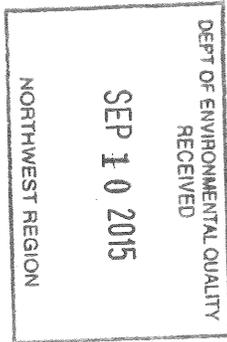




State of Oregon
Department of
Environmental
Quality



Application for a Solid Waste Beneficial Use Determination

DEQ USE ONLY - BUSINESS OFFICE

Date Received: 9/10/15

Amount Received: \$2000.00

Check No.: 100898818

Deposit No.: _____

Forward confirmation of fee payment for:
Eastern Region to DEQ, The Dalles
Northwestern Region to DEQ-NWR, Portland
Western Region to DEQ, Eugene

A. REFERENCE INFORMATION (Please type or print clearly.)

<u>Andrew D. Swartwout</u> Legal name of applicant		<u>United States Gypsum Company</u> Business name of applicant if different	
<u>PO Box 37</u> Mailing address	<u>Rainier</u> City	<u>Oregon</u> State	<u>97048</u> Zip
<u>503-556-4342</u> Phone	<u>928-301-9225</u> Mobile	<u>Aswartwout@usg.com</u> E-mail	_____ Fax

<u>United States Gypsum Company</u> Generator of solid waste (may be same as applicant)			
<u>PO Box 37</u> Mailing address	<u>Rainier</u> City	<u>Oregon</u> State	<u>97048</u> Zip
<u>503-556-4342</u> Phone	<u>928-301-9225</u> Mobile	<u>Aswartwout@usg.com</u> E-mail	_____ Fax

B. TYPE OF BENEFICIAL USE DETERMINATION REQUESTED Beneficial Use Determination applications are categorized based on the type of information and potential amount of work required by DEQ staff to review application materials and render a decision. A tiered review and fee system has been established in rule. The tiers are:

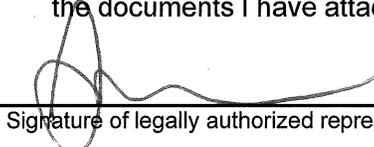
- Tier 1 For a beneficial use of a solid waste that does not contain hazardous substances significantly exceeding the concentration in a comparable raw material or commercial product and that will be used in a manufactured product;
- Tier 2 For a beneficial use of a solid waste that contains hazardous substances significantly exceeding the concentration in a comparable raw material or commercial product, or involves application on the land;
- Tier 3 For a beneficial use of a solid waste that requires research, such as a literature review or risk assessment, or for a demonstration project to demonstrate compliance with this rule.

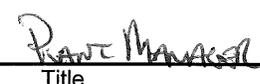
I am applying for a Tier 1 Tier 2 Tier 3 determination.

C. DOES THIS PROPOSED BENEFICIAL USE INVOLVE LAND APPLICATION OF ANY MATERIAL?

Yes No

D. SIGNATURE I hereby certify by my signature below that the information contained in this application, and the documents I have attached, are true and correct to the best of my knowledge and belief.




8.31.2015
 Signature of legally authorized representative Print name Title Date

E. REQUIRED ATTACHMENTS TO THIS APPLICATION *(For an application to be complete, it must provide the required information for each listed item of the tier which is being applied for.)*

Tier 1

- A description of the material, manner of generation, and estimated quantity to be used each year;
- A description of the proposed use;
- A comparison of the chemical and physical characteristics of the material proposed for use with the material it will replace;
- A demonstration of compliance with the performance criteria in OAR 340-093-0280 based on knowledge of the process that generated the material, properties of the finished product, or testing; and
- Any other information that DEQ may require to evaluate the proposal.

Tier 2

- The information required for a Tier 1 application;
- Sampling and analysis that provides chemical, physical, and biological characterization of the material and that identifies potential contaminants in the material or the end product, as applicable;
- A risk screening comparing the concentration of hazardous substances in the material to existing, DEQ approved, risk-based screening level values, and demonstrating compliance with acceptable risk levels;
- Location or type of land use where the material will be applied, consistent with the risk scenarios used to evaluate risk;
- Contact information of property owner(s) if this is a site-specific land application proposal, including name, address, phone number, e-mail, site address and site coordinates (latitude and longitude); and
- A description of how the material will be managed to minimize potential adverse impacts to public health, safety, welfare, or the environment.

Tier 3

- The information required for a Tier 1 & 2 application;
- A discussion of the justification for the proposal;
- An estimate of the expected length of time that would be required to complete the project, if it is a demonstration; and
- If it is a demonstration project, the methods proposed to ensure safe and proper management of the material.

F. PERFORMANCE CRITERIA *(For all tiers - An application for a beneficial use determination must demonstrate satisfactory compliance with the following performance criteria.)*

The use is productive, including:

- ◆ There is an identified or reasonably likely use for the material that is not speculative;
- ◆ The use is a valuable part of a manufacturing process, an effective substitute for a valuable raw material or commercial product, or otherwise authorized by DEQ, and does not constitute disposal; and
- ◆ The use is in accordance with applicable engineering standards, commercial standards, and agricultural or horticultural practices.

The use will not create an adverse impact to public health, safety, welfare, or the environment, including:

- ◆ The material is not a hazardous waste under ORS 466.005;
- ◆ Until the time the material is used in accordance with a beneficial use determination, the material will be managed, including any storage, transportation, or processing, to prevent releases to the environment or nuisance conditions;
- ◆ Hazardous substances in the material do not significantly exceed the concentration in a comparable raw material or commercial product, or do not exceed naturally occurring background concentrations, or do not exceed acceptable risk levels, including evaluation of persistence and potential bioaccumulation, when the material is managed according to a beneficial use determination.

The use will not result in the increase of a hazardous substance in a sensitive environment.

The use will not create objectionable odors, dust, unsightliness, fire, or other nuisance conditions.

The use will comply with all applicable federal, state, and local regulations.

G. FEES (Must accompany the application for it to be considered complete)

<input type="checkbox"/>	Tier 1 beneficial use determination	\$1,000
<input checked="" type="checkbox"/>	Tier 2 beneficial use determination	\$2,000
<input type="checkbox"/>	Tier 3 beneficial use determination	\$5,000

Make checks out to: **Oregon DEQ**

Total fees included: _____

H. APPLICATION PROCEDURE

Step 1

Contact a DEQ staff person for assistance with the preparation of the application. DEQ staff will help with: 1) Determination of the eligibility for a beneficial use determination of a particular waste or process; and, 2) If eligible, establish the tier of beneficial use determination review required and associated fee to submit with the application.

Step 2

Mail the original signed application, all attachments, including the fee payment plus one extra copy to the appropriate regional office (see listing below.) Note that DEQ review work will not begin until a complete application packet is received. Incomplete applications may be returned. DEQ recommends the applicant keep a full copy of all application materials to guard against possible loss in transit.

Step 3

DEQ will contact the applicant, acknowledging receipt of the application, and will identify the staff person assigned to carryout the review. This staff person will contact the applicant if any additional information is needed.

Region	Counties Served	Address & Phone
Eastern Region	Baker, Crook, Deschutes, Gilliam, Grant, Harney, Hood River, Jefferson, Klamath, Lake, Malheur, Morrow, Sherman, Umatilla, Union, Wallowa, Wasco, and Wheeler	Eastern Region Department of Environmental Quality 400 E Scenic Drive, Ste 2.307 The Dalles, OR 97058 (541) 298-7255 ext. 221
Northwest Region	Clatsop, Clackamas, Columbia, Multnomah, Tillamook, and Washington	Northwest Region DEQ Solid Waste Programs 2020 SW Fourth Ave. Ste 400 Portland, OR 97201 (503) 229-5353
Western Region	Benton, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Polk, and Yamhill	Western Region DEQ Solid Waste Programs 165 E 7 th Ave., Ste 100 Eugene, OR 97401 (541) 687-7465



Date: 8/31/2015
To: Oregon DEQ
From: Andy Swartwout
Subject: Beneficial Use Application Attachments

Section E

Tier 1:

1. The proposed material is shredded wallboard. The content is approximately 50% wallboard paper and 50% gypsum by weight. The material proposed to be used will be virgin wallboard from the Rainier Wallboard Plant, recycle wallboard collectors, and returned damage board. The Rainier Wallboard Plant recycles its own off-spec product. Roughly 10%-20% of all purchased wallboard becomes unused scrap. Recycle wallboard collectors bring in this clean, unused scrap material which is subsequently tested for trace metals, asbestos, silica, and radiation. Total quantity of shredded wallboard material generated each year is estimated at 6,000 tons.
 2. The material would be used first as animal bedding for livestock and then applied on farm land as a soil amendment.
 3. Many different products are used for animal bedding such as wood shavings, paper, sand, and gypsum. Because paper and gypsum are both already used as animal bedding there would be no chemical difference between what is currently used and the proposed use. There are other companies that sell recycled wallboard product specifically for animal bedding (<http://www.usagyypsum.com/animalbedding.aspx>). Wallboard has been shown in studies* to improve soil porosity, reduce acidity, and provide important micronutrients. The EPA has also done research on the benefits of using recycled wallboard in agriculture with respect to emissions (<http://www.epa.gov/osw/conservation/tools/warm/pdfs/Drywall.pdf>). Chemical differences between gypsum/paper and drywall waste can come from minor concentrations of various additives named in the SDS of each drywall product available at USG's website**. The state of Washington Department of Ecology has recognized*** both applications described above as an environmentally beneficial way to keep excess wallboard waste outside of landfills.
 4. The waste product satisfies all conditions in OAR 340-093-0280. The use is productive with demonstrated benefits and customers as an effective substitute for animal bedding and soil amendments. It is not a hazardous waste under ORS 466.005. The additives in the wallboard are in low enough concentrations such that the risk levels for persistence or bioaccumulation is minimal. There is not any foreseeable unsightliness or nuisance conditions that would come from using wallboard as animal bedding or soil amendment.
5. Other information requested by the Oregon DEQ
- a. Gypsum Sourcing: The Rainier Wallboard Plant uses gypsum mined from the ground. Other company's sources may vary and are unknown to the Rainier Wallboard Plant. They could be mined or synthetic. Synthetic gypsum comes from coal power plants which scrub the sulfur out of the air leaving the stacks producing gypsum with a purity that approaches 99%. Regardless, all

*"Construction Drywall As A Soil Amendment", Edwin H. White and Mark E. Burger July 1993

**<https://www.usg.com/content/usgcom/en/resource-center/search-results.html?charset=UTF-8&query=&sort=&mode=showDocs&filters=doc-types:sds-msds,USG:language/english>

***<https://fortress.wa.gov/ecy/publications/SummaryPages/961556SWFS.html>

incoming material is tested by USG which shows the trace metal concentrations are below clean fill/background soil concentrations.

- b.** Fungicide: The Rainier Wallboard plant uses Sodium Pyrithione (CAS # 3811-73-2) as a fungicide in its Mold Tough® panels. The fungicide is less than 0.25% by weight according to USG's SDS*. Mold Tough® panels represent approximately 4.2% of sales by square footage. Therefore, total fungicide content in USG products is approximately 0.0105%. USG does not have information on competitor fungicides or concentrations but it would be reasonable to assume they are similar in nature to USG's values.
- c.** It would be reasonable to assume the actual contaminant levels in the paper/gypsum product are close to half the values stated in the testing. This is because the material tested is 94% gypsum and 6% paper while the product USG is submitting as a beneficial resource is approximately 50% rock and 50% paper.
- d.** Hydrocarbons: There are no hydrocarbons such as oils, gasoline, kerosene, etc. in the production of drywall. There should not be any hydrocarbons from the scrap drywall because it is all clean, unpainted, and unused.
- e.** Borates/Boric Acid/Borax: The Rainier Wallboard Plant does not use any type of Boric Acid, Borax, or Borate in the wallboard products. Rainier makes no claims of knowledge regarding usage of borates and their derivations by competitors.

Tier 2

1. See above for Tier 1 checklist items.
2. See attached Appendix A for a chemical analysis of the recycled wallboard content. Physical characteristics would be identical to that of a commercially available gypsum/paper product.
3. See Appendix B for a risk screen comparison between USG's product and Clean Fill/Background soil concentrations for trace metals
4. Current land use target would be livestock operations requiring bedding material and agricultural lands needing gypsum soil amendments in the state of Oregon. Due to shipping cost constraints the material would likely stay near farms in the Portland Basin or Coastal region.
5. We currently have an end user at a farm in Astoria, Oregon interested in the product; however, USG does not want to restrict the application of this product to one site. USG believes there are multiple locations throughout Oregon that would benefit from the paper/gypsum product as an animal bedding and soil amendment product.
6. Wallboard manufactured at the Rainier Wallboard Plant is highly controlled to keep additives along with the gypsum and paper under tight quality tolerances. Materials coming from outside sources are tested using the procedures described in Appendix A. This should ensure that no foreign contaminants are present in the product above acceptable levels. There should not be any concerns with usage of animal bedding as it will be contained inside a sheltered area. When used in the same manner as commercially available gypsum soil supplements the risk of potential adverse effects from applying USG's product to soil would be minimal. Storage would be kept dry under a roof until the time of application and transport would occur via a covered truck to minimize runoff and dust nuisance.

*"Construction Drywall As A Soil Amendment", Edwin H. White and Mark E. Burger July 1993

**[https://www.usg.com/content/usgcom/en/resource-center/search-results.html? charset =UTF-8&query=&sort=&mode=showDocs&filters=doc-types:sds-msds,USG:language/english](https://www.usg.com/content/usgcom/en/resource-center/search-results.html?charset=UTF-8&query=&sort=&mode=showDocs&filters=doc-types:sds-msds,USG:language/english)

***<https://fortress.wa.gov/ecy/publications/SummaryPages/961556SWFS.html>



RJ Lee Group, Inc.

Appendix A

RJ Lee Group, Inc.
350 Hochberg Road, Monroeville, PA 15146
Tel: 724-325-1776 | Fax: 724-733-1799

Laboratory Report - Meets USG Targets

US Gypsum Corporation
PO Box 37
Rainier, OR 97048
United States
Attention: Dan Murphy
Telephone: 503-556-4434

Report Date 10/27/2014
Sample Receipt Date 10/14/2014
RJ Lee Group Job No. CUH1034025-1
Authorization/P.O. No. 1684413
Client Job No./Name

Analysis: Asbestos in Bulk Samples by Point Count
Method: EPA/600/R-93/116

RJLG Sample Number	Client Sample Number	Homogeneous	# of Layers	Asbestos Detected(%)	Non-Asbestos Fibers(%)	Non-Fibrous Materials(%)	Matrix Material	Analyst - Analysis Date
10301095.HPL	RM#81263 September 2014 Comp.	Yes	1	ND	0.67 CE 0.66 MW	98.67	Q, F, OP, M	CW-10/17/2014
Description: Brown Filter Residue. Limit of detection = 0.01%. No asbestiform minerals detected. Meets USG Targets.								
Weight Loss: 94.0871%								

Client Job No./Name: RJ Lee Group Job No: CUH1034025-1

RJLG Sample Number	Client Sample Number	Homogeneous	# of Layers	Asbestos Detected(%)	Non-Asbestos Fibers(%)	Non-Fibrous Materials(%)	Matrix Material	Analyst - Analysis Date
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Courtney N. Weir

Authorized Signature:

Courtney N. Weir, Microscopist

- ASBESTOS**
- AM = Amosite
 - AC = Actinolite
 - AN = Anthophyllite
 - CH = Chrysotile
 - CR = Crocidolite
 - TR = Tremolite
- NON-ASBESTOS**
- CE = Cellulose
 - MW = Mineral Wool
 - FG = Fibrous Glass
 - SF = Synthetic Fibers
 - H = Hair
 - W = Wollastonite
 - OF = Other Fibers

- NON-FIBROUS MATERIALS**
- AM = Amphibole
 - B = Binder
 - CA = Carbonates
 - CL = Clay
 - F = Feldspar
 - G = Gypsum
 - HY = Hydromagnesite
 - M = Miscellaneous
 - MI = Mica
 - OP = Opaque
 - OR = Organic
 - P = Perlite
 - Q = Quartz
 - T = Tar
 - V = Vermiculite

DISCLAIMER NOTES

- "ND" indicates no asbestos was detected; the method detection limit is 0.01%.
- "Trace" or "<1" indicates asbestos was identified in the sample, but the concentration is less than the method quantitation limit of 0.01%. PLM coefficients of variance range from approximately 1.8 at the quantitation limit of 0.25% to 0.32 at high fiber concentrations.
- Samples are archived for three months following analysis and are then properly discarded.
- These results are submitted pursuant to RJ Lee Group's current terms and conditions of sale, including the company's standard warranty and limitation of liability provisions. No responsibility or liability is assumed for the manner in which these results are used or interpreted.
- This test report relates to the items tested.
- This report is not valid unless it bears the name of a NVLAP-approved signatory.
- Any reproduction of this document must be in full in order for the report to be valid.
- This report may not be used to claim product endorsement by NVLAP, any agency of the U.S. Government or any other laboratory accrediting agency.
- Polarized-light microscopy is not consistently reliable in detecting asbestos in floor coverings and similar nonfriable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as "non-asbestos-containing."
- Sample(s) for this project were analyzed at our: Monroeville, PA (AIHA #100364) facility.
- If RJ Lee Group, Inc. did not collect the samples analyzed, the verifiability of the laboratorys results are limited to the reported values.

United States Gypsum Company
Quality Assurance

ALS Project ID: P1400960

ALS AQL 103A
 HP6890+/GC23/ECD
 Evelyn Ibarra
 Wallboard

Date Received: 3/12/14
 Date Extracted: 3/19/14
 Date Analyzed: 3/19/14

Client Sample ID	ALS Sample ID	Sample	Extract		Result mg/Kg	LOQ mg/Kg	Data Qualifier
		Amount Gram(s)	Volume ml(s)	Dilution Factor			
RM# 81263 Feb 2014 Comp.	P1400960-001	1.01	5.0	1.00	ND	5.0	
Negative Control Sample	P140319-NCS	1.00	5.0	1.00	ND	5.0	

ND = Compound was analyzed for, but not detected above the limit of quantitation.

LOQ = Limit of Quantitation.

According to the Florida Department of Health (<http://www.doh.state.fl.us/environment/community/indoor-air/casedefinition.html>, 1/5/2010), a positive result above 10 mg/kg is indicative of corrosive drywall.

A positive result between 5-10 mg/kg is inconclusive; further testing may be warranted.

CAS Sample ID	Spike Amount	Result		% Recovery		CAS	RPD	RPD	Data Limit Qualifier
	LCS / DLCS mg/Kg	LCS mg/Kg	DLCS mg/Kg	LCS	DLCS	Acceptance Limits			
Dup Lab Control Sample	P140319-DLCS	126	125	123	99	98	90-113	1	7

LABORATORY REPORT

US Gypsum Corp
PO Box 37
Rainier, OR 97048

ATTENTION: Dan Murphy
Telephone: 503-556-4434

Report Date: October 27, 2014
Samples Received: October 14, 2014
RJ Lee Group Job No.: CUH1034025
Client Project No.: N/A
Purchase Order No.: 1684413

ANALYSIS: Total and Respirable Crystalline Silica

METHODS: X-Ray Diffraction (XRD) and Computer-Controlled Scanning Electron Microscopy (CCSEM)

A portion of the sample was mixed with calcium fluoride (CaF₂) as an internal standard, ground further, and backloaded into a standard XRD holder. The sample was scanned using standard run parameters on a PANalytical X'Pert Pro diffractometer equipped with copper radiation. The weight percentage of silica was calculated through the use of the internal standard and calibration coefficients derived from standards NBS - 1878a quartz, NBS - 1879a cristobalite, and NIOSH/IITRI TY 27 tridymite mixed with CaF₂. A portion of the unground material was examined by CCSEM to determine particle sizing. The percentage respirable quartz is determined by multiplying the appropriate size fraction by the percentage quartz determined by XRD.

Sample Identification		Total Crystalline Silica*	Respirable Silica in Bulk	
Client	RJ Lee Group	(weight %)	<10µm (weight %)	<5µm (weight %)
RM# 81263 September 2014 Comp.	10301095	0.3	0.07	0.02

*no cristobalite or tridymite detected

Authorized Signature  Date 10/27/14
Heather L. Adamson
Scientist, X-ray Diffraction Group

This laboratory operates in accord with ISO 17025:2005 guidelines, and holds a limited scope of accreditations under different accrediting agencies; refer to <http://www.rjlg.com/about-us/accreditations/> for more information and current status.

Selected Metals by SOP 7040, Rev 12
 Inductively Coupled Plasma - Mass Spectrometry

Sample preparation: A sample portion (0.2 g) was digested in 1 mL nitric acid, 3 mL hydrochloric acid, and 1 mL hydrofluoric acid for 1 hour on a block digester set at 110°C. After cooling, 1 mL of 30% hydrogen peroxide was added and the digestion resumed for 30 minutes. Internal standards were added and the sample was diluted to 100 g with high-purity water. The sample mostly dissolved.

Parts Per Million (µg/g)

<u>Element</u>	RM#81263 September 2014 Comp.		<u>Detection Limit</u>
	<u>Sample</u>	<u>Duplicate</u>	
Antimony	0.20	0.20	0.02
Arsenic	1.9	2.0	0.1
Barium	26	24	0.03
Beryllium	ND	ND	0.1
Bismuth	ND	ND	0.1
Cadmium	0.35	0.31	0.01
Chromium	2.2	2.4	0.2
Cobalt	5.3	4.6	0.009
Copper	16	14	0.01
Lead	8.8	8.2	0.06
Mercury	0.11	0.11	0.03
Molybdenum	1.5	1.4	0.02
Nickel	2.2	2.2	0.04
Selenium	0.3	ND	0.2
Silver	ND	ND	0.2
Thallium	0.27	0.22	0.08
Uranium	0.58	0.58	0.005
Vanadium	4	5	0.1
Zinc	99	90	0.8

Date Analyzed: 10-21-14

Quality Control Summary

Parts Per Million (µg/g)

Sample: RM#81263 September 2014 Comp.

Analyte	Sample Result	Duplicate Result	Sample RPD	Spike Conc	Spike Result	Spike % Rec
Antimony	0.20	0.20	0	49.9	49.8	99
Arsenic	1.9	2.0	5	49.9	48.4	93
Barium*	25.6	23.6	8	49.9	47.3	45
Beryllium*	ND	ND	NA	49.9	18.6	37
Bismuth	ND	ND	NA	49.9	52.6	105
Cadmium	0.35	0.31	12	49.9	51.1	102
Chromium	2.2	2.4	9	49.9	43.9	83
Cobalt	5.31	4.58	15	49.9	50.5	91
Copper	16.0	14.1	13	49.9	61.4	93
Lead	8.81	8.20	7	49.9	50.6	84
Mercury	0.11	0.11	NA	4.99	4.80	94
Molybdenum	1.54	1.35	13	49.9	49.8	97
Nickel	2.24	2.15	4	49.9	48.1	92
Selenium	0.3	ND	NA	499	462	93
Silver	ND	ND	NA	49.9	51.2	103
Thallium	0.27	0.22	NA	49.9	51.3	102
Uranium	0.575	0.576	0	49.9	50.2	99
Vanadium	4	5	NA	49.9	50	91
Zinc	98.5	90.3	9	49.9	137	NR

Date Analyzed: 10-21-14

NR - Not reported; sample result exceeds the amount spiked.

* Spike recovery is outside expected range (compared to LFB) due to a probable sample matrix or solubility effect.

Quality Control Summary

Parts Per Million (µg/g)

Sample: Laboratory Fortified Blank (LFB)

<u>Analyte</u>	<u>Blank Result</u>	<u>Spike Conc</u>	<u>Spike Result</u>	<u>Spike % Rec</u>
Antimony	ND	50.0	49.1	98
Arsenic	0.09	50.0	48.9	98
Barium	0.028	50.0	50.6	101
Beryllium	ND	50.0	46.8	94
Bismuth	ND	50.0	51.9	104
Cadmium	ND	50.0	52.0	104
Chromium	ND	50.0	50.8	102
Cobalt	ND	50.0	50.6	101
Copper	ND	50.0	51.4	103
Lead	0.04	50.0	51.6	103
Mercury	0.029	5.00	4.89	97
Molybdenum	0.017	50.0	48.5	97
Nickel	ND	50.0	51.6	103
Selenium	ND	500	488	98
Silver	ND	50.0	37.0	74
Thallium	0.08	50.0	51.6	103
Uranium	ND	50.0	49.5	99
Vanadium	ND	50.0	48.9	98
Zinc	0.77	50.0	53.6	106

Date Analyzed: 10-21-14



6312 West Oakton Street
Morton Grove, IL 60053-2723
847-965-1999
Fax 847-965-1991

Tuesday, October 14, 2014

Dan Murphy
USG Corporation
PO Box 37
Rainier, OR 97048

RE: RM# 81263

Dear Mr. Murphy:

A summary of gamma spectroscopy results for our sample number G140184 is in Table 1. USG identified the sample as RM# 81263 September 2014 Comp. The table below lists the concentrations of radionuclides specified by USG. Values with a less-than symbol (" $<$ ") indicate a concentration below RSSI's minimum detectable concentration (MDC). Other identified radionuclides are in the complete gamma spectroscopy report.

Table 1. High-resolution Gamma Spectroscopy Results [pCi/g]

Radionuclide	Sample
	G140184 RM# 81263 September 2014 Comp
Pb-214	<0.04
Bi-214	0.3
K-40	0.7
Tl-208	0.07
Th-232 (Ac-228)	<0.06
Cs-137 (Ba-137m)	<0.04
U-235 (Th-231)	<0.2

Some radionuclides of interest, cesium-137 (Cs-137), uranium-235 (U-235), thorium-232 (Th-232), and radium-226 (Ra-226), are difficult to identify and quantify directly at low concentrations with reasonable counting intervals. The concentrations of surrogates with more abundant high energy photons usually represent the concentration of Ra-226 and Th-232. The successful use of surrogates depends upon the radionuclides in each series being in equilibrium.

Dan Murphy
October 14, 2014
Page 2

RSSI

Cs-137 does not emit a photon when it decays. Cs-137 is easily identified and quantified using barium-137m (Ba-137m), which it is in secular equilibrium with, as a surrogate.

U-235, with a natural abundance of 0.7%, is difficult to detect and quantify using its principal photon energy because of interferences from Ra-226 and Pa-234 in the more abundant uranium series. Thorium-231 (Th-231) is used as a surrogate for U-235. Abundance is the mass fraction of an element represented by each isotope of that element.

Th-232, in the thorium series, emits photons with very low gamma fractions. In the thorium series, Ac-228 is usually in equilibrium with Ra-228 and Th-232 when collected. Gamma fraction is the fraction of decays that produce a photon of a given energy.

Ra-226, in the uranium series, has only one significant photon at 186.21 keV with a gamma fraction slightly greater than 0.03. Analysis for Ra-226 using this energy is difficult because of the possible presence of U-235, which has an interfering 185.72 keV photon with a 0.57 gamma fraction, and protactinium-234 (Pa-234) which emits an interfering 186.15 keV photon with a 0.02 gamma fraction. Bismuth-214 (Bi-214) and lead-214 (Pb-214), in the uranium series, may be used as surrogates for Ra-226 when these radionuclides are in equilibrium.

The equilibrium between Ra-226 and its surrogates may be disturbed when samples are collected; radon-222 (Rn-222), a short-lived (half-life of 3.8 days) gaseous Ra-226 decay product, can be released. Pb-214 and Bi-214 return to equilibrium with Ra-226 in a sample after an ingrowth period. Equilibrium is reestablished within seven half-lives of Rn-222. In standard protocols, samples are held for a 30-day ingrowth period to reestablish equilibrium.

The complete spectroscopy analysis results are attached. Please call me at 847-965-1999 if you have any questions.

Sincerely,


Aaron Morris

attachment

Sample description

G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide	Activity uCi/g	Time of Count	Uncertainty Counting	1 Sigma Total
CS-134	<	4.1872E-09		
CS-137	<	1.3334E-08		
Th-231	<	2.3649E-07		
AC-228	<	5.8084E-08		
PB-214	<	4.2853E-08		
BI-214		2.7405E-07	1.699E+01%	1.714E+01%
K-40		7.2667E-07	4.266E+01%	4.280E+01%
Tl-208	#	6.6923E-08	3.209E+01%	3.217E+01%
Pb-212	<	2.3849E-08		
Bi-212	<	1.2510E-07		
Th-234	<	5.0408E-07		
Tl-210	<	1.0052E-08		
Pb-210	<	8.7613E-06		
Ra-223	<	7.2273E-08		

- # - All peaks for activity calculation had bad shape.
- * - Activity omitted from total
- & - Activity omitted from total and all peaks had bad shape.
- < - MDA value printed.
- A - Activity printed, but activity < MDA.
- B - Activity < MDA and failed test.
- C - Area < Critical level.
- F - Failed fraction or key line test.
- H - Half-life limit exceeded

----- S U M M A R Y -----
Total Activity (3.4 to 1783.7 keV) 1.068E-06 uCi/g
This section based on library: USG - Groza.Lib

Sample description
 G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide -		Average	Peak				
Name	Code	Activity uCi/g	Energy keV	Activity uCi/g	Code	MDA Value uCi/g	COMMENTS
CS-134	I	0.0000E+00	604.72	0.000E+00 %		4.187E-09 1.00E+03 G	
			795.86	0.000E+00 %		3.213E-09 1.00E+03 G	
			569.33	0.000E+00 %		7.913E-08 1.00E+03 G	
CS-137	I	0.0000E+00	661.66	0.000E+00 %		1.333E-08 1.00E+03 G	
Th-231	N	0.0000E+00	84.22	0.000E+00 %		2.365E-07 1.00E+03 G	
			89.94	0.000E+00 %		1.226E-06 1.00E+03 G	
			81.23	0.000E+00 %		1.655E-06 1.00E+03 G	
			102.27	0.000E+00 %		1.381E-06 1.00E+03 G	
			82.09	0.000E+00 %		3.580E-06 1.00E+03 G	
AC-228	N	0.0000E+00	911.20	0.000E+00 %		5.808E-08 1.00E+03 G	
			968.97	0.000E+00 %		1.214E-07 1.00E+03 G	
			338.32	0.000E+00 %		9.480E-08 1.00E+03 G	
			964.77	0.000E+00 %		1.457E-07 1.00E+03 G	
			463.00	0.000E+00 %		8.108E-08 1.00E+03 G	
PB-214	N	0.0000E+00	351.93	0.000E+00 %		4.285E-08 1.00E+03 G	
			295.22	0.000E+00 %		5.707E-08 1.00E+03 G	
			242.00	0.000E+00 %		1.448E-07 1.00E+03 G	
			258.87	0.000E+00 %		1.541E-06 1.00E+03 G	
			785.96	0.000E+00 %		6.352E-07 1.00E+03 G	
BI-214	N	2.7405E-07	609.31	2.629E-07 (P		3.053E-08 1.20E+01 G	
			1120.29	4.301E-07 + P		1.359E-07 1.90E+01 G	
			1764.49	0.000E+00 % P		1.156E-07 2.43E+01 G	
			768.36	3.784E-07 ?(1.225E-07 4.40E+01 G	
			1238.11	0.000E+00 & P		2.347E-07 3.00E+01 G	
			934.06	1.599E-06 +		4.326E-07 1.80E+01 G	
			1377.67	0.000E+00 %		1.641E-07 1.29E+02 G	
K-40	N	7.2667E-07	1460.82	7.267E-07 (P		4.118E-07 7.00E+00 G	
Tl-208	N	6.6923E-08	583.19	6.350E-08 ?(P		1.456E-08 2.44E+01 G	
			277.35	0.000E+00 %		6.072E-08 1.00E+03 G	
			860.56	9.024E-08 ?(3.684E-08 5.31E+01 G	
Pb-212	N	0.0000E+00	238.63	0.000E+00 %		2.385E-08 1.00E+03 G	
			300.09	0.000E+00 %		2.728E-07 1.00E+03 G	
			115.18	0.000E+00 %		1.250E-06 1.00E+03 G	
Bi-212	N	0.0000E+00	727.33	0.000E+00 %		1.251E-07 1.00E+03 G	
			785.37	0.000E+00 %		3.703E-07 1.00E+03 G	

Sample description

G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

		288.20	0.000E+00	%	2.293E-06	1.00E+03	G
		1620.50	0.000E+00	%	6.997E-07	1.00E+03	G
Th-234	N	0.0000E+00					
		92.38	0.000E+00	%	5.041E-07	1.00E+03	G
		92.80	0.000E+00	%	5.073E-07	1.00E+03	G
		63.29	0.000E+00	%	7.986E-07	1.00E+03	G
Tl-210	N	0.0000E+00					
		298.00	0.000E+00	%	1.005E-08	1.00E+03	G
		799.70	0.000E+00	&	6.308E-09	1.00E+03	G
		1316.00	0.000E+00	&	5.809E-08	1.00E+03	G
		1210.00	0.000E+00	%	2.931E-08	1.00E+03	G
		1070.00	0.000E+00	%	3.734E-08	1.00E+03	G
		97.90	0.000E+00	&	2.715E-07	1.00E+03	G
		356.00	0.000E+00	&	1.366E-07	1.00E+03	G
		860.00	0.000E+00	%	5.424E-08	1.00E+03	G
Pb-210	N	0.0000E+00					
		46.54	0.000E+00	%	8.761E-06	1.00E+03	G
Ra-223	N	0.0000E+00					
		269.46	0.000E+00	&	7.227E-08	1.00E+03	G
		154.21	0.000E+00	&	1.807E-07	1.00E+03	G
		144.23	0.000E+00	&	3.531E-07	1.00E+03	G
		323.87	0.000E+00	%	8.088E-08	1.00E+03	G

(- This peak used in the nuclide activity average.

- * - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

Nuclide Codes:

T - Thermal Neutron Activation
F - Fast Neutron Activation
I - Fission Product
N - Naturally Occurring Isotope
P - Photon Reaction
C - Charged Particle Reaction
M - No MDA Calculation
R - Coincidence Corrected
H - Half-life limit exceeded

Peak Codes:

G - Gamma Ray
X - X-Ray
P - Positron Decay
S - Single-Escape
D - Double-Escape
K - Key Line
A - Not in Average
C - Coincidence Peak

This section based on library: USG - Groza.Lib

ORTEC g v - i (1215) Env32 G53W4.22 14-OCT-2014 14:12:46
RSSI Spectrum name: G140184.An1

Sample description

G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

***** U N I D E N T I F I E D P E A K S U M M A R Y *****

Channel	Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide
120.42	25.34	7148.	6932.	1.926	3.18	2.878	- s
158.23	33.62	4098.	915.	0.254	15.73	0.430	- sD
181.95	38.81	1660.	896.	0.249	9.48	1.398	- D
185.00	39.48	1660.	142.	0.040	41.38	1.426	- D

- s - Peak fails shape tests.
- D - Peak area deconvoluted.
- L - Peak written from unknown list.
- C - Area < Critical level.

This section based on library: USG - Groza.Lib

ORTEC g v - i (1215) Env32 G53W4.22 14-OCT-2014 14:12:46
RSSI Spectrum name: G140184.An1

Sample description

G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

Acquisition information

Start time: 14-Oct-2014 13:11:13
Live time: 3600
Real time: 3604
Dead time: 0.11 %
Detector ID: 3

Detector system

CLTCOMP MCB 9

Calibration

Filename: G140184.An1
2014-10-09 30% GEM-30185-P Calibration

Energy Calibration

Created: 14-Oct-2014 09:37:08
Zero offset: -1.028 keV
Gain: 0.219 keV/channel
Quadratic: 2.519E-08 keV/channel^2

Efficiency Calibration

Created: 09-Oct-2014 15:33:32
Type: Polynomial
Uncertainty: 12.376 %
Coefficients: -0.488700 -4.235942 0.407585
-0.033257 0.000391 0.000001

Library Files

Main analysis library: USG - Groza.Lib
Library Match Width: 0.500
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.22
Start channel: 20 (3.35keV)
Stop channel: 8144 (1783.67keV)
Peak rejection level: 100.000%
Peak search sensitivity: 3
Sample Size: 3.5190E+02
Activity scaling factor: 1.0000E+00/(1.0000E+00* 3.5190E+02) =
2.8417E-03
Detection limit method: Traditional ORTEC method
Random error: 1.0000000E+00
Systematic error: 1.0000000E+00
Fraction Limit: 0.000%
Background width: best method (based on spectrum).
Half lives decay limit: 12.000
Activity range factor: 2.000
Min. step backg. energy: 0.000
Multiplet shift channel: 2.000

Corrections

Corrections	Status	Comments
Decay correct to date:	NO	
Decay during acquisition:	NO	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	YES	2014-10-09-10 Background, 30%, G 10-Oct-2014 12:56:45
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	NO	

total peaks alloc. 13 cutoff 20.00000 %
Energy Calibration
Normalized diff: 0.1140

ORTEC g v - i (1215) Env32 G53W4.22 14-OCT-2014 14:12:46
RSSI Spectrum name: G140184.An1

Sample description

G140184 USG Corporation, RM# 81263 September 2014 Comp, 351.9 g

Spectrum Filename: H:\GammaVision\User\Spectra\G140184.An1

Appendix B

USG Paper/Gypsum vs. Clean Fill Background Concentrations

Contaminant Medium	USG Test ppm	Clean Fill Value (ppm)*	Coast Range (ppm)*	USG Below Clean Fill/Coast?	Portland Basin (ppm)*	USG Below Clean Fill/Portland Basin
Contaminant						
Antimony	0.2		0.55	yes	0.56	yes
Arsenic	2		12	yes	8.8	yes
Barium	23.6		840	yes	790	yes
Beryllium	0	21		yes		yes
Bismuth	0	20		yes		yes
Cadmium	0.31		0.54	yes	0.63	yes
Chromium	2.4		240	yes	76	yes
Cobalt	4.58	43		yes		yes
Copper	14.1		100	yes	34	yes
Lead	8.2		34	yes	28	yes
Mercury	0.11		0.11	yes	0.23	yes
Molybdenum	1.35	2.1		yes		yes
Nickel	2.15		160	yes	47	yes
Selenium	0		1.5	yes	0.71	yes
Silver	0	4.2		yes		yes
Thallium	0.22		5.4	yes	5.2	yes
Uranium	0.576	5		yes		yes
Vandium	5		260	yes	180	yes
Zinc	90.3		140	yes	180	yes
Silica total	0.3% by weight	* http://www.oregon.gov/deq/docs/cleanfill/IMD.pdf				
Silica < 10 um	0.07% by weight					
Silica < 5 um	0.02% by weight					
Radiation	Nuclide total for each element < 10E-6					