $-20$ to $120$ Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.7645 Ohms					
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.39467 Ohms					
15.4290 F	15.432F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.9865 Ohms					
50.3790 F	50.378F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.539 Ohms					
85.3510 F	85.348F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.0545 Ohms					
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.7645 Ohms					
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.39467 Ohms					
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.9865 Ohms					
10.2100 c	10.210c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.539 Ohms					
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.0545 Ohms					
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 99.99953						
Alpha= 0.003851854						
Delta= 1.536849363	79					

\*\*\*\*\* End of Report \*\*\*\*\*

0.00391105119369 -5.91971936933e-007

A=

B=



# REPORTOFCALIBRATION

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT012	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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Standards U	Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT012					
Probe Calibration 1	Range = -20 to 120 De	g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value a	t Temp = 88.772 Ohms					
-19.4830 F	-19.486F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 96.40167 Ohm	S				
15.4290 F	15.434F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 103.99167 Oh	ms				
50.3790 F	50.382F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 111.53767 Oh	ms				
85.3510 F	85.341F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value a	t Temp = 119.05 Ohms			_		
120.3530 F	120.357F	0.1000F	4	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value a	t Temp = 88.772 Ohms					
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 96.40167 Ohm	IS				
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 103.99167 Oh	ms				
10.2100 c	10.212c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 111.53767 Oh	ms				
29.6390 c	29.634c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value a	t Temp = 119.05 Ohms					
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficien	ts:					
Equation Used= Cal	lendar-Van Dusen					
where $T = Deg C an$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Rot)]	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.00522						
Alpha= 0.003848467						
Delta= 1.587202007	69					
A= 0.003909549	94549					

\*\*\*\*\* End of Report \*\*\*\*\*

-6.10829454892e-007

B=



# **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT016	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards U	Jsed			
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT016					
Probe Calibration H	Range = -20 to 120 De	g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 88.77033 Ohm	S				
-19.4830 F	-19.484F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 96.39683 Ohm	s				
15.4290 F	15.429F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 103.98667 Oh	ms				
50.3790 F	50.379F	0.1000F	0	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 111.53617 Oh	ms				
85.3510 F	85.349F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 119.04817 Oh	ms				
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C**********					
Resistance Value at	: Temp = 88.77033 Ohm	S				
-28.6020 c	-28.602c	0.0560c	0	Pass	1.9e-002c	2 95
Resistance Value at	. Temp = 96.39683 Ohm	s	Ū	1 400		
-9.2060 c	-9.206c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	. Temp = 103.98667 Oh	ms	Ū	1 400		2.00
10.2100 c	10 211c	0.0560c	1 79	Pass	1.9e-002c	2 95
Resistance Value at	: Temp = 111.53617 Oh	ms		1 400		2.00
29.6390 c	29 639c	0.0560c	0	Pass	1 9e-002c	2 95
Resistance Value at	: Temp = 119.04817 Oh	ms	Ū	1 400		2.00
49.0850 c	49.085c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient						
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at	Temp				
T = [-RoA + Sart(Ro	$p^{2}A^{2}-4Ro^{B}(Ro-R^{+})$	1/(2*Ro*B)				
Ro= 100.00095	( 1.0/)					
Alpha= 0.00385019						
Dolto = 1.5406977700	5					

Delta= 1.54069777005 A= 0.00390950979147

B= -5.93197914725e-007

\*\*\*\*\* End of Report \*\*\*\*\*



# **REPORTOFCALIBRATION**

McHalePerformance of

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT018	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
Sooromen.	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used							
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date			
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017			
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018			
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018			
Test Results							
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Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>	
DAS Asset	= 10219						
Probe ID Number	= CT018						
Probe Calibration F	Range = -20 to 120 Deg	F					
	= -28.9	to 48.9 Deg	С				
AS LEFT RESULTS							
Degrees F							
Resistance Value at	Temp = 88.77467 Ohms						
-19.4830 F	-19.484F	0.1000F	1	Pass	3.4e-002F	2.94	
Resistance Value at	Temp = 96.40417 Ohms						
15.4290 F	15.430F	0.1000F	1	Pass	3.4e-002F	2.94	
Resistance Value at	: Temp = 103.99633 Ohms	3					
50.3790 F	50.379F	0.1000F	0	Pass	3.4e-002F	2.94	
Resistance Value at	Temp = 111.54783 Ohms	3 	_	_			
85.3510 F	85.349F	0.1000F	2	Pass	3.4e-002F	2.94	
Resistance Value at	Temp = 119.062 Ohms	0.40005		5	0 4 0005		
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94	
************Degree	es C***********						
Resistance Value at	Temp = 88.77467 Ohms						
-28.6020 c	-28.602c	0.0560c	0	Pass	1.9e-002c	2.95	
Resistance Value at	Temp = 96.40417 Ohms						
-9.2060 c	-9.205c	0.0560c	1.79	Pass	1.9e-002c	2.95	
Resistance Value at	Temp = 103.99633 Ohms	5					
10.2100 c	10.211c	0.0560c	1.79	Pass	1.9e-002c	2.95	
Resistance Value at	: Temp = 111.54783 Ohms	5					
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95	
Resistance Value at	Temp = 119.062 Ohms						
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95	
As Left Coefficient	s:						
Equation Used= Call	lendar-Van Dusen						
where $T = Deg C$ and	d Rt = Resistance at Te	emp					
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]/	/(2*Ro*B)					
Ro= 100.00934							
Alpha= 0.003850766							
Delta= 1.5502351203	35						
A= 0.0039104619	92693						

-5.96959269344e-007



#### REPORTOFCALIBRATION

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT027	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY:	0 - 09/30/04 Jessica Trent	HUMIDITY:	30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT027					
Probe Calibration H	Range = -20 to 120 Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.74033 Ohms					
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.37417 Ohms					
15.4290 F	15.432F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.96917 Ohm	IS				
50.3790 F	50.378F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.52483 Ohm	IS				
85.3510 F	85.348F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.043 Ohms					
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.74033 Ohms					
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.37417 Ohms					
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.96917 Ohm	IS				
10.2100 c	10.210c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.52483 Ohm	IS				
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.043 Ohms					
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 99.98057						
Alpha= 0.003853911						
Delta= 1.5462396948	32					
A= 0.0039135017	70169					

-5.95907016852e-007



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT040	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	IIIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT040					
Probe Calibration H	Range = -20 to 120 Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.74767 Ohms					
-19.4830 F	-19.487F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.385 Ohms					
15.4290 F	15.438F	0.1000F	9	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.9785 Ohms			_		
50.3790 F	50.375F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.53233 Ohm	S 0 40005	_	-		
85.35 IU F	85.346F	0.1000F	5	Pass	3.4e-002F	2.94
120 3530 F	120 2565	S 0 1000E	2	Dooo	2 40 0025	2.04
120.00001	120.330F	0.1000F	5	F d 5 5	3.40-002F	2.94
*****	os C*************					
Resistance Value at	t Temp = 88.74767 Ohms					
-28.6020 c	-28.604c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.385 Ohms					
-9.2060 c	-9.201c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.9785 Ohms					
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.53233 Ohm	S				
29.6390 c	29.637c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.04783 Ohm	s				
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 99.99054						
Alpha= 0.003851191	21					
Delta= 1.6094212969	91					
A= 0.0039131728	38814					

-6.19818881385e-007



#### **REPORTOFCALIBRATION**

0 Coster Road . Knoxville, TN 37934 . 865-588-2654

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT044	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT044					
Probe Calibration H	Range = -20 to 120 Dec	q F				
	= -28.9	9 to 48.9 Deg	с			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.767 Ohms					
-19.4830 F	-19.488F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.40533 Ohms	S				
15.4290 F	15.441F	0.1000F	12	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.99717 Ohr	ns				
50.3790 F	50.373F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.55117 Ohr	ns				
85.3510 F	85.346F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.06617 Ohr	ns 0.40005	•	5	0 4 0005	
120.3530 F	120.356F	0.1000F	3	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value at	t Temp = 88.767 Ohms					
-28.6020 c	-28.605c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.40533 Ohm	5				
-9.2060 c	-9.199c	0.0560c	12.5	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.99717 Ohr	ms				
10.2100 c	10.207c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.55117 Ohr	ns				
29.6390 c	29.637c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.06617 Ohr	ns				
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at 1	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.00996						
Alpha= 0.003850088						
Delta= 1.6152869236	6					
A= 0.0039122779	96801					

-6.21899680112e-007



## **REPORTOFCALIBRATION**

McHalePerformance co

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UNIT UNDER TEST:	RTD, Analog, 4-Wire, 8"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	CT049	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= CT049					
Probe Calibration H	Range = -20 to 120 Dec	g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.74133 Ohm	5				
-19.4830 F	-19.487F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.38183 Ohm	3				
15.4290 F	15.437F	0.1000F	8	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.9795 Ohm	5				
50.3790 F	50.376F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.53767 Ohr	ns				
85.3510 F	85.345F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.05867 Ohr	ns				
120.3530 F	120.356F	0.1000F	3	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.74133 Ohm	5				
-28.6020 c	-28.604c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.38183 Ohm	3				
-9.2060 c	-9.201c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.9795 Ohm	5				
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.53767 Ohr	ns				
29.6390 c	29.636c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.05867 Ohr	ns				
49.0850 c	49.087c	0.0560c	3.57	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at '	Гemp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.98922						
Alpha= 0.003854172						
Delta= 1.584569067	48					
A= 0.003915244	01732					

-6.10720173195e-007



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R05	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R05					
Probe Calibration H	Range = -20 to 120 De	:g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.78733 Ohm	IS				
-19.4830 F	-19.490F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.43967 Ohm	IS				
15.4290 F	15.444F	0.1000F	15	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 104.04483 Oh	ms				
50.3790 F	50.374F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.61117 Oh	ms				
85.3510 F	85.341F	0.1000F	10	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.1415 Ohm	IS				
120.3530 F	120.358F	0.1000F	5	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.78733 Ohm	IS				
-28.6020 c	-28.605c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.43967 Ohm	IS				
-9.2060 c	-9.198c	0.0560c	14.3	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 104.04483 Oh	ms				
10.2100 c	10.208c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.61117 Oh	ms				
29.6390 c	29.634c	0.0560c	8.93	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.1415 Ohm	IS				
49.0850 c	49.088c	0.0560c	5.36	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C and$	d Rt = Resistance at	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 100.05016						
Alpha= 0.003855762						
Delta= 1.6044484785	57					
A= 0.003917625	71475					

-6.18637147461e-007



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	R119	CAL DUE:	06 March 2018
ASSET NUMBER:	R119	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R119					
Probe Calibration H	Range = -20 to 120 Deg	f F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.86833 Ohms					
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.51567 Ohms	5				
15.4290 F	15.433F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 104.12367 Ohm	IS				
50.3790 F	50.377F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.69267 Ohm	15		_	0 / 0005	
85.3510 F	85.349F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.2235 Ohms	0.40005	4	Daaa		0.04
120.3030 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
*****	es C**********					
Resistance Value at	t Temp = 88.86833 Ohms	5				
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.51567 Ohms	5				
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 104.12367 Ohm	IS				
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.69267 Ohm	IS				
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.2235 Ohms					
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	'emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	/(2*Ro*B)				
Ro= 100.1283						
Alpha= 0.003854766	- A					
Delta= 1.5505320455	54					
A= 0.0039145353	38211					

-5.97693821107e-007



## **REPORT OF CALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R273	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUISTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	IIIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R273					
Probe Calibration R	ange = $-20$ to $120$ Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 88.76383 Ohms					
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 96.40133 Ohms					
15.4290 F	15.433F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 104.0005 Ohms					
50.3790 F	50.378F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 111.561 Ohms					
85.3510 F	85.348F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 119.08483 Ohms			_		
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	s C*******					
Resistance Value at	Temp = 88.76383 Ohms					
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 96.40133 Ohms					
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 104.0005 Ohms					
10.2100 c	10.210c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 111.561 Ohms					
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 119.08483 Ohms					
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C$ and	Rt = Resistance at Te	mp				
T = [-RoA + Sqrt(Ro	^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.0096						
Alpha= 0.003855842						
Delta= 1.522228516						
A= 0.0039145367	2646					

-5.86947264559e-007



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R321	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	0 - 09/30/04 Jessica Trent McHale & Associates	HUMIDITY:	30 %
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R321					
Probe Calibration R	ange = -20 to 120 Deg B	?				
	= -28.9 t	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 88.77283 Ohms					
-19.4830 F	-19.490F	0.1000F	7	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 96.42233 Ohms					
15.4290 F	15.444F	0.1000F	15	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 104.024 Ohms					
50.3790 F	50.374F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 111.58717 Ohms			_		
85.3510 F	85.342F	0.1000F	9	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 119.1135 Ohms	0.40005	-	Daar		0.04
120.3530 F	120.358F	0.1000F	5	Pass	3.4e-002F	2.94
***********Degree	s C******					
Resistance Value at	Temp = 88.77283 Ohms					
-28.6020 c	-28.606c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 96.42233 Ohms					
-9.2060 c	-9.198c	0.0560c	14.3	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 104.024 Ohms					
10.2100 c	10.208c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 111.58717 Ohms					
29.6390 c	29.635c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 119.1135 Ohms					
49.0850 c	49.088c	0.0560c	5.36	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C$ and	.Rt = Resistance at Tem	np				
T = [-RoA + Sqrt(Ro	^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.03124						
Alpha= 0.00385446						
Delta= 1.6150214879	4					
A= 0.0039167103	5724					

-6.2250357244e-007



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R397A	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used						
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>		
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017		
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018		
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018		

Test Results						
Standard Reading	<b>UUT Reading</b>	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R397A					
Probe Calibration H	Range = -20 to 120 Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.72583 Ohms					
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.35667 Ohms					
15.4290 F	15.435F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.949 Ohms					
50.3790 F	50.374F	0.1000F	5	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.507 Ohms					
85.3510 F	85.352F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.02733 Ohm	IS				
120.3530 F	120.353F	0.1000F	0	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.72583 Ohms					
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.35667 Ohms					
-9.2060 c	-9.203c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.949 Ohms					
10.2100 c	10.208c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.507 Ohms					
29.6390 c	29.640c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.02733 Ohm	IS				
49.0850 c	49.085c	0.0560c	0	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at T	emp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))]	- / (2*Ro*B)				
Ro= 99.96169	. ,,,	·				
Alpha= 0.003856811						
Dolto 1 470049406	12					

Delta= 1.47004840642 A= 0.00391350798864

B= -5.6696988644e-007

\*\*\*\*\* End of Report \*\*\*\*\*



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
PROCEDURE NAME:	Analog RTD Cal	DATA TYPE: TEMPERATURE:	21.00 °C
PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	0 - 09/30/04 Jessica Trent McHale & Associates	HUMIDITY:	30 %
	4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R652					
Probe Calibration R	ange = -20 to 120 Deg	F				
	= -28.9	to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 88.964 Ohms					
-19.4830 F	-19.484F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 96.61633 Ohms					
15.4290 F	15.430F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 104.23167 Ohms	3				
50.3790 F	50.382F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 111.80467 Ohms	3		_		
85.3510 F	85.345F	0.1000F	6	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 119.3425 Ohms	0.40005	0	5	0 4 0005	
120.3530 F	120.355F	0.1000F	2	Pass	3.4e-002F	2.94
***********Degree	s C**********					
Resistance Value at	Temp = 88.964 Ohms					
-28.6020 c	-28.602c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 96.61633 Ohms					
-9.2060 c	-9.205c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 104.23167 Ohms	3				
10.2100 c	10.212c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 111.80467 Ohms	5				
29.6390 c	29.636c	0.0560c	5.36	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 119.3425 Ohms					
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	s:					
Equation Used= Call	endar-Van Dusen					
where $T = Deg C$ and	Rt = Resistance at Te	emp				
T = [-RoA + Sqrt(Ro	^2*A^2-4Ro*B(Ro-Rt))]/	(2*Ro*B)				
Ro= 100.23224						
Alpha= 0.003853843						
Delta= 1.5461891498	4					
A= 0.0039134307	0232					

-5.95877023177e-007



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R785	DATA TYPE:	AS-LEFT
PROCEDURE NAME:	Analog RTD Cal	TEMPERATURE:	21.00 °C
PROCEDURE REV.:	0 - 09/30/04	HUMIDITY:	30 %
CALIBRATED BY:	Jessica Trent		
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
Asset #	Description	<u>Serial #</u>	Cal Date	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	IIIIT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R785					
Probe Calibration H	Range = -20 to 120 De	g F				
	= -28.	9 to 48.9 Deg	C			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	Temp = 88.743 Ohms					
-19.4830 F	-19.487F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 96.382 Ohms					
15.4290 F	15.437F	0.1000F	8	Pass	3.4e-002F	2.94
Resistance Value at	Temp = 103.97917 Ohr	ns				
50.3790 F	50.376F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 111.53783 Oh	ns				
85.3510 F	85.347F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	: Temp = 119.05917 Oh	ns				
120.3530 F	120.355F	0.1000F	2	Pass	3.4e-002F	2.94
************Degree	es C************					
Resistance Value at	Temp = 88.743 Ohms					
-28.6020 c	-28.604c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	Temp = 96.382 Ohms					
-9.2060 c	-9.202c	0.0560c	7.14	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 103.97917 Oh	ns				
10.2100 c	10.209c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 111.53783 Oh	ns				
29.6390 c	29.637c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	: Temp = 119.05917 Oh	ns				
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	cs:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at '	Temp				
T = [-RoA + Sqrt(Ro	o^2*A^2-4Ro*B(Ro-Rt))	]/(2*Ro*B)				
Ro= 99.98921						
Alpha= 0.003854755						
Delta= 1.5614009921	L 4					
A= 0.0039149431	18281					

-6.01881828146e-007



#### **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R886	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
Sooromen.	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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**Approved By:** 

Standards Used					
<u>Asset #</u>	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date	
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017	
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018	
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018	

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R886					
Probe Calibration H	Range = -20 to 120 Dec	J F				
	= -28.9	) to 48.9 Deg	С			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.74867 Ohms	3				
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.384 Ohms					
15.4290 F	15.433F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 103.98067 Ohn	ns		_		
50.3790 F	50.378F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.53783 Ohn	15 0 40005		_	0 4 0005	
85.3510 F	85.347F	0.1000F	4	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.05867 Ohn	ns 0 40005	2	Deee	2 4- 0025	0.04
120.3330 F	120.355F	0.1000F	2	Pass	3.4e-002F	2.94
*****	es C***********					
Resistance Value at	t Temp = 88.74867 Ohms	5				
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.384 Ohms					
-9.2060 c	-9.204c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 103.98067 Ohm	ns				
10.2100 c	10.210c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.53783 Ohm	ıs				
29.6390 c	29.637c	0.0560c	3.57	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.05867 Ohn	ns				
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where T = Deg C and	d Rt = Resistance at 1	lemp				
T = [-ROA + Sqrt(Ro	o^2*A^2-4Ko*B(Ro-Rt))]	/(2*Ro*B)				
KO= 99.99104						
Aipna= 0.003854/5	7					
A 0 0030130250	۶, 8,9,8,2,1					
V- 0.0029128230	00021					

-5.91758882099e-007



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER:	N/A	CAL DUE:	06 March 2018
ASSET NUMBER:	R961	DATA TYPE:	AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY: CUSTOMER:	Analog RTD Cal 0 - 09/30/04 Jessica Trent McHale & Associates	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
	4700 Coster Rd.	CAL RANGE:	-20~120
	Knoxville, TN 37912	CAL UNITS:	Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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	Calibrate	ed By:

**Approved By:** 

Standards Used								
Asset #	<b>Description</b>	<u>Serial #</u>	<u>Cal Date</u>	<u>Due Date</u>				
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017				
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018				
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018				

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R961					
Probe Calibration H	Range = -20 to 120 De	g F				
	= -28.	9 to 48.9 Deg	С			
AS LEFI RESULIS						
Degrees r Registance Value at	+ Tomp - 99 75067 Ohr					
-10 /830 F	10 492E	0 1000E	0	Dooo	2 40 0025	2.04
	-19.403F	0.1000F	0	Pass	3.40-002F	2.94
15 4200 E	15 4205	0 10005	1	Daga	2 40 0025	2.04
Decistance Value of	ID.420Г	0.1000F	I	Pass	3.40-002F	2.94
	co 2005	0 4000F	4	Deee	2 4- 0025	2.04
	00.300F	0.1000F	I	Pass	3.40-002F	2.94
RESISCANCE VALUE A	95 250E	0 1000E	1	Daga	2 40 0025	2.04
	00.000F	0.1000F	I	Pass	3.40-002F	2.94
120 3530 F	120 353E	0 1000E	0	Pass	3 40 0025	2.04
120.00001	120.3331	0.10001	0	F 855	3.46-0021	2.34
************Dearea	aa (^*************					
Resistance Value at	t Temp = 88 75067 Obr	19				
-28 6020 c	-28 602c	0.0560c	0	Pass	1 9e-002c	2 95
Resistance Value at	t Temp = 96.384 Ohms	0.00000	0	1 435	1.00 0020	2.00
-9 2060 c	-9 207c	0.0560c	1 79	Pass	1 9e-002c	2 95
Resistance Value at	t Temp = 103.98117 Oh	ms	1.10	1 465	1.00 0020	2.00
10 2100 c	10 211c	0.0560c	1 79	Pass	1 9e-002c	2 95
Resistance Value at	t Temp = 111.5375 Ohm	IS	1.10	1 465	1.00 0020	2.00
29.6390 c	29.639c	0.0560c	0	Pass	1.9e-002c	2 95
Resistance Value at	t Temp = 119.05567 Oh	ms	0	1 400	1.00 0020	2.00
49.0850 c	49 085c	0.0560c	0	Pass	1.9e-002c	2 95
	40.0000	0.00000	0	1 465	1.00 0020	2.00
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at	Temp				
T = [-RoA + Sart.(Ro	o^2*A^2-4Ro*B(Ro-Rt.))	]/(2*Ro*B)				
Ro= 99.99174		- · /				
Alpha= 0.00385379						
Delta= 1.5486111170	03					

0.00391347022037 -5.96802203671e-007

A=



## **REPORTOFCALIBRATION**

McHalePerformance.com

UNIT UNDER TEST:	RTD, Analog, 4-Wire, 16"	TEST RESULT: CAL DATE:	PASS 06 March 2017
SERIAL NUMBER: ASSET NUMBER:	N/A R1108	CAL DUE: DATA TYPE:	06 March 2018 AS-LEFT
PROCEDURE NAME: PROCEDURE REV.: CALIBRATED BY:	Analog RTD Cal 0 - 09/30/04 Jessica Trent	TEMPERATURE: HUMIDITY:	21.00 °C 30 %
CUSTOMER:	McHale & Associates 4700 Coster Rd. Knoxville, TN 37912	CAL RANGE: CAL UNITS:	-20~120 Deg F

McHale Performance certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted. It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with ANSI/NCSL Z540.1-1994 (R2002) and ISO/IEC 17025:2005.

Measurement uncertainties are calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement."

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2. Any Test Uncertainty Ratio (TUR) that is less than four to one will appear under the "TUR" heading on the data record. If the TUR meets or exceeds four to one, the field is left blank.

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to	ssic~	1 the
	Calibrated	By:

**Approved By:** 

Standards U	Standards Used								
Asset #	Description	<u>Serial #</u>	<u>Cal Date</u>	Due Date					
10219	Agilent 34970A Data Logger	US37042760	3/2/2017	6/2/2017					
10261	Hart Scientific 1529 Thermometer Chub-E4	23202	1/20/2017	1/20/2018					
10328	Hart Scientific 5699 Standard Platinum Resistance Thermometer	1021	1/9/2017	1/9/2018					

Test Results						
Standard Reading	UUT Reading	<u>Test Tol</u>	<u>% Tol Error</u>	PASS/FAIL	Expanded Unc.	<u>TUR</u>
DAS Asset	= 10219					
Probe ID Number	= R1108					
Probe Calibration H	Range = -20 to 120 Dec	J F				
	= -28.9	) to 48.9 Deg	с			
AS LEFT RESULTS						
Degrees F						
Resistance Value at	t Temp = 88.82767 Ohms	5				
-19.4830 F	-19.485F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 96.46517 Ohms	3				
15.4290 F	15.431F	0.1000F	2	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 104.06533 Ohr	ns		_		
50.3790 F	50.378F	0.1000F	1	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 111.62633 Ohr	ns a tabar		_		
85.3510 F	85.348F	0.1000F	3	Pass	3.4e-002F	2.94
Resistance Value at	t Temp = 119.15083 Ohr	ns a tabar		_		
120.3530 F	120.354F	0.1000F	1	Pass	3.4e-002F	2.94
************Degree	es C***********					
Resistance Value at	t Temp = 88.82767 Ohms	5				
-28.6020 c	-28.603c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 96.46517 Ohms	5				
-9.2060 c	-9.205c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 104.06533 Ohr	ıs				
10.2100 c	10.210c	0.0560c	0	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 111.62633 Ohr	ıs				
29.6390 c	29.638c	0.0560c	1.79	Pass	1.9e-002c	2.95
Resistance Value at	t Temp = 119.15083 Ohr	ıs				
49.0850 c	49.086c	0.0560c	1.79	Pass	1.9e-002c	2.95
As Left Coefficient	ts:					
Equation Used= Call	lendar-Van Dusen					
where $T = Deg C$ and	d Rt = Resistance at 5	lemp				
T = [-RoA + Sart.(Ro	o^2*A^2-4Ro*B(Ro-Rt.))	/(2*Ro*B)				
Ro= 100.07396						
Alpha= 0.003853787						
Delta= 1.5179898633	3					
A= 0.0039122870	09601					

-5.85000960133e-007

## **APPENDIX F**

# **CORRECTION CURVES**



			Ambient Dry Bulb Temperature (Deg F)						
		25	40	50	59	70	80	95	105
	20.0%	0.922805	0.955999	0.979224	1.001267	1.030532	1.059359	1.106500	1.140663
	30.0%	0.922642	0.955590	0.978773	1.000818	1.030319	1.059388	1.107059	1.141685
Relative	40.0%	0.922431	0.955211	0.978394	1.000525	1.030163	1.059449	1.107625	1.142646
Humidity	50.0%	0.922185	0.954838	0.978031	1.000253	1.030101	1.059591	1.108194	1.143559
(%)	65.0%	0.921869	0.954295	0.977516	1.000000	1.030082	1.059882	1.108943	1.144668
	70.0%	0.921766	0.954122	0.977362	0.999943	1.030082	1.059978	1.109189	1.144950
	80.0%	0.921575	0.953781	0.977054	0.999801	1.030169	1.060167	1.109622	1.145420



Barometric Pressure (psia)								
14.167	14.267	14.367	14.467	14.567				
1.014641	1.007260	1.000000	0.992851	0.985809				



	Fuel H/C		Fuel H/C		H/C	Fuel	H/C
		3.0			3.1		3.2
	19,873	0.997888		19,901	0.999747	19,701	1.001054
Fuel I HV	20,049	0.998246		20,067	1.000083	20,013	1.001703
(BTU/lb)	20,477	0.999103		20,403	1.000735	20,329	1.002337
(810/18)	20,766	0.999695		20,742	1.001404	20,648	1.002958
	21,108	1.000288		20,913	1.001728	20,961	1.003545
				21,075	1.002030		



	Frequency (Hz)						
59.0	59.5	60.0	60.5	61.0			
1.011491	1.005282	1.000000	0.995539	0.991773			



	Site Boundary Fuel Temperature (Deg F)							
20.0	30.0	40.0	50.0	60.0	70.0	80.0		
1.000078	1.000033	1.000000	0.999951	0.999911	0.999867	0.999827		



Compressors are in operation until site inlet pressure exceeds 750 psig

	Gas Compressor Suction Pressure (psig)*					
	400	424.0	600.0	750.0	1000	
Compressor On	No plant	0.0	-1,027.0	-1,027.0	-	
Compressor Off	operation	-	-	-1,928.0	-1,928.0	

\*Pressure upstream regulating valve


			CT WBT - CTG WBT (Deg F)							
		-5	-2.5	0	2.5	5				
Ambient	40.0	61.0	11.0	0.0	0.0					
DB	50.0	-193.0	-104.0	0.0	117.0	308.0				
Temperat	59.0	-409.0	-213.0	0.0	303.0	625.0				
ure (Deg	70.0	-773.0	-406.0	0.0	426.0	897.0				
F)	80.0	-998.0	-515.0	0.0	554.0	1,121.0				



	Corrected STG Net Output (kW)									
142,814 146,572 150,330 154,088 157										
	7,569.0	3,784.0	0.0	-3,784.0	-7,569.0					



Corrected CTG Net Output (kW)								
298,490	306,345	314,200	322,055	329,910				
15,796.0	7,913.5	0.0	-7,920.5	-15,838.0				



Corrected CTG Net Heat Rate (Btu/kWh)								
	7,785.3	7,990.1	8,195.0	8,399.9	8,604.8			
	200.0	99.0	0.0	-99.0	-197.0			



Corrected CTG Exhaust Temperature (Deg F)									
1,168.0	1,173.0	1,178.0	1,183.0	1,188.0	1,193.0	1,198.0	1,203.0	1,208.0	
4,171.0	3,127.0	2,081.0	1,032.0	0.0	-995.0	-1,940.0	-2,887.0	-3,827.0	



Corrected CTG Exhaust Flow (lb/h)								
4,526,750	4,645,875	4,765,000	4,884,125	5,003,250				
6,563.0	3,235.0	0.0	-3,196.0	-6,369.0				



Corrected CTG TCA Energy (MMBtu/h)									
31.21	32.03	32.85	33.67	34.49					
212.0	104.0	0.0	-108.0	-214.0					



Corrected CTG Steam Cooling Energy (MMBtu/h)									
25.63	26.31	26.98	27.65	28.33					
205.0	99.0	0.0	-97.0	-200.0					



Corrected HRSG Backpressure (inH2O)										
6.00	8.50	11.00	13.50	16.00	18.50	21.00	23.50	26.00		
-1,082.4	-929.2	-670.4	-353.7	0.0	351.3	691.6	1,052.7	1,460.4		



Correc	Corrected HRSG Reheater Pressure Drop (psi)									
14.63	15.02	15.40	15.79	16.17						
-20.0	-10.0	0.0	13.0	22.0						



		Co	rrected HR	SG HP Stear	n Flow (lb/	h)
		599,479	615,254	631,030	646,806	662,582
Data data data data data data data data	1,005.5	2,370.8	1,187.6	0.0	-1,190.1	-2,385.3
Reneat Steam	1,051.5	2,369.2	1,185.4	0.0	-1,192.9	-2,387.4
	1,095.5	2,371.4	1,187.8	0.0	-1,191.9	-2,386.2



		Corrected HRSG HP Steam Temperature (Deg F)								
		1,042.0	1,044.5	1,047.0	1,049.5	1,052.0	1,054.5	1,057.0	1,059.5	1,062.0
	567,927	298.8	225.4	149.1	74.8	0.0	-74.0	-150.1	-224.2	-300.1
Flow (lb/h)	631,030	352.7	265.0	175.2	87.4	0.0	-90.3	-179.8	-269.0	-357.6
,	694,133	406.7	304.7	202.9	101.6	0.0	-100.8	-202.8	-303.5	-405.2



		Co	rrected HR	SG IP Stean	n Flow (lb/h	1)
		130,587	134,024	137,460	140,897	144,333
Data data data data data data data data	1,005.5	4,567.5	4,076.8	3,584.7	3,094.7	2,603.0
Temp (Deg F)	1,051.5	1,013.8	505.4	0.0	-508.3	-1,015.5
	1,095.5	-2,439.6	-2,962.1	-3,485.1	-4,006.3	-4,529.3



		Co	rrected HR	SG LP Stear	n Flow (lb/ł	n)
		61,465	63,083	64,700	66,318	67,935
I D Tomp	430.9	453.5	351.0	246.8	143.9	39.7
	486.2	217.6	107.9	0.0	-110.3	-221.7
(Bugr)	549.8	-50.7	-168.3	-284.6	-403.0	-518.9



				Ambient	Dry Bulb T	emperature	e (Deg F)		
		25	40	50	59	70	80	95	105
	20.0%	0.922355	0.957583	0.981439	1.003170	1.031182	1.057004	1.096142	1.122501
	30.0%	0.922208	0.957198	0.980886	1.002459	1.030028	1.055427	1.093893	1.119778
Relative	40.0%	0.922055	0.956812	0.980334	1.001752	1.028884	1.053866	1.091669	1.117088
Humidity	50.0%	0.921895	0.956423	0.979784	1.001049	1.027747	1.052313	1.089459	1.114416
(%)	65.0%	0.921652	0.955840	0.978960	1.000000	1.026051	1.050000	1.086170	1.110441
	70.0%	0.921574	0.955648	0.978687	0.999651	1.025488	1.049235	1.085083	1.109129
	80.0%	0.921428	0.955268	0.978142	0.998952	1.024366	1.047712	1.082926	1.106528



Barometric Pressure (psia)										
14.167	14.267	14.367	14.467	14.567						
1.014282	1.007085	1.000000	0.993019	0.986130						



	Fuel H/C		Fuel H/C		Fuel	H/C
		3.0		3.1		3.2
	19,873	0.998345	19,901	0.999758	19,701	1.000743
	20,049	0.998640	20,067	1.000039	20,013	1.001268
	20,477	0.999340	20,403	1.000585	20,329	1.001792
(B10/IB)	20,766	0.999799	20,742	1.001127	20,648	1.002309
	21,108	1.000327	20,913	1.001391	20,961	1.002797
			21,075	1.001639		



Frequency (Hz)										
59.0	59.5	60.0	60.5	61.0						
1.012254	1.005860	1.000000	0.994648	0.989767						



	Corrected CTG Net Output (kW)										
	298,490	306,345	314,200	322,055	329,910						
ĺ	128.8	64.4	0.0	-64.4	-128.8						



Corrected CTG Net Heat Rate (Btu/kWh)									
7,785.3	7,990.1	8,195.0	8,399.9	8,604.8					
128.8	64.4	0.0	-64.4	-128.8					



Corrected HRSG Backpressure (inH2O)											
6.00	8.50	11.00	13.50	16.00	18.50	21.00	23.50	26.00			
-4.22	-1.19	-0.17	0.00	0.00	0.06	-0.04	-0.93	-3.61			



			Ambient Dry Bulb Temperature (Deg F)							
		Chille	er Off	Chiller On						
		50	60	55	60	75	85	99.4	105	
	20.0%	0.982733	1.005377	0.984649	0.985287	0.988371	0.990784	0.993954	0.997263	
	34.4%	0.982116	1.004690	0.984030	0.984445	0.987564	0.991256	1.000000	1.023586	
Rolativo	40.0%	0.981900	1.004484	0.983806	0.984179	0.987441	0.992674	1.013614	1.037808	
Lumidity	50.0%	0.981512	1.004137	0.983398	0.983820	0.989038	0.995438	1.034853	1.061890	
Humaily	60.0%	0.981134	1.003857	0.983082	0.983856	0.990911	1.004595	1.054526	1.084664	
(%)	70.0%	0.980769	1.003812	0.982862	0.984201	0.996287	1.013094	1.073213	1.106270	
	80.0%	0.980411	1.003749	0.982715	0.985069	1.002104	1.022026	1.091097	1.126923	
	90.0%	0.980092	1.003495	0.982877	0.985687	1.007875	1.030990	1.107755	1.146133	



Barometric Pressure (psia)									
14.167	14.267	14.367	14.467	14.567					
1.013792	1.006848	1.000000	0.993259	0.986690					



	Fue	H/C		Fuel	H/C	Fuel	H/C
		3.0			3.1		3.2
	19,873	0.998046		19,901	0.999765	19,701	1.000977
	20,049	0.998367		20,067	1.000080	20,013	1.001586
	20,477	0.999167		20,403	1.000686	20,329	1.002166
(BT0/ID)	20,766	0.999721		20,742	1.001301	20,648	1.002747
	21,108	1.000263		20,913	1.001606	20,961	1.003293
			-	21,075	1.001882		



	Frequency (Hz)									
ſ	59.0	59.5	60.0	60.5	61.0					
ĺ	1.010912	1.005077	1.000000	0.995644	0.992218					



Site Boundary Fuel Temperature (Deg F)									
20.0	30.0	40.0	50.0	60.0	70.0	80.0			
1.000139	1.000071	1.000000	0.999921	0.999848	0.999778	0.999701			



Compressors are in operation until site inlet pressure exceeds 750 psig

	Gas C	Gas Compressor Suction Pressure (psig)*						
	400	424.0	600.0	750.0	1000			
Compressor On	No plant	0.0	-1,003.0	-1,003.0	-			
Compressor Off	operation	-	-	-1,888.0	-1,888.0			

\*Pressure upstream regulating valve



			CT WBT - CTG WBT (Deg F)					
		-5	-2.5	0	2.5	5		
Ambient	50.00	148.0	72.0	0.0	2.0	15.0		
DB	60.00	-42.0	-26.0	0.0	56.0	197.0		
Temperat	79.40	-784.0	-361.0	0.0	407.0	863.0		
ure (Deg	99.40	-1,135.0	-585.0	0.0	634.0	1,294.0		
F)	105.00	-1,280.0	-649.0	0.0	687.0	1,409.0		

Valid for chiller on operation only



Corrected STG Net Output (kW)								
182,5	14	187,317	192,120	196,923	201,726			
9,654	1.0	4,827.0	0.0	-4,828.0	-9,654.0			



Corrected CTG Net Output (kW)								
306,850	314,925	323,000	331,075	339,150				
16,245.0	8,126.6	0.0	-8,121.2	-16,256.7				



Corrected CTG Net Heat Rate (Btu/kWh)									
	7,748.2	7,952.1	8,156.0	8,359.9	8,563.8				
	203.0	105.0	0.0	-108.0	-221.0				



Corrected CTG Exhaust Temperature (Deg F)								
1,163.0	1,168.0	1,173.0	1,178.0	1,183.0	1,188.0	1,193.0	1,198.0	1,203.0
4,035.0	3,012.0	2,007.0	995.0	0.0	-986.0	-1,960.0	-2,937.0	-3,626.0



ĺ	Corrected CTG Exhaust Flow (lb/h)									
ſ	4,603,700	4,724,850	4,846,000	4,967,150	5,088,300					
ľ	6,830.0	3,407.0	0.0	-3,202.0	-5,258.0					



Corrected CTG TCA Energy (MMBtu/h)									
30.88	31.69	32.50	33.31	34.13					
237.0	124.0	0.0	-124.0	-247.0					



Corrected CTG Steam Cooling Energy (MMBtu/h)										
26.23	26.92	27.61	28.30	28.99						
203.0	99.0	0.0	-102.0	-203.0						



Corrected HRSG Backpressure (inH2O)									
7.10	9.60	12.10	14.60	17.10	19.60	22.10	24.60	27.10	
-802.2	-859.4	-660.8	-346.3	0.0	337.9	711.2	1,201.7	1,983.1	


Correc	Corrected HRSG Reheater Pressure Drop (psi)									
19.48	19.99	20.50	21.01	21.53						
-25.0	-12.0	0.0	7.0	23.0						



Duct Burner Heat Input LHV (mmBtu/h)								
299.25	307.13	315.00	322.88	330.75				
2,186.0	1,099.0	0.0	-1,084.0	-2,156.0				



		Co	Corrected HRSG HP Steam Flow (lb/h)				
		831,725	853,613	875,500	897,388	919,275	
Dahard Otaam	1,004.4	3,106.4	1,554.9	0.0	-1,557.9	-3,115.5	
Reneat Steam	1,050.4	3,106.5	1,554.7	0.0	-1,557.2	-3,116.2	
remp (Deg P)	1,094.4	3,105.3	1,553.8	0.0	-1,555.9	-3,114.0	



			Corrected HRSG HP Steam Temperature (Deg F)							
		1,038.7	1,041.2	1,043.7	1,046.2	1,048.7	1,051.2	1,053.7	1,056.2	1,058.7
	787,950	442.9	331.5	223.5	113.3	0.0	-107.6	-219.4	-329.4	-439.9
HP Steam	875,500	523.4	392.1	261.8	131.2	0.0	-131.0	-259.4	-391.6	-517.8
110W (15/11)	963,050	602.6	451.2	302.0	151.4	0.0	-152.0	-300.9	-451.7	-602.2



		Co	Corrected HRSG IP Steam Flow (lb/h)				
		130,046	133,468	136,890	140,312	143,735	
Dahart Otar	1,004.4	5,672.2	5,173.6	4,675.7	4,179.6	3,684.7	
Reneat Steam	1,050.4	1,022.3	513.2	0.0	-511.7	-1,022.6	
Temp (Deg F)	1,094.4	-3,484.7	-4,012.9	-4,539.5	-5,066.5	-5,593.6	



		Corrected HRSG LP Steam Flow (lb/h)					
		28,576	29,328	30,080	30,832	31,584	
L B Tomp	512.1	194.5	150.5	107.7	62.6	17.4	
	571.4	95.3	49.5	0.0	-46.8	-93.4	
(Deg F)	631.2	-6.3	-53.9	-104.7	-155.1	-206.5	



			Ambient Dry Bulb Temperature (Deg F)						
		Chille	er Off			Chille	er On		
		50	60	0 55 60 75 85 99.4 10					105
	20.0%	1.002529	1.023746	1.002600	1.002721	1.003393	1.002797	0.999993	0.999993
	34.4%	1.002072	1.023175	1.001993	1.001883	1.001094	0.999993	1.000000	1.018437
Relative	40.0%	1.001886	1.022944	1.001745	1.001555	1.000204	0.999993	1.010547	1.029033
Humidity	50.0%	1.001547	1.022526	1.001306	1.001003	0.999993	0.999993	1.026482	1.046425
(0/)	60.0%	1.001210	1.022116	1.000893	1.000495	0.999993	1.006422	1.040651	1.062137
(%)	70.0%	1.000889	1.021727	1.000511	0.999993	1.003401	1.011965	1.053645	1.076416
	80.0%	1.000588	1.021364	1.000129	0.999993	1.007143	1.017456	1.065622	1.089443
	90.0%	1.000300	1.021013	0.999993	0.999993	1.011366	1.023394	1.076705	1.101342



Barometric Pressure (psia)								
14.167	14.267	14.367	14.467	14.567				
1.012737	1.006323	1.000000	0.993760	0.987593				



	Fue	H/C	Fuel	H/C	Fuel	H/C
		3.0		3.1		3.2
	19,873	0.998522	19,901	0.999783	19,701	1.000664
	20,049	0.998785	20,067	1.000035	20,013	1.001132
	20,477	0.999410	20,403	1.000522	20,329	1.001600
(610/10)	20,766	0.999820	20,742	1.001006	20,648	1.002062
	21,108	1.000292	20,913	1.001243	20,961	1.002497
			21,075	1.001464		



Frequency (Hz)								
59.0	59.5	60.0	60.5	61.0				
1.010931	1.005231	1.000000	0.995216	0.990850				



Corrected CTG Net Output (kW)							
306,850	314,925	323,000	331,075	339,150			
131.8	65.9	0.0	-65.8	-131.7			



Co	Corrected CTG Net Heat Rate (Btu/kWh)									
7,748.2	7,952.1	8,156.0	8,359.9	8,563.8						
131.7	65.9	0.0	-65.9	-131.7						



Corrected HRSG Backpressure (inH2O)								
7.10	9.60	12.10	14.60	17.10	19.60	22.10	24.60	27.10
-0.11	-0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.17



Duct Burner Heat Input LHV (mmBtu/h)							
299.25	307.13	315.00	322.88	330.75			
15.8	7.9	0.0	-7.9	-15.8			

## KC922290A



KC922290A

## USA / GRDA Grand River Energy Center Unit 3 Gas Turbine Generator

### HYDROGEN INDIRECTLY COOLED TURBINE GENERATOR GENERATOR LOSS CURVE

410,000 kVA, 369,000 kW, 90 %PF, 60 Hz, 3,600 min<sup>-1</sup>, 20.0 kV, 11,836 A, 0.45 MPa-g, 390 VEXC.



(Note) Exciter loss and field winding loss are not included in the calculation.

APPROVED To paragra
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DECIGNED IN THE MOUNT

COMPANY PROPRIETARY INFORMATION NOT TO BE REPRODUCED OR DISCLOSED WITHOUT SPECIFIC WRITTEN PERMISSION OF MITSUBISHI ELECTRIC CORPORATION

## KC921145A



## Turbine-Generators for Combined Cycle Unit 3 (GTG)

410000 kVA, 369000 kW, 90 %PF, 60 Hz, 3600 min-1, 20 kV, 11836 A, 0.45 MPa-g, 390 VEXC

### HYDROGEN INDIRECTLY COOLED GENERATOR

### V-CURVE VOLTAGE 20 kV



Approved - Returned: 07/01/2015

# KC921145A

12

GAE-MP-EXOICTG

94.03.36.100-DA-0001-001 - Packet 94.03.36.100-324 - Grand River Energy Center Unit 3 - 2014071 - Received: 06/11/2015

## KC922291A



## USA / GRDA Grand River Energy Center Unit 3 Steam Turbine Generator

### HYDROGEN INDIRECTLY COOLED TURBINE GENERATOR GENERATOR LOSS CURVE

257,000 kVA, 231,300 kW, 90 %PF, 60 Hz, 3,600 min<sup>-1</sup>, 21.0 kV, 7,066 A, 0.30 MPa-g, 335 VEXC.



GENERATOR OUTPUT (MW)

(Note) Exciter loss and field winding loss are not included in the calculation.

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## KC921154A

### USA / GRDA

### Turbine-Generators for Combined Cycle Unit 3 (STG)

257000 kVA, 231300 kW, 90 %PF, 60 Hz, 3600 min-1, 21 kV, 7066 A, 0.3 MPa-g, 335 VEXC

### HYDROGEN INDIRECTLY COOLED GENERATOR

### V-CURVE VOLTAGE 21 kV

Rev.A: Added zero power factor current saturation curve.



12

94.03.64-DA-0002-001 - Packet 94.03.64-096 - Grand River Energy Center Unit 3 - 2014071 - Received: 02/03/2015

## **APPENDIX G**

## PERFORMANCE TEST DATA

Previously provided electronically

## **APPENDIX H**

**FUEL ANALYSIS** 



MAIN PAGE

LEASE #:		NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE A-01	
PROJECT NO. :	201707030	ANALYSIS NO. :	01	
COMPANY NAME :	MCHALE & ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 10:56	
OFFICE / BRANCH:	KNOXVILLE, TN	SAMPLE DATE :	JULY 6, 2017 23:05	
CUSTOMER REF:	PRJ 17041.0	TO:		
PRODUCER :		EFFECTIVE DATE:		
***FIELD DATA***				
SAMPLE CYCLE:		SAMPLE TYPE:		
SAMPLE PRES. :	psig	CYLINDER NO. :	M-12298	
LAB PRES:	psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :	°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:	°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_ #/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:				
LAB COMMENTS:				
			GPM @	GPM @
COMPONENT	MOLE %	MASS %	14.730	14.696
HELIUM	0.04	0.01		
HYDROGEN	0.00	0.00		
OXYGEN/ARGON	0.01	0.02		
NITROGEN	1.7300	2.7800		
CARBON DIOXIDE	0.61	1.54		
METHANE	90.58110	83.20820		
ETHANE	6.6807	11.5026	1.7902	1.7861
PROPANE	0.3023	0.7633	0.0834	0.0832
I-BUTANE	0.0110	0.0366	0.0040	0.0040
N-BUTANE	0.0200	0.0665	0.0060	0.0060
I-PENTANE	0.0033	0.0136	0.0010	0.0010
N-PENTANE	0.0030	0.0124	0.0010	0.0010
HEXANES PLUS	0.0086	0.0468	0.0010	0.0010
TOTALS	100.00000	100.00000	1.8866	1.8823

BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	944.4 /scf	942.2 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	928.0 /scf	925.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1046.9 /scf	1044.5 /scf
XYLENES	0.0001	0.0006	GROSS WET REAL :	1028.7 /scf	1026.3 /scf
TOTAL BTEX	0.0006	0.0031	NET DRY REAL :	20529.2 /lb	20481.8 / <b>lb</b>
			GROSS DRY REAL :	22755.4 /lb	22702.8 /lb
(CALC: GPA STD 2145 & TP-17	7 @14.696 & 60 F	7)	RELATIVE DENSITY (A	AIR=1): 0.6	6027

COMPRESSIBILITY FACTOR :

0.99773

#### \*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730



PROJECT NO. : 201707030 COMPANY NAME : MCHALE & ACCOUNT NO. : PRJ 17041. PRODUCER : LEASE NO. : NAME/DESCRIP : GREC - KII U3, SAMPI

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE A-01 

 ANALYSIS NO.:
 01

 ANALYSIS DATE:
 JULY 13, 2017 10:56

 SAMPLE DATE :
 JULY 6, 2017 23:05

 CYLINDER NO.:
 M-12298

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.73	2.78		
Carbon Dioxide		0.61	1.54		
Methane	P1	90.58110	83.20820		
Ethane	P2	6.6807	11.5026	1.790	1.786
Propane	P3	0.3023	0.7633	0.083	0.083
i-Butane	I4	0.0110	0.0366	0.004	0.004
n-Butane	P4	0.0200	0.0665	0.006	0.006
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0030	0.0124	0.001	0.001
n-Pentane	P5	0.0030	0.0124	0.001	0.001
2,2-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
Cyclopentane	N5	0.0001	0.0004	0.000	0.000
2,3-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
2-Methylpentane	I6	0.0009	0.0045	0.000	0.000
3-Methylpentane	I6	0.0006	0.0030	0.000	0.000
n-Hexane	P6	0.0013	0.0064	0.001	0.001
Methylcyclopentane	N6	0.0004	0.0019	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0004	0.0019	0.000	0.000
2-Methylhexane	I7	0.0003	0.0017	0.000	0.000
2,3-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0003	0.0017	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
UnknownC6s	U6	0.0001	0.0005	0.000	0.000
n-Heptane	P7	0.0006	0.0034	0.000	0.000
Methylcyclohexane	N7	0.0007	0.0039	0.000	0.000
2,2,3-Trimethylpentane	18	0.0001	0.0006	0.000	0.000
2,4-Dimethylhexane	18	0.0001	0.0006	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	18	0.0002	0.0013	0.000	0.000
4-Methylheptane	18	0.0001	0.0006	0.000	0.000

1c,2t,3-Trimethylcyclopentane		N8	0.0003	0.0019	0.000	0.000
3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0004	0.0026	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
1,3-Dimethylbenzene (m-Xylene)		A8	0.0001	0.0006	0.000	0.000
3-Methyloctane		19	0.0001	0.0007	0.000	0.000
n-Nonane		P9	0.0001	0.0007	0.000	0.000
TOTAL			100.00000	100.00000	1.8866	1.8823
BTEX COMPONENTS MOLE	2%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW N	IET DRY REAL :	944.4 /scf	942.2 /scf
TOLUENE	0.0003	0.0016	N	IET WET REAL :	928.0 /scf	925.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH G	ROSS DRY REAL :	1046.9 /scf	1044.5 /scf
XYLENES	0.0001	0.0006	G	ROSS WET REAL :	1028.7 /scf	1026.3 /scf
TOTAL BTEX	0.0006	0.0031	N	IET DRY REAL :	20529.2 /lb	20481.8 / <b>Ib</b>
			G	ROSS DRY REAL :	22755.4 /lb	22702.8 /lb
			R	ELATIVE DENSITY (AIF	R=1):	0.6027
(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)			C	OMPRESSIBILITY FAC	TOR :	0.99773
*(DETAILED HYDROCARBON ANALYSIS/NJ	1993); AS	TM D6730				

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc.

Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility for interpretation or any consequences from application of the reported information and is the sole liability of the user. The reproduction in any media of this reported information may not be made, in portion or as a whole, without the written permission of EMPACT Analytical Systems, Inc.



MAIN PAGE

LEASE #:		NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE A-03	
PROJECT NO. :	201707030	ANALYSIS NO. :	02	
COMPANY NAME :	MCHALE & ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 13:24	
OFFICE / BRANCH:	KNOXVILLE, TN	SAMPLE DATE :	JULY 6, 2017 23:20	
CUSTOMER REF:	PRJ 17041.0	TO:		
PRODUCER :		EFFECTIVE DATE:		
***FIELD DATA***				
SAMPLE CYCLE:		SAMPLE TYPE:		
SAMPLE PRES. :	psig	CYLINDER NO. :	M-23773	
LAB PRES:	psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :	°f	SAMPLING COMPAN	NY: MCHALE	
AMBIENT TEMP .:	°f	H2S BY STAIN TUBE	E: _ ppm	
H2O BY STAIN TUBE:	_ #/mmcf	CO2 BY STAIN TUBE	E: <u>Mol</u> %	
FIELD COMMENTS:				
LAB COMMENTS:				
			GPM @	GPM @
COMPONENT	MOLE %	MASS %	14.730	14.696
HELIUM	0.04	0.01		
HYDROGEN	0.00	0.00		
OXYGEN/ARGON	0.01	0.02		
NITROGEN	1.8000	2.8900		
CARBON DIOXIDE	0.60	1.51		
METHANE	90.57370	83.21960		
ETHANE	6.6372	11.4301	1.7781	1.7740
PROPANE	0.2943	0.7432	0.0814	0.0812
I-BUTANE	0.0100	0.0333	0.0030	0.0030
N-BUTANE	0.0180	0.0599	0.0060	0.0060
I-PENTANE	0.0034	0.0140	0.0010	0.0010
N-PENTANE	0.0030	0.0124	0.0010	0.0010
HEXANES PLUS	0.0104	0.0575	0.0010	0.0010

BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	943.4 /scf	941.2 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	927.0 /scf	924.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1045.7 /scf	1043.3 /scf
XYLENES	0.0004	0.0024	GROSS WET REAL :	1027.5 /scf	1025.1 /scf
TOTAL BTEX	0.0009	0.0049	NET DRY REAL :	20512.9 /lb	20465.6 /lb
			GROSS DRY REAL :	22737.4 /lb	22684.9 /lb
(CALC: GPA STD 2145 & TP-17	7 @14.696 & 60 I	7)	RELATIVE DENSITY (A	<b>NR=1):</b> 0.60	26
*(DETAILED HYDROCARBON	ANALYSIS/NJ 19	93); ASTM D6730	COMPRESSIBILITY FA	CTOR : 0.997	73

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730



PROJECT NO. : 201707030 COMPANY NAME : MCHALE & ACCOUNT NO. : PRJ 17041. PRODUCER : LEASE NO. : NAME/DESCRIP : GREC - KII U3, SAMPI

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE A-03 

 ANALYSIS NO.:
 02

 ANALYSIS DATE:
 JULY 13, 2017 13:24

 SAMPLE DATE :
 JULY 6, 2017 23:20

 CYLINDER NO.:
 M-23773

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.80	2.89		
Carbon Dioxide		0.60	1.51		
Methane	P1	90.57370	83.21960		
Ethane	P2	6.6372	11.4301	1.778	1.774
Propane	P3	0.2943	0.7432	0.081	0.081
i-Butane	I4	0.0100	0.0333	0.003	0.003
n-Butane	P4	0.0180	0.0599	0.006	0.006
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0030	0.0124	0.001	0.001
n-Pentane	P5	0.0030	0.0124	0.001	0.001
2,2-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0010	0.0049	0.000	0.000
3-Methylpentane	I6	0.0006	0.0030	0.000	0.000
n-Hexane	P6	0.0014	0.0069	0.001	0.001
Methylcyclopentane	N6	0.0004	0.0019	0.000	0.000
2,4-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0005	0.0024	0.000	0.000
2-Methylhexane	I7	0.0003	0.0017	0.000	0.000
2,3-Dimethylpentane	I7	0.0002	0.0011	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0004	0.0023	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
UnknownC6s	U6	0.0001	0.0005	0.000	0.000
n-Heptane	P7	0.0007	0.0040	0.000	0.000
Methylcyclohexane	N7	0.0008	0.0045	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
4-Methylheptane	I8	0.0001	0.0006	0.000	0.000

1c,2t,3-Trimethylcyclopentane		N8	0.0003	0.0019	0.000	0.000
3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0003	0.0019	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
Ethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xylen	e)	A8	0.0002	0.0012	0.000	0.000
1,4-Dimethylbenzene (p-Xylene	e)	A8	0.0001	0.0006	0.000	0.000
4-Methyloctane		I9	0.0001	0.0007	0.000	0.000
2-Methyloctane		I9	0.0001	0.0007	0.000	0.000
3-Methyloctane		I9	0.0001	0.0007	0.000	0.000
1,2-Dimethylbenzene (o-Xylene	e)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	1.8715	1.8672
BTEX COMPONENTS MO	LE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW N	ET DRY REAL :	943.4 /scf	941.2 /scf
TOLUENE	0.0003	0.0016	N	ET WET REAL :	927.0 /scf	924.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH G	ROSS DRY REAL :	1045.7 /scf	1043.3 /scf
XYLENES	0.0004	0.0024	G	ROSS WET REAL :	1027.5 /scf	1025.1 /scf
TOTAL BTEX	0.0009	0.0049	N	ET DRY REAL :	20512.9 /lb	20465.6 /lb
			G	ROSS DRY REAL :	22737.4 /lb	22684.9 /lb
			R	ELATIVE DENSITY (AIF	R=1):	0.6026
(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)			C	OMPRESSIBILITY FAC	TOR :	0.99773

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc.

Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility

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MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE A-05	
PROJECT NO. :	201707030		ANALYSIS NO. :	03	
COMPANY NAME :	MCHALE &	& ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 15:06	
OFFICE / BRANCH:	KNOXVILL	E, TN	SAMPLE DATE :	JULY 6, 2017 23:35	
CUSTOMER REF:	PRJ 17041.0	1	TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-23779	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT	_	MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.8300	2.9200		
CARBON DIOXIDE		0.64	1.61		
METHANE		90.18210	82.54420		
ETHANE		6.9122	11.8585	1.8525	1.8482
PROPANE		0.3355	0.8441	0.0924	0.0922
I-BUTANE		0.0110	0.0365	0.0040	0.0040
N-BUTANE		0.0220	0.0730	0.0070	0.0070
I-PENTANE		0.0034	0.0139	0.0010	0.0010
N-PENTANE		0.0040	0.0165	0.0010	0.0010
HEXANES PLUS		0.0098	0.0533	0.0010	0.0010
TOTALS		100.00000	100.00000	1.9589	1.9544
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	945.4 /scf	943.3 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	929.0 /scf	926.8 /scf

0.0000 ETHYLBENZENE 0.0000 HIGH GROSS DRY REAL : 1047.9 /scf 1045.5 /scf **XYLENES** 0.0003 0.0018 GROSS WET REAL : 1029.7 /scf 1027.3 /scf TOTAL BTEX 0.0008 0.0043 NET DRY REAL : 20478.6 /lb 20431.3 /lb 22697.2 /lb GROSS DRY REAL : 22644.8 /lb **RELATIVE DENSITY (AIR=1):** (CALC: GPA STD 2145 & TP-17 @14.696 & 60 F) 0.6048 \*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730 COMPRESSIBILITY FACTOR : 0.99772



PROJECT NO. : 20 COMPANY NAME : MG ACCOUNT NO. : PR PRODUCER : LEASE NO. : NAME/DESCRIP : GF U3

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE A-05 ANALYSIS NO.: 03 ANALYSIS DATE: JULY 13, 2017 15:06 SAMPLE DATE : JULY 6, 2017 23:35 CYLINDER NO.: M-23779 SAMPLED BY : HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.83	2.92		
Carbon Dioxide		0.64	1.61		
Methane	P1	90.18210	82.54420		
Ethane	P2	6.9122	11.8585	1.853	1.848
Propane	P3	0.3355	0.8441	0.092	0.092
i-Butane	I4	0.0110	0.0365	0.004	0.004
n-Butane	P4	0.0220	0.0730	0.007	0.007
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0030	0.0123	0.001	0.001
n-Pentane	P5	0.0040	0.0165	0.001	0.001
2,2-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0011	0.0054	0.000	0.000
3-Methylpentane	I6	0.0006	0.0030	0.000	0.000
n-Hexane	P6	0.0015	0.0074	0.001	0.001
Methylcyclopentane	N6	0.0004	0.0019	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0005	0.0024	0.000	0.000
2-Methylhexane	I7	0.0004	0.0023	0.000	0.000
2,3-Dimethylpentane	I7	0.0002	0.0011	0.000	0.000
3-Methylhexane	I7	0.0004	0.0023	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
UnknownC6s	U6	0.0001	0.0005	0.000	0.000
n-Heptane	P7	0.0008	0.0046	0.000	0.000
Methylcyclohexane	N7	0.0008	0.0045	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
4-Methylheptane	18	0.0001	0.0006	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0003	0.0019	0.000	0.000
3-Ethylhexane	I8	0.0001	0.0006	0.000	0.000

1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0003	0.0019	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,1,4-Trimethylcyclohexand	e	N9	0.0001	0.0007	0.000	0.000
1,3-Dimethylbenzene (m-X	ylene)	A8	0.0002	0.0012	0.000	0.000
1,4-Dimethylbenzene (p-Xy	(lene)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
TOTAL			100.00000	100.00000	1.9589	1.9544
BTEX COMPONENTS	MOLE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NE	T DRY REAL :	945.4 /scf	943.3 /scf
TOLUENE	0.0003	0.0016	NE	T WET REAL :	929.0 /scf	926.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GF	ROSS DRY REAL :	1047.9 /scf	1045.5 /scf
XYLENES	0.0003	0.0018	GF	ROSS WET REAL :	1029.7 /scf	1027.3 /scf
TOTAL BTEX	0.0008	0.0043	NE	T DRY REAL :	20478.6 /lb	20431.3 /lb
			GF	ROSS DRY REAL :	22697.2 /lb	22644.8 /lb
			RE	LATIVE DENSITY (AIR	=1):	0.6048
(CALC: GPA STD 2145 & TP-17 @14	4.696 & 60 F)		CC	MPRESSIBILITY FACT	OR :	0.99772
*(DETAILED HYDROCARBON ANA	LYSIS/NJ 1993) ; AS	STM D6730				



MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE A-07	
PROJECT NO. :	201707030		ANALYSIS NO. :	04	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 16:43	
OFFICE / BRANCH:	KNOXVILLE	E, TN	SAMPLE DATE :	JULY 7, 2017 00:00	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :	]	psig	CYLINDER NO. :	M-23822	
LAB PRES:	]	psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :	c.	ŕf	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_ ;	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.8400	2.9400		
CARBON DIOXIDE		0.64	1.61		
METHANE		90.12050	82.41510		
ETHANE		6.9499	11.9128	1.8625	1.8582
PROPANE		0.3397	0.8539	0.0934	0.0932
I-BUTANE		0.0120	0.0397	0.0040	0.0040
N-BUTANE		0.0230	0.0762	0.0070	0.0070
I-PENTANE		0.0054	0.0222	0.0020	0.0020
N-PENTANE		0.0050	0.0206	0.0020	0.0020
HEXANES PLUS	: =	0.0145	0.0795	0.0030	0.0030
TOTALS		100.00000	100.00000	1.9739	1.9694
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	946.1 /scf	944.0 /scf
TOLUENE	0.0005	0.0026	NET WET REAL :	929.7 /scf	927.5 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1048.5 /scf	1046.1 /scf
XYLENES	0.0003	0.0018	GROSS WET REAL :	1030.3 /scf	1027.9 /scf
TOTAL BTEX	0.0010	0.0053	NET DRY REAL :	20472.6 /lb	20425.4 /lb
			GROSS DRY REAL :	22690.0 /lb	22637.6 /lb

#### (CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

RELATIVE DENSITY (AIR=1): COMPRESSIBILITY FACTOR :

0.6053 0.99772



PROJECT NO. : 201707030 COMPANY NAME : MCHALE & ACCOUNT NO. : PRJ 17041. PRODUCER : LEASE NO. : NAME/DESCRIP : GREC - KII U3, SAMPI

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE A-07 

 ANALYSIS NO.:
 04

 ANALYSIS DATE:
 JULY 13, 2017 16:43

 SAMPLE DATE :
 JULY 7, 2017 00:00

 CYLINDER NO.:
 M-23822

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.84	2.94		
Carbon Dioxide		0.64	1.61		
Methane	P1	90.12050	82.41510		
Ethane	P2	6.9499	11.9128	1.863	1.858
Propane	P3	0.3397	0.8539	0.093	0.093
i-Butane	I4	0.0120	0.0397	0.004	0.004
n-Butane	P4	0.0230	0.0762	0.007	0.007
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0050	0.0206	0.002	0.002
n-Pentane	P5	0.0050	0.0206	0.002	0.002
2,2-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0016	0.0079	0.001	0.001
3-Methylpentane	I6	0.0008	0.0039	0.000	0.000
n-Hexane	P6	0.0021	0.0103	0.001	0.001
Methylcyclopentane	N6	0.0006	0.0028	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0007	0.0034	0.000	0.000
2-Methylhexane	I7	0.0005	0.0028	0.000	0.000
2,3-Dimethylpentane	I7	0.0003	0.0017	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0006	0.0034	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
UnknownC6s	U6	0.0002	0.0010	0.000	0.000
n-Heptane	P7	0.0011	0.0063	0.001	0.001
Methylcyclohexane	N7	0.0011	0.0062	0.000	0.000
2,2,3-Trimethylpentane	I8	0.0001	0.0006	0.000	0.000
Toluene	A7	0.0005	0.0026	0.000	0.000
2-Methylheptane	I8	0.0004	0.0026	0.000	0.000
4-Methylheptane	18	0.0001	0.0006	0.000	0.000

1c,2t,3-Trimethylcyclopentane		N8	0.0004	0.0026	0.000	0.000
3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0002	0.0012	0.000	0.000
1t,2-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0006	0.0039	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
Ethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Propylcyclopentane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xylene	)	A8	0.0002	0.0012	0.000	0.000
1,4-Dimethylbenzene (p-Xylene)	)	A8	0.0001	0.0006	0.000	0.000
4-Methyloctane		I9	0.0001	0.0007	0.000	0.000
2-Methyloctane		I9	0.0001	0.0007	0.000	0.000
3-Methyloctane		19	0.0001	0.0007	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	1.9739	1.9694
BTEX COMPONENTS MOL	LE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NE	T DRY REAL :	946.1 /scf	944.0 /scf
TOLUENE	0.0005	0.0026	NE	T WET REAL :	929.7 /scf	927.5 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GF	ROSS DRY REAL :	1048.5 /scf	1046.1 /scf
XYLENES	0.0003	0.0018	GF	ROSS WET REAL :	1030.3 /scf	1027.9 /scf
TOTAL BTEX	0.0010	0.0053	NE	T DRY REAL :	20472.6 /lb	20425.4 /lb
			GF	ROSS DRY REAL :	22690.0 /lb	22637.6 /lb
			RE	LATIVE DENSITY (AIF	R=1):	0.6053
(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)				COMPRESSIBILITY FACTOR :		0.99772

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730

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MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-01	
PROJECT NO. :	201707030		ANALYSIS NO. :	05	
COMPANY NAME :	MCHALE &	& ASSOCIATES	ANALYSIS DATE:	JULY 14, 2017 06:27	
OFFICE / BRANCH:	KNOXVILL	E, TN	SAMPLE DATE :	JULY 7, 2017 03:23	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-13031	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.8600	2.9700		
CARBON DIOXIDE		0.65	1.63		
METHANE		89.99610	82.20790		
ETHANE		7.0276	12.0321	1.8837	1.8793
PROPANE		0.3544	0.8898	0.0974	0.0972
I-BUTANE		0.0130	0.0430	0.0040	0.0040
N-BUTANE		0.0260	0.0860	0.0080	0.0080
I-PENTANE		0.0054	0.0222	0.0020	0.0020
N-PENTANE		0.0050	0.0206	0.0020	0.0020
HEXANES PLUS	:	0.0125	0.0684	0.0020	0.0020
TOTALS		100.00000	100.00000	1.9991	1.9945
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	946.5 /scf	944.4 /scf
TOLUENE	0.0004	0.0021	NET WET REAL :	930.0 /scf	927.9 /scf

(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F) \*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730

0.0000

0.0003

0.0009

0.0000

0.0018

0.0048

ETHYLBENZENE

**XYLENES** 

TOTAL BTEX

RELATIVE DENSITY (AIR=1): COMPRESSIBILITY FACTOR :

0.6061 0.99771 1046.5 /scf

1028.3 /scf

20412.8 /lb

22623.1 /lb

1048.9 /scf

1030.7 /scf

20460.1 /lb

22675.4 /lb

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc. Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility for interpretation or any consequences from application of the reported information and is the sole liability of the user. The reproduction in any media of this reported information may not be made, in portion or as a whole, without the written permission of EMPACT Analytical Systems, Inc.

HIGH GROSS DRY REAL :

GROSS WET REAL :

GROSS DRY REAL :

NET DRY REAL :



PROJECT NO. : 20 COMPANY NAME : M ACCOUNT NO. : PH PRODUCER : LEASE NO. : NAME/DESCRIP : G

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-01 

 ANALYSIS NO.:
 05

 ANALYSIS DATE:
 JULY 14, 2017 06:27

 SAMPLE DATE :
 JULY 7, 2017 03:23

 CYLINDER NO.:
 M-13031

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.86	2.97		
Carbon Dioxide		0.65	1.63		
Methane	P1	89.99610	82.20790		
Ethane	P2	7.0276	12.0321	1.884	1.879
Propane	P3	0.3544	0.8898	0.097	0.097
i-Butane	I4	0.0130	0.0430	0.004	0.004
n-Butane	P4	0.0260	0.0860	0.008	0.008
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	I5	0.0050	0.0206	0.002	0.002
n-Pentane	P5	0.0050	0.0206	0.002	0.002
2,2-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0014	0.0069	0.001	0.001
3-Methylpentane	I6	0.0008	0.0039	0.000	0.000
n-Hexane	P6	0.0018	0.0088	0.001	0.001
Methylcyclopentane	N6	0.0005	0.0024	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0006	0.0028	0.000	0.000
2-Methylhexane	I7	0.0005	0.0028	0.000	0.000
2,3-Dimethylpentane	I7	0.0002	0.0011	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0005	0.0028	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
UnknownC6s	U6	0.0001	0.0005	0.000	0.000
n-Heptane	P7	0.0009	0.0051	0.000	0.000
Methylcyclohexane	N7	0.0009	0.0050	0.000	0.000
Toluene	A7	0.0004	0.0021	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
4-Methylheptane	I8	0.0001	0.0006	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0003	0.0019	0.000	0.000

3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0005	0.0032	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
Ethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Propylcyclopentane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xylene)	)	A8	0.0001	0.0006	0.000	0.000
1,4-Dimethylbenzene (p-Xylene)		A8	0.0001	0.0006	0.000	0.000
4-Methyloctane		I9	0.0001	0.0007	0.000	0.000
2-Methyloctane		I9	0.0001	0.0007	0.000	0.000
3,3-Diethylpentane		I9	0.0001	0.0007	0.000	0.000
1,2-Dimethylbenzene (o-Xylene)		A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
3-Methyl-5-ethylheptane		I10	0.0001	0.0008	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	1.9991	1.9945
BTEX COMPONENTS MOL	E%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NE	T DRY REAL :	946.5 /scf	944.4 /scf
TOLUENE	0.0004	0.0021	NE	ET WET REAL :	930.0 /scf	927.9 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GF	ROSS DRY REAL :	1048.9 /scf	1046.5 /scf
XYLENES	0.0003	0.0018	GF	ROSS WET REAL :	1030.7 /scf	1028.3 /scf
TOTAL BTEX	0.0009	0.0048	NE	T DRY REAL :	20460.1 /lb	20412.8 / <b>lb</b>
			GF	ROSS DRY REAL :	22675.4 /lb	22623.1 /lb
			RE	ELATIVE DENSITY (AIR	l=1):	0.6061
(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)				MPRESSIBILITY FACT	FOR :	0.99771
*(DETAILED HYDROCARBON ANALYSIS/N	J 1993) ; AST	M D6730				



MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-03	
PROJECT NO. :	201707030		ANALYSIS NO. :	06	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 14, 2017 08:42	
OFFICE / BRANCH:	KNOXVILLI	E, TN	SAMPLE DATE :	JULY 7, 2017 03:34	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-23144	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.9100	3.0500		
CARBON DIOXIDE		0.64	1.60		
METHANE		89.92600	82.10180		
ETHANE		7.0603	12.0818	1.8917	1.8873
PROPANE		0.3476	0.8723	0.0964	0.0962
I-BUTANE		0.0130	0.0430	0.0040	0.0040
N-BUTANE		0.0260	0.0860	0.0080	0.0080
I-PENTANE		0.0055	0.0225	0.0020	0.0020
N-PENTANE		0.0060	0.0246	0.0020	0.0020
HEXANES PLUS		0.0156	0.0880	0.0020	0.0020
TOTALS		100.00000	100.00000	2.0061	2.0015
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	946.4 /scf	944.3 /scf
TOLUENE	0.0004	0.0021	NET WET REAL :	929.9 /scf	927.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1048.7 /scf	1046.3 /scf
XYLENES	0.0004	0.0024	GROSS WET REAL :	1030.5 /scf	1028.1 /scf
TOTAL BTEX	0.0010	0.0054	NET DRY REAL :	20448.4 /lb	20401.2 / <b>Ib</b>
			GROSS DRY REAL :	22662.3 /lb	22610.0 /lb

#### (CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730

RELATIVE DENSITY (AIR=1): COMPRESSIBILITY FACTOR : 0.6062

0.99771


PROJECT NO. : 2 COMPANY NAME : M ACCOUNT NO. : F PRODUCER : LEASE NO. : NAME/DESCRIP : C

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-03 

 ANALYSIS NO.:
 06

 ANALYSIS DATE:
 JULY 14, 2017 08:42

 SAMPLE DATE :
 JULY 7, 2017 03:34

 CYLINDER NO.:
 M-23144

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.91	3.05		
Carbon Dioxide		0.64	1.60		
Methane	P1	89.92600	82.10180		
Ethane	P2	7.0603	12.0818	1.892	1.887
Propane	P3	0.3476	0.8723	0.096	0.096
i-Butane	I4	0.0130	0.0430	0.004	0.004
n-Butane	P4	0.0260	0.0860	0.008	0.008
2,2-Dimethylpropane	I5	0.0003	0.0012	0.000	0.000
i-Pentane	15	0.0050	0.0205	0.002	0.002
n-Pentane	P5	0.0060	0.0246	0.002	0.002
2,2-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0003	0.0015	0.000	0.000
2-Methylpentane	I6	0.0016	0.0078	0.001	0.001
3-Methylpentane	I6	0.0009	0.0044	0.000	0.000
n-Hexane	P6	0.0021	0.0103	0.001	0.001
Methylcyclopentane	N6	0.0006	0.0028	0.000	0.000
2,4-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0006	0.0028	0.000	0.000
2-Methylhexane	I7	0.0005	0.0028	0.000	0.000
2,3-Dimethylpentane	I7	0.0002	0.0011	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0006	0.0034	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
2,2,4-Trimethylpentane	I8	0.0001	0.0006	0.000	0.000
UnknownC6s	U6	0.0001	0.0005	0.000	0.000
n-Heptane	P7	0.0010	0.0057	0.000	0.000
1c,2-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
Methylcyclohexane	N7	0.0011	0.0061	0.000	0.000
Ethylcyclopentane	N7	0.0001	0.0006	0.000	0.000

2,4-Dimethylhexane		I8	0.0001	0.0006	0.000	0.000
Toluene		A7	0.0004	0.0021	0.000	0.000
2-Methylheptane		I8	0.0004	0.0026	0.000	0.000
4-Methylheptane		18	0.0002	0.0013	0.000	0.000
3-Methyl-3-ethylpentane		18	0.0001	0.0006	0.000	0.000
1c,2t,3-Trimethylcyclopentan	ne	N8	0.0004	0.0026	0.000	0.000
3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0005	0.0032	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
Ethylcyclohexane		N8	0.0002	0.0012	0.000	0.000
n-Propylcyclopentane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xyl	ene)	A8	0.0002	0.0012	0.000	0.000
1,4-Dimethylbenzene (p-Xyle	ene)	A8	0.0001	0.0006	0.000	0.000
4-Methyloctane		I9	0.0001	0.0007	0.000	0.000
2-Methyloctane		I9	0.0002	0.0015	0.000	0.000
3,3-Diethylpentane		I9	0.0001	0.0007	0.000	0.000
1,2-Dimethylbenzene (o-Xyle	ene)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
5-Methylnonane		I10	0.0001	0.0008	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
n-Undecane		P11	0.0001	0.0009	0.000	0.000
UnknownC11s		U11	0.0001	0.0009	0.000	0.000
n-Dodecane		P12	0.0001	0.0010	0.000	0.000
UnknownC12s		U12	0.0001	0.0009	0.000	0.000
n-Tridecane		P13	0.0001	0.0010	0.000	0.000
TOTAL			100.00000	100.00000	2.0061	2.0015
BTEX COMPONENTS M	IOLE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW	NET DRY REAL :	946.4 /scf	944.3 /scf
TOLUENE	0.0004	0.0021		NET WET REAL :	929.9 /scf	927.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH	GROSS DRY REAL :	1048.7 /scf	1046.3 /scf
XYLENES	0.0004	0.0024		GROSS WET REAL :	1030.5 /scf	1028.1 /scf
TOTAL BTEX	0.0010	0.0054		NET DRY REAL :	20448.4 /lb	20401.2 /lb
				GROSS DRY REAL :	22662.3 /lb	22610.0 /lb
				RELATIVE DENSITY (AI	R=1):	0.6062
(CALC: GPA STD 2145 & TP-17 @14.6	596 & 60 F)			COMPRESSIBILITY FAC	TOR :	0.99771
*(DETAILED HYDROCARBON ANALY	SIS/NJ 1993) ; ASTI	M D6730				



MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-05	
PROJECT NO. :	201707030		ANALYSIS NO. :	07	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 14, 2017 10:43	
OFFICE / BRANCH:	KNOXVILLE	e, TN	SAMPLE DATE :	JULY 7, 2017 03:51	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :	]	psig	CYLINDER NO. :	M-10469	
LAB PRES:	]	psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		ŕf	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		ŕf	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_ ;	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT	-	MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.8200	2.9000		
CARBON DIOXIDE		0.65	1.63		
METHANE		90.06860	82.32520		
ETHANE		6.9926	11.9797	1.8736	1.8693
PROPANE		0.3576	0.8984	0.0985	0.0982
I-BUTANE		0.0140	0.0464	0.0050	0.0050
N-BUTANE		0.0260	0.0861	0.0080	0.0080
I-PENTANE		0.0054	0.0222	0.0020	0.0020
N-PENTANE		0.0040	0.0165	0.0010	0.0010
HEXANES PLUS	=	0.0118	0.0655	0.0020	0.0020
TOTALS		100.00000	100.00000	1.9901	1.9855
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	946.6 /scf	944.5 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	930.1 /scf	928.0 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1049.1 /scf	1046.7 /scf
XYLENES	0.0003	0.0018	GROSS WET REAL :	1030.9 /scf	1028.5 /scf
TOTAL BTEX	0.0008	0.0043	NET DRY REAL :	20475.8 / <b>lb</b>	20428.6 /lb

#### (CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

RELATIVE DENSITY (AIR=1): COMPRESSIBILITY FACTOR :

22693.0 /lb

0.6057

0.99771

22640.6 /lb

GROSS DRY REAL :



PROJECT NO. : COMPANY NAME : ACCOUNT NO. : PRODUCER : LEASE NO. : NAME/DESCRIP :

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-05 

 ANALYSIS NO.:
 07

 ANALYSIS DATE:
 JULY 14, 2017 10:43

 SAMPLE DATE :
 JULY 7, 2017 03:51

 CYLINDER NO.:
 M-10469

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.82	2.90		
Carbon Dioxide		0.65	1.63		
Methane	P1	90.06860	82.32520		
Ethane	P2	6.9926	11.9797	1.874	1.869
Propane	P3	0.3576	0.8984	0.099	0.098
i-Butane	I4	0.0140	0.0464	0.005	0.005
n-Butane	P4	0.0260	0.0861	0.008	0.008
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0050	0.0206	0.002	0.002
n-Pentane	P5	0.0040	0.0165	0.001	0.001
2,2-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0014	0.0069	0.001	0.001
3-Methylpentane	I6	0.0008	0.0039	0.000	0.000
n-Hexane	P6	0.0017	0.0083	0.001	0.001
Methylcyclopentane	N6	0.0005	0.0024	0.000	0.000
2,4-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0005	0.0024	0.000	0.000
2-Methylhexane	I7	0.0004	0.0023	0.000	0.000
2,3-Dimethylpentane	I7	0.0002	0.0011	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0005	0.0029	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
n-Heptane	P7	0.0008	0.0046	0.000	0.000
Methylcyclohexane	N7	0.0008	0.0045	0.000	0.000
2,4-Dimethylhexane	18	0.0001	0.0006	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	18	0.0002	0.0013	0.000	0.000
4-Methylheptane	18	0.0002	0.0013	0.000	0.000

1c,2t,3-Trimethylcyclopentane		N8	0.0003	0.0019	0.000	0.000
3-Ethylhexane		I8	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0004	0.0026	0.000	0.000
1,1,4-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
Ethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
n-Propylcyclopentane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xylene	)	A8	0.0002	0.0012	0.000	0.000
1,4-Dimethylbenzene (p-Xylene)	)	A8	0.0001	0.0006	0.000	0.000
4-Methyloctane		I9	0.0001	0.0007	0.000	0.000
2-Methyloctane		I9	0.0001	0.0007	0.000	0.000
3,3-Diethylpentane		I9	0.0001	0.0007	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
5-Methylnonane		I10	0.0001	0.0008	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
UnknownC11s		U11	0.0001	0.0009	0.000	0.000
TOTAL			100.00000	100.00000	1.9901	1.9855
BTEX COMPONENTS MOL	LE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NE	ET DRY REAL :	946.6 /scf	944.5 /scf
TOLUENE	0.0003	0.0016	NE	ET WET REAL :	930.1 /scf	928.0 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH G	ROSS DRY REAL :	1049.1 /scf	1046.7 /scf
XYLENES	0.0003	0.0018	GF	ROSS WET REAL :	1030.9 /scf	1028.5 /scf
TOTAL BTEX	0.0008	0.0043	NE	ET DRY REAL :	20475.8 /lb	20428.6 /lb
			GI	ROSS DRY REAL :	22693.0 /lb	22640.6 /lb
			RE	ELATIVE DENSITY (AIR	R=1):	0.6057
(CALC: GPA STD 2145 & TP-17 @14.696 &	60 F)		CC	OMPRESSIBILITY FACT	TOR :	0.99771

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc. Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility for interpretation or any consequences from application of the reported information and is the sole liability of the user. The reproduction in any media of this

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MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-07	
PROJECT NO. :	201707030		ANALYSIS NO. :	08	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 14, 2017 10:30	
OFFICE / BRANCH:	KNOXVILLI	E, TN	SAMPLE DATE :	JULY 7, 2017 04:14	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-13131	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.9000	3.0300		
CARBON DIOXIDE		0.65	1.63		
METHANE		89.94300	82.11530		
ETHANE		7.0259	12.0229	1.8826	1.8783
PROPANE		0.3616	0.9074	0.0995	0.0992
I-BUTANE		0.0150	0.0496	0.0050	0.0050
N-BUTANE		0.0300	0.0993	0.0090	0.0090
I-PENTANE		0.0064	0.0262	0.0020	0.0020
N-PENTANE		0.0060	0.0246	0.0020	0.0020
HEXANES PLUS	=	0.0121	0.0647	0.0020	0.0020
TOTALS		100.00000	100.00000	2.0021	1.9975
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0003	0.0013	LOW NET DRY REAL :	946.4 /scf	944.3 /scf
TOLUENE	0.0004	0.0021	NET WET REAL :	929.9 /scf	927.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1048.8 /scf	1046.4 /scf
XYLENES	0.0000	0.0000	GROSS WET REAL :	1030.6 /scf	1028.2 /scf

#### (CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)

TOTAL BTEX

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

0.0007

0.0034

RELATIVE DENSITY (AIR=1): COMPRESSIBILITY FACTOR :

NET DRY REAL :

GROSS DRY REAL :

0.6064 0.99771 20399.5 /lb

22608.5 /lb

20446.7 /lb

22660.8 /lb



PROJECT NO. : 20 COMPANY NAME : MG ACCOUNT NO. : PR PRODUCER : LEASE NO. : NAME/DESCRIP : GF U3

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-07 

 ANALYSIS NO.:
 08

 ANALYSIS DATE:
 JULY 14, 2017 10:30

 SAMPLE DATE :
 JULY 7, 2017 04:14

 CYLINDER NO.:
 M-13131

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.90	3.03		
Carbon Dioxide		0.65	1.63		
Methane	P1	89.94300	82.11530		
Ethane	P2	7.0259	12.0229	1.883	1.878
Propane	P3	0.3616	0.9074	0.100	0.099
i-Butane	I4	0.0150	0.0496	0.005	0.005
n-Butane	P4	0.0300	0.0993	0.009	0.009
2,2-Dimethylpropane	I5	0.0002	0.0008	0.000	0.000
i-Pentane	I5	0.0060	0.0246	0.002	0.002
n-Pentane	P5	0.0060	0.0246	0.002	0.002
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0005	0.0024	0.000	0.000
2-Methylpentane	I6	0.0008	0.0039	0.000	0.000
3-Methylpentane	I6	0.0017	0.0084	0.001	0.001
n-Hexane	P6	0.0022	0.0108	0.001	0.001
Methylcyclopentane	N6	0.0005	0.0024	0.000	0.000
Benzene	A6	0.0003	0.0013	0.000	0.000
Cyclohexane	N6	0.0006	0.0028	0.000	0.000
2-Methylhexane	I7	0.0003	0.0017	0.000	0.000
2,3-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0007	0.0040	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
n-Heptane	P7	0.0010	0.0057	0.000	0.000
Methylcyclohexane	N7	0.0009	0.0050	0.000	0.000
Toluene	A7	0.0004	0.0021	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
3-Methylheptane	I8	0.0002	0.0013	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0002	0.0012	0.000	0.000
3-Ethylhexane	18	0.0001	0.0006	0.000	0.000
n-Octane	P8	0.0005	0.0032	0.000	0.000
1c,4-Dimethylcyclohexane	N8	0.0001	0.0006	0.000	0.000

n-Nonane		P9	0.0003	0.0022	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	2.0021	1.9975
BTEX COMPONENTS	MOLE%	WT%		BTU @	14.730	14.696
BENZENE	0.0003	0.0013	LOW NE	T DRY REAL :	946.4 /scf	944.3 /scf
TOLUENE	0.0004	0.0021	NE	T WET REAL :	929.9 /scf	927.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GF	ROSS DRY REAL :	1048.8 /scf	1046.4 /scf
XYLENES	0.0000	0.0000	GF	ROSS WET REAL :	1030.6 /scf	1028.2 /scf
TOTAL BTEX	0.0007	0.0034	NE	T DRY REAL :	20446.7 /lb	20399.5 /lb
			GF	ROSS DRY REAL :	22660.8 /lb	22608.5 /lb
			RE	LATIVE DENSITY (AIR	R=1):	0.6064
(CALC: GPA STD 2145 & TP-17 (	@14.696 & 60 F)		CC	MPRESSIBILITY FACT	TOR :	0.99771

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc.

Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility

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MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-09	
PROJECT NO. :	201707030		ANALYSIS NO. :	09	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 14, 2017 08:18	
OFFICE / BRANCH:	KNOXVILLE	E, TN	SAMPLE DATE :	JULY 7, 2017 04:30	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :	F	psig	CYLINDER NO. :	M-21838	
LAB PRES:	F	osig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :	o	ŕ	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:	o	ŕ	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_ #	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
COMPONENT HELIUM		<b>MOLE %</b> 0.04	MASS % 0.01	<u>14.730</u>	<u>14.696</u>
COMPONENT HELIUM HYDROGEN		MOLE % 0.04 0.00	<u>MASS %</u> 0.01 0.00	<u>14.730</u> 	<u>14.696</u> 
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON	· _	MOLE % 0.04 0.00 0.01	<u>MASS %</u> 0.01 0.00 0.02	<u>14.730</u>  	<u>14.696</u>  
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN		MOLE % 0.04 0.00 0.01 1.8500	MASS % 0.01 0.00 0.02 2.9500	<u>14.730</u>   	<u>14.696</u>   
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE		MOLE % 0.04 0.00 0.01 1.8500 0.65	MASS % 0.01 0.00 0.02 2.9500 1.63	<u>14.730</u>    	<u>14.696</u>    
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE	· _	MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520	<u>14.730</u>    	<u>14.696</u>     
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520 11.9773	<u>14.730</u>    1.8746	<u>14.696</u>     1.8703
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE	· _	MOLE % 0.04 0.00 1.8500 0.65 90.03350 6.9944 0.3518	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520 11.9773 0.8835	<u>14.730</u>    1.8746 0.0974	14.696     1.8703 0.0972
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE I-BUTANE	· _	MOLE % 0.04 0.00 1.8500 0.65 90.03350 6.9944 0.3518 0.0140	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520 11.9773 0.8835 0.0464	<u>14.730</u>     1.8746 0.0974 0.0050	14.696     1.8703 0.0972 0.0050
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE I-BUTANE N-BUTANE		MOLE % 0.04 0.00 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963	<u>14.730</u>    1.8746 0.0974 0.0050 0.0090	14.696    1.8703 0.0972 0.0050 0.0090
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE ETHANE PROPANE I-BUTANE N-BUTANE I-PENTANE		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291 0.0065	MASS % 0.01 0.00 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963 0.0267	14.730    1.8746 0.0974 0.0050 0.0090 0.0020	14.696     1.8703 0.0972 0.0050 0.0090 0.0020
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE ETHANE PROPANE I-BUTANE N-BUTANE N-PENTANE N-PENTANE		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291 0.0065 0.0070	MASS % 0.01 0.00 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963 0.0267 0.0288	14.730    1.8746 0.0974 0.0050 0.0090 0.0020 0.0020 0.0030	14.696    1.8703 0.0972 0.0050 0.0090 0.0020 0.0030
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE I-BUTANE N-BUTANE N-BUTANE N-PENTANE HEXANES PLUS		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291 0.0065 0.0070 0.0070 0.0137	MASS % 0.01 0.00 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963 0.0267 0.0288 0.0758	14.730    1.8746 0.0974 0.0050 0.0090 0.0020 0.0030 0.0020	14.696    1.8703 0.0972 0.0050 0.0090 0.0020 0.0030 0.0020
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE I-BUTANE N-BUTANE I-PENTANE N-PENTANE HEXANES PLUS TOTALS		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291 0.0065 0.0070 0.0137 100.00000	MASS % 0.01 0.00 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963 0.0267 0.0288 0.0758 100.00000	14.730    1.8746 0.0974 0.0050 0.0090 0.0020 0.0020 0.0030 0.0020 1.9930	14.696    1.8703 0.0972 0.0050 0.0090 0.0020 0.0020 0.0030 0.0020 1.9885
COMPONENT HELIUM HYDROGEN OXYGEN/ARGON NITROGEN CARBON DIOXIDE METHANE ETHANE PROPANE I-BUTANE N-BUTANE N-BUTANE N-PENTANE HEXANES PLUS TOTALS BTEX COMPONENTS		MOLE % 0.04 0.00 0.01 1.8500 0.65 90.03350 6.9944 0.3518 0.0140 0.0291 0.0065 0.0070 0.0137 100.00000 WT%	MASS % 0.01 0.00 0.02 2.9500 1.63 82.25520 11.9773 0.8835 0.0464 0.0963 0.0267 0.0288 0.0758 100.00000 BTU @	14.730    1.8746 0.0974 0.0050 0.0090 0.0020 0.0020 0.0020 1.9930 14.730	14.696    1.8703 0.0972 0.0050 0.0090 0.0020 0.0020 1.9885 14.696

BENZENE	0 0002	0 0009	LOW NET DBY BEAL	946.6 /	sef	944 5 /scf
TOLUENE	0.0002	0.0021	NET WET REAL :	930.1 /	scf	928.0 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1049.1 /	scf	1046.7 /scf
XYLENES	0.0003	0.0018	GROSS WET REAL :	1030.9 /	scf	1028.5 /scf
TOTAL BTEX	0.0009	0.0048	NET DRY REAL :	20464.6 /	b	20417.4 / <b>lb</b>
			GROSS DRY REAL :	22680.8 /	b	22628.4 /lb
(CALC: GPA STD 2145 & TP-1	7 @14.696 & 60 F)	1	<b>RELATIVE DENSITY (AI</b>	R=1):	0.6060	
*(DETAILED HYDROCARBON	ANALYSIS/NJ 199	93); ASTM D673		CTOR :	0.99771	

-



PROJECT NO. : 20 COMPANY NAME : M ACCOUNT NO. : P PRODUCER : LEASE NO. : NAME/DESCRIP : G U

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

201707030 MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-09 

 ANALYSIS NO.:
 09

 ANALYSIS DATE:
 JULY 14, 2017 08:18

 SAMPLE DATE :
 JULY 7, 2017 04:30

 CYLINDER NO.:
 M-21838

 SAMPLED BY :
 HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.85	2.95		
Carbon Dioxide		0.65	1.63		
Methane	P1	90.03350	82.25520		
Ethane	P2	6.9944	11.9773	1.875	1.870
Propane	P3	0.3518	0.8835	0.097	0.097
i-Butane	I4	0.0140	0.0464	0.005	0.005
n-Butane	P4	0.0291	0.0963	0.009	0.009
2,2-Dimethylpropane	I5	0.0003	0.0012	0.000	0.000
i-Pentane	15	0.0060	0.0247	0.002	0.002
n-Pentane	P5	0.0070	0.0288	0.003	0.003
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0004	0.0019	0.000	0.000
2-Methylpentane	I6	0.0009	0.0044	0.000	0.000
3-Methylpentane	I6	0.0015	0.0073	0.001	0.001
n-Hexane	P6	0.0022	0.0108	0.001	0.001
Methylcyclopentane	N6	0.0006	0.0028	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0007	0.0034	0.000	0.000
2-Methylhexane	I7	0.0004	0.0023	0.000	0.000
2,3-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0006	0.0034	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
n-Heptane	P7	0.0010	0.0057	0.000	0.000
Methylcyclohexane	N7	0.0012	0.0067	0.000	0.000
Toluene	A7	0.0004	0.0021	0.000	0.000
2-Methylheptane	18	0.0004	0.0026	0.000	0.000
4-Methylheptane	I8	0.0002	0.0013	0.000	0.000
3-Methylheptane	18	0.0002	0.0013	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0003	0.0019	0.000	0.000
1t,4-Dimethylcyclohexane	N8	0.0001	0.0006	0.000	0.000
n-Octane	P8	0.0006	0.0039	0.000	0.000

1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-X	ylene)	A8	0.0002	0.0012	0.000	0.000
4-Methyloctane		I9	0.0002	0.0015	0.000	0.000
2-Methyloctane		I9	0.0001	0.0007	0.000	0.000
1c,2t,3-Trimethylcyclohexane		N9	0.0001	0.0007	0.000	0.000
1,2-Dimethylbenzene (o-Xy	lene)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
n-Undecane		P11	0.0001	0.0009	0.000	0.000
UnknownC14s		U14	0.0001	0.0011	0.000	0.000
TOTAL			100.00000	100.00000	1.9930	1.9885
BTEX COMPONENTS	MOLE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NE	T DRY REAL :	946.6 /scf	944.5 /scf
TOLUENE	0.0004	0.0021	NE	T WET REAL :	930.1 /scf	928.0 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GF	ROSS DRY REAL :	1049.1 /scf	1046.7 /scf
XYLENES	0.0003	0.0018	GF	ROSS WET REAL :	1030.9 /scf	1028.5 /scf
TOTAL BTEX	0.0009	0.0048	NE	T DRY REAL :	20464.6 /lb	20417.4 / <b>lb</b>
			GF	ROSS DRY REAL :	22680.8 /lb	22628.4 /lb
			RE	LATIVE DENSITY (AIR	=1):	0.6060
(CALC: GPA STD 2145 & TP-17 @14	4.696 & 60 F)		CC	MPRESSIBILITY FACT	OR:	0.99771

#### \*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730



MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-11	
PROJECT NO. :	201707030		ANALYSIS NO. :	10	
COMPANY NAME :	MCHALE &	ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 16:49	
OFFICE / BRANCH:	KNOXVILLI	E, TN	SAMPLE DATE :	JULY 7, 2017 04:45	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-24723	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT	-	MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.02	0.04		
NITROGEN		1.9600	3.1200		
CARBON DIOXIDE		0.65	1.63		
METHANE		89.87990	82.03930		
ETHANE		7.0389	12.0424	1.8867	1.8823
PROPANE		0.3465	0.8693	0.0954	0.0952
I-BUTANE		0.0130	0.0430	0.0040	0.0040
N-BUTANE		0.0270	0.0893	0.0080	0.0080
I-PENTANE		0.0064	0.0262	0.0020	0.0020
N-PENTANE		0.0060	0.0246	0.0020	0.0020
HEXANES PLUS	: =	0.0123	0.0659	0.0020	0.0020
TOTALS		100.00000	100.00000	2.0001	1.9955
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0003	0.0013	LOW NET DRY REAL :	945.5 /scf	943.4 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	929.1 /scf	926.9 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1047.8 /scf	1045.4 /scf
XYLENES	0.0001	0.0006	GROSS WET REAL :	1029.6 /scf	1027.2 /scf

(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F) \*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

TOTAL BTEX

0.0007

0.0035

**RELATIVE DENSITY (AIR=1):** COMPRESSIBILITY FACTOR :

GROSS DRY REAL :

NET DRY REAL :

0.6066 0.99771 20376.3 /lb

22582.8 /lb

20423.4 /lb

22635.1 /lb



PROJECT NO. : 201707030 COMPANY NAME : MCHALE & ACCOUNT NO. : PRJ 17041. PRODUCER : LEASE NO. : NAME/DESCRIP : GREC - KII U3, SAMPI

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-11 ANALYSIS NO.: 10 ANALYSIS DATE: JULY 13, 2017 16:49 SAMPLE DATE : JULY 7, 2017 04:45 CYLINDER NO.: M-24723 SAMPLED BY : HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.02	0.04		
Nitrogen		1.96	3.12		
Carbon Dioxide		0.65	1.63		
Methane	P1	89.87990	82.03930		
Ethane	P2	7.0389	12.0424	1.887	1.882
Propane	P3	0.3465	0.8693	0.095	0.095
i-Butane	I4	0.0130	0.0430	0.004	0.004
n-Butane	P4	0.0270	0.0893	0.008	0.008
2,2-Dimethylpropane	I5	0.0002	0.0008	0.000	0.000
i-Pentane	I5	0.0060	0.0246	0.002	0.002
n-Pentane	P5	0.0060	0.0246	0.002	0.002
2,2-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
Cyclopentane	N5	0.0002	0.0008	0.000	0.000
2,3-Dimethylbutane	I6	0.0002	0.0010	0.000	0.000
2-Methylpentane	I6	0.0010	0.0049	0.000	0.000
3-Methylpentane	I6	0.0017	0.0084	0.001	0.001
n-Hexane	P6	0.0020	0.0098	0.001	0.001
Methylcyclopentane	N6	0.0006	0.0028	0.000	0.000
Benzene	A6	0.0003	0.0013	0.000	0.000
Cyclohexane	N6	0.0006	0.0028	0.000	0.000
2-Methylhexane	I7	0.0004	0.0023	0.000	0.000
2,3-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0005	0.0028	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
n-Heptane	P7	0.0009	0.0051	0.000	0.000
Methylcyclohexane	N7	0.0009	0.0050	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
4-Methylheptane	I8	0.0002	0.0013	0.000	0.000
3-Methylheptane	I8	0.0002	0.0013	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0003	0.0019	0.000	0.000

3-Ethylhexane		18	0.0001	0.0006	0.000	0.000
1t,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
UnknownC7s		U7	0.0001	0.0006	0.000	0.000
n-Octane		P8	0.0003	0.0019	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xylene	e)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	2.0001	1.9955
BTEX COMPONENTS MOI	LE%	WT%		BTU @	14.730	14.696
BENZENE	0.0003	0.0013	LOW N	ET DRY REAL :	945.5 /scf	943.4 /scf
TOLUENE	0.0003	0.0016	N	ET WET REAL :	929.1 /scf	926.9 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH G	ROSS DRY REAL :	1047.8 /scf	1045.4 /scf
XYLENES	0.0001	0.0006	G	ROSS WET REAL :	1029.6 /scf	1027.2 /scf
TOTAL BTEX	0.0007	0.0035	Ν	ET DRY REAL :	20423.4 /lb	20376.3 /lb
			G	ROSS DRY REAL :	22635.1 /lb	22582.8 /lb
			R	ELATIVE DENSITY (AIF	R=1):	0.6066
(CALC: GPA STD 2145 & TP-17 @14.696 d	& 60 F)		C	OMPRESSIBILITY FAC	TOR :	0.99771

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc.

Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility for interpretation or any consequences from application of the reported information and is the sole liability of the user. The reproduction in any media of this reported information may not be made, in portion or as a whole, without the written permission of EMPACT Analytical Systems, Inc.



MAIN PAGE

LEASE #:			NAME/DESCRIP :	GREC - KIEWIT U3, SAMPLE B-13	
PROJECT NO. :	201707030		ANALYSIS NO. :	11	
COMPANY NAME :	MCHALE &	& ASSOCIATES	ANALYSIS DATE:	JULY 13, 2017 15:08	
OFFICE / BRANCH:	KNOXVILL	E, TN	SAMPLE DATE :	JULY 7, 2017 05:14	
CUSTOMER REF:	PRJ 17041.0		TO:		
PRODUCER :			EFFECTIVE DATE:		
***FIELD DATA***					
SAMPLE CYCLE:			SAMPLE TYPE:		
SAMPLE PRES. :		psig	CYLINDER NO. :	M-30404	
LAB PRES:		psig	SAMPLED BY :	HF GROTKOPF	
SAMPLE TEMP. :		°f	SAMPLING COMPANY	(: MCHALE	
AMBIENT TEMP .:		°f	H2S BY STAIN TUBE:	_ ppm	
H2O BY STAIN TUBE:	_	#/mmcf	CO2 BY STAIN TUBE:	_ Mol %	
FIELD COMMENTS:					
LAB COMMENTS:					
				GPM @	GPM @
COMPONENT		MOLE %	MASS %	14.730	14.696
HELIUM		0.04	0.01		
HYDROGEN		0.00	0.00		
OXYGEN/ARGON		0.01	0.02		
NITROGEN		1.8500	2.9500		
CARBON DIOXIDE		0.67	1.68		
METHANE		89.98180	82.17350		
ETHANE		7.0340	12.0399	1.8847	1.8803
PROPANE		0.3497	0.8778	0.0964	0.0962
I-BUTANE		0.0130	0.0430	0.0040	0.0040
N-BUTANE		0.0270	0.0893	0.0080	0.0080
I-PENTANE		0.0055	0.0225	0.0020	0.0020
N-PENTANE		0.0060	0.0246	0.0020	0.0020
HEXANES PLUS		0.0130	0.0694	0.0020	0.0020
TOTALS		100.00000	100.00000	1.9991	1.9945
BTEX COMPONENTS	MOLE%	WT%	BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW NET DRY REAL :	946.4 /scf	944.3 /scf
TOLUENE	0.0003	0.0016	NET WET REAL :	929.9 /scf	927.8 /scf
ETHYLBENZENE	0.0000	0.0000	HIGH GROSS DRY REAL :	1049.0 /scf	1046.6 /scf

The data presented herein has been acquired by means of current analytical techniques and represents the judicious conclusion EMPACT Analytical Systems, Inc. Results of the analysis can be affected by the sampling conditions, therefore, are only warranted through proper lab protocol. EMPACT assumes no responsibility for interpretation or any consequences from application of the reported information and is the sole liability of the user. The reproduction in any media of this reported information may not be made, in portion or as a whole, without the written permission of EMPACT Analytical Systems, Inc.

XYLENES

TOTAL BTEX

(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)

\*(DETAILED HYDROCARBON ANALYSIS/NJ 1993); ASTM D6730

0.0002

0.0007

0.0012

0.0037

GROSS WET REAL :

GROSS DRY REAL :

**RELATIVE DENSITY (AIR=1):** 

COMPRESSIBILITY FACTOR :

NET DRY REAL :

1030.8 /scf

0.6062

0.99771

20453.6 /lb 22668.4 /lb 1028.4 /scf

20406.4 /lb

22616.1 /lb



PROJECT NO. : 201707030 COMPANY NAME : MCHALE & ACCOUNT NO. : PRJ 17041. PRODUCER : LEASE NO. : NAME/DESCRIP : GREC - KII U3, SAMPI

\*\*\*FIELD DATA\*\*\*

SAMPLE PRES. :

COMMENTS :

MCHALE & ASSOCIATES PRJ 17041.0 GREC - KIEWIT U3, SAMPLE B-13 ANALYSIS NO.: 11 ANALYSIS DATE: JULY 13, 2017 15:08 SAMPLE DATE : JULY 7, 2017 05:14 CYLINDER NO.: M-30404 SAMPLED BY : HF GROTKOPF

SAMPLE TEMP. : AMBIENT TEMP.:

				GPM @	GPM @
COMPONENT	PIANO #	MOLE %	MASS %	14.730	14.696
Helium		0.04	0.01		
Oxygen/Argon		0.01	0.02		
Nitrogen		1.85	2.95		
Carbon Dioxide		0.67	1.68		
Methane	P1	89.98180	82.17350		
Ethane	P2	7.0340	12.0399	1.885	1.880
Propane	P3	0.3497	0.8778	0.096	0.096
i-Butane	I4	0.0130	0.0430	0.004	0.004
n-Butane	P4	0.0270	0.0893	0.008	0.008
2,2-Dimethylpropane	15	0.0002	0.0008	0.000	0.000
i-Pentane	15	0.0050	0.0205	0.002	0.002
n-Pentane	P5	0.0060	0.0246	0.002	0.002
2,2-Dimethylbutane	I6	0.0001	0.0005	0.000	0.000
Cyclopentane	N5	0.0003	0.0012	0.000	0.000
2,3-Dimethylbutane	I6	0.0003	0.0015	0.000	0.000
2-Methylpentane	I6	0.0011	0.0054	0.000	0.000
3-Methylpentane	I6	0.0018	0.0088	0.001	0.001
n-Hexane	P6	0.0025	0.0122	0.001	0.001
Methylcyclopentane	N6	0.0007	0.0034	0.000	0.000
Benzene	A6	0.0002	0.0009	0.000	0.000
Cyclohexane	N6	0.0006	0.0028	0.000	0.000
2-Methylhexane	I7	0.0004	0.0023	0.000	0.000
2,3-Dimethylpentane	I7	0.0001	0.0006	0.000	0.000
1,1-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
3-Methylhexane	I7	0.0005	0.0028	0.000	0.000
1c,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,3-Dimethylcyclopentane	N7	0.0001	0.0006	0.000	0.000
1t,2-Dimethylcyclopentane	N7	0.0002	0.0011	0.000	0.000
n-Heptane	P7	0.0009	0.0051	0.000	0.000
Methylcyclohexane	N7	0.0010	0.0056	0.000	0.000
Toluene	A7	0.0003	0.0016	0.000	0.000
2-Methylheptane	I8	0.0003	0.0019	0.000	0.000
3-Methylheptane	18	0.0002	0.0013	0.000	0.000
1c,2t,3-Trimethylcyclopentane	N8	0.0002	0.0012	0.000	0.000
3-Ethylhexane	I8	0.0001	0.0006	0.000	0.000

n-Octane		P8	0.0006	0.0039	0.000	0.000
1c,4-Dimethylcyclohexane		N8	0.0001	0.0006	0.000	0.000
1,3-Dimethylbenzene (m-Xyle	ne)	A8	0.0001	0.0006	0.000	0.000
1,2-Dimethylbenzene (o-Xyler	ne)	A8	0.0001	0.0006	0.000	0.000
n-Nonane		P9	0.0002	0.0015	0.000	0.000
n-Decane		P10	0.0001	0.0008	0.000	0.000
TOTAL			100.00000	100.00000	1.9991	1.9945
BTEX COMPONENTS MO	OLE%	WT%		BTU @	14.730	14.696
BENZENE	0.0002	0.0009	LOW	IET DRY REAL :	946.4 /scf	944.3 /sci
TOLUENE	0.0003	0.0016	Ν	IET WET REAL :	929.9 /scf	927.8 /sci
ETHYLBENZENE	0.0000	0.0000	HIGH G	ROSS DRY REAL :	1049.0 /scf	1046.6 /sci
XYLENES	0.0002	0.0012	G	ROSS WET REAL :	1030.8 /scf	1028.4 /sci
TOTAL BTEX	0.0007	0.0037	Ν	IET DRY REAL :	20453.6 /lb	20406.4 /lb
			G	ROSS DRY REAL :	22668.4 /lb	22616.1 /lb
			F	RELATIVE DENSITY (AIF	R=1):	0.6062
(CALC: GPA STD 2145 & TP-17 @14.696 & 60 F)			C	OMPRESSIBILITY FAC	TOR :	0.99771
*(DETAILED HYDROCARBON ANALYS)	IS/NJ 1993); AS	TM D6730				



201707030 **CHAIN OF CUSTODY FORM FOR** 

# **NATURAL GAS**

Please analyze the enclosed fuel samples by the methods indicated below.

Project Name	GR	E(-	Kiewit

Project Number 17041.0

TEST CODE SECTIONS (	REFERENCE	ONLY)	
ASME PTC 22-1997	4.12.5	4.12.6	
ASME PTC 22-2005	4-4.4.1	4-4.4	
ASME PTC 46-1996	10 - N. M.	4.5.3	Other (Write-In Below)
Description	LHV / HHV	Composition	
Test Method	ASTM D	ASTM D	
SAMPLES TO BE ANALYZED	3588	1945	
A-01-12248			
· A- 03 - 23773			
· A-05- 23799			
A-07-23822			
B-01-13031			
B-03 - 23144			
B-05 - 10469			
B-07- 13 131			
B-09 - 21838			
8-11 - 24723			
B-13 - 30404			
×			
		If extended analys check here	is

Turn Around Time:	Business Days
Retention Time:	Business Days

Unless otherwise specified, sample analyses should be completed within 5 business days of receipt of the samples by the laboratory. Additionally, any unused or referee samples should be retained for 30 business days after issuance of certificates of analysis, unless otherwise specified. , com

Requ	uested/Sent By: .	Cory Smith NAME	Cory, Smith @ mcho E-MAIL	10 per tormanic 865-282-0855 PHONE
Please email the lab to the followin	analysis results ng parties	Party 1	Party 2	Party 3
FOR LAB USE C	<u>DNLY</u> Received By:	Eric Hoffmon PRINT	E.Q. Number:	<u>ארו רון זא: 54</u>
Remarks: (Please place additional notes on the back of this sheet)	SAMPLE #	REMARKS		

McHale - Redmond, WA 425-883-2058

McHale - Knoxville, TN 865-588-2654

Same At

McHale - Arvada, CO 303-800-3739

**APPENDIX I** 

SIGNED DEVIATION LETTER



Subject: GREC U3 EPC Performance Test Deviations

The following are a list of the test deviations/clarifications from the current performance test procedure (73.09.02.010\_TP\_EPC – PERFORMANCE TEST PROCEDURE) Revision 1, Dated 5/17/2017:

## **Deviations:**

- Section 2.3 and Appendix C of the procedure state that the auxiliary power will be measured using a temporary instrument at five-minute time intervals. All parties to the test agree to use the station instruments (which have been validated using temporary instruments) for the HRSG Aux Power measurement and to use the STG Aux Power measurements taken using a temporary instrument one time after the performance test.
- All parties to the test agree two closed cooling water heat exchangers will be in service during testing as one heat exchanger is insufficient to support plant operation.
- All parties to the test agreed the fuel gas heater 3 way gas bypass valve will not be closed during the testing. This is inconsistent with the thermal design of the plant, but required by MHPSA to support CTG operation.
- All parties to the test agree that an IGV inspection shall not be performed within 24 fired hours of the start of testing.
- All parties to the test agree that a separate pretest need not be performed.
- All parties to the test agree that in order to accurately measure the cooling steam going to the gas turbine, the HP backup steam warming line and the associated DSH (03-V035635 and 03-TV-035636) shall be closed for the duration of the testing.
- All parties to the test agree that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.

## **Clarifications:**

- At this time, testing will only be conducted for the unfired conditions.
- The vacuum pump heat exchangers will be run on service water in between test runs, and switched to circulating water for the test runs to minimize fouling of the strainers and heat exchangers.
- The most recent fuel gas analysis available will be used for calculation of preliminary results instead of the station gas chromatograph.

Approval Signatures:	$\bigcirc$	76
GRDA Representative	Print Name: Jamme Kurrau	Signature: /4.4. Mun 7/11/17
Kiewit Representative	Print Name: PARAG PATHAK	Signature: perparte 07/10/17



Subject: GREC U3 CTG Performance Test Deviations

The following are a list of the test deviations/clarifications from the current performance test procedure (73.09.02.010\_TP\_CTG – PERFORMANCE TEST PROCEDURE) Revision 2, Dated 6/21/2017:

**Deviations:** 

- All parties to the test agreed the fuel gas heater 3 way gas bypass valve will not be closed during the testing. This is inconsistent with the thermal design of the plant, but required by MHPSA to support CTG operation.
- All parties to the test agree that an IGV inspection shall not be performed within 24 fired hours of the start of testing.
- All parties to the test agree that a separate pretest need not be performed.
- All parties to the test agree that in order to accurately measure the cooling steam going to the gas turbine, the HP backup steam warming line and the associated DSH (03-V035635 and 03-TV-035636) shall be closed for the duration of the testing.
- All parties to the test agree that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.
- All parties to the test agree that the CTG is not required to operate only in exhaust temperature control mode, but rather operation on either blade path temperature control or exhaust temperature control is acceptable.

**Clarifications:** 

- At this time, testing will only be conducted for the unfired conditions.
- There are 9 RH transmitters measuring ambient RH. 3 were provided by MHI and 6 were provided by Kiewit.
- The most recent fuel gas analysis available will be used for calculation of preliminary results instead of the station gas chromatograph.

Approval Signatures:	turnen	
GRDA Representative	Print Name: Jumente Burrow	Signature: And Tall
MHPS Representative	Print Name: Marc Fujinaka	Signature: 7/7/17
Kiewit Representative	Print Name: Adam Decher	Signature: 1/7/1



### Subject: GREC U3 HRSG Performance Test Deviations

The following are a list of the test deviations/clarifications from the current performance test procedure (73.09.02.010 TP HRSG - PERFORMANCE TEST PROCEDURE) Revision 2, Dated 6/2/2017:

**Deviations:** 

- Appendix C of the procedure states the auxiliary power will be measured using a temporary 0 instrument. All parties to the test agree to use the station instruments (which have been validated using temporary instruments) for this measurement.
- All parties to the test agree that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.

#### Clarifications:

Testing was only conducted for the unfired conditions. At this time, testing will only be conducted for the unfired conditions.

- 0
- BHP 7/10/17 PSP 07/10/17 The most recent fuel gas analysis available will be used for calculation of preliminary results ø instead of the station gas chromatograph.

**Approval Signatures:** 

Print Name: Variable Karne **GRDA** Representative

Signature:

NE Representative

Print Name: Brendan H. Phillips

Signature: Signature

Kiewit Representative Print Name: PARAG PATHAK



Subject: GREC U3 STG Performance Test Deviations

The following are a list of the test deviations/clarifications from the current performance test procedure (73.09.02.010\_TP\_STG – PERFORMANCE TEST PROCEDURE) Revision 2, Dated 6/9/2017:

**Deviations:** 

- Section 3.5.2.7 of the procedure states the unfired f<sub>Design</sub> is 0.0693. All parties to the test agree to the correct value is 0.0369.
- Section 2.3 and Appendix C of the procedure state that the auxiliary power will be measured using a temporary instrument at five-minute time intervals. All parties to the test agree to use the STG Aux Power measurements taken using a temporary instrument one time after the performance test.
- One of the steam turbine balance pipe sensing lines on DP1 is plugged and cannot be cleared. All parties to the test agree to use the design value for the flows through the balance piping.
- All parties to the test agree that there shall be no load change between test runs 2 and 3 due to the length of time required to get the CTG back in "high power" mode after a load change.

**Clarifications:** 

• At this time, testing will only be conducted for the unfired conditions.

Print Name: Jamie Kurren	Signature: 10- Mm 7/1/17
Print Name: YUKI SUMI	Signature: Y. Smi
Print Name: PARAG PATHAK	Signature: popado 07/10/17
	Print Name: Junie Rumen Print Name: YUKI SUMI Print Name: PARAG PATHAK