

COMMISSIONING

Public Buildings



in the Northwest

Commissioning Solves Building Problems That Robbed State Police of Comfort, Healthy Air

With 24 state buildings to maintain totaling 3.5 million ft², the Oregon Department of Administrative Services (DAS) is all too aware of the time and money required to keep buildings working — and people safe and comfortable — when building systems aren't installed correctly during construction.

So when the department built its first buildings for the State Police, Project Manager Tom Haeg and HVAC Supervisor Phil Teague went to work with the Building Commissioning Toolkit they received at an Oregon Office of Energy workshop.

The commissioning process for the State Police buildings was different than the norm: Commissioning didn't begin until construction was substantially complete. That meant lost savings opportunities and less-than-perfect fixes. And because commissioning was performed by operations and maintenance staff instead of a commissioning service provider, an experienced, third-party engineer wasn't checking work at recommended stages, beginning at completion of schematic designs.

Even with these shortcomings, commissioning fixed significant deficiencies before they caused heating and cooling systems to fail, exposed workers to unsafe air quality, led to endless comfort complaints and finger-pointing, and wasted \$6,500 worth of energy a year. Next project, Haeg and Teague plan to build in commissioning from the start.



The 20,000 ft² State Police Headquarters in Central Point, Ore., houses a forensic lab and offices; a 5,000 ft² support services building includes an autopsy suite, vehicle lab, gun testing room, drying room and freezers.

“If we would have done this project the ‘normal’ way — when we don’t do commissioning and deal with issues as they arise — it would have been a year of absolute misery for everyone, not to mention the dollars.” — Tom Haeg

Commissioning Finds and Solves Deficiencies Before They're a Problem: State Police Headquarters - Southern Oregon

<i>Deficiencies Identified</i>	<i>Problems Avoided</i>
Drip legs missing for natural gas lines	Heating failure
Control wires rubbing against sheet metal edges in rooftop package units	Heating or air-conditioning failure
Improperly specified/installed boiler expansion tank	Heating failure
Boiler exhaust drawn into fresh air intakes on roof	Unsafe air quality, liability
Improperly installed temperature sensor	Drastic temperature swings, comfort complaints, high energy bills
Lab fume hoods not modified to variable-volume, hoods and exhaust ductwork left unsealed	Unsafe air quality, comfort complaints, high energy bills
Autopsy and evidence drying room exhaust drawn back inside through fresh air intakes	Unsafe air quality, liability
Insufficient cooling for autopsy room	Comfort complaints

What Is Commissioning?

Building commissioning is the systematic process of ensuring that building systems are designed, installed, tested, and capable of being operated and maintained to perform according to the design intent and the owner's needs.

Commissioning can:

- Ensure that a new building begins its life with systems at optimal productivity
- Improve the likelihood that the building will maintain this level of performance
- Restore an existing building to high productivity
- Ensure that building renovations and equipment upgrades function as designed

“You need to look at it from point A to point Z, not from point O to point Z,” Teague said. “You need someone on the front end to put commissioning tasks into the bid documents and to do the documenting.”

“Bringing another engineer into the picture to help with things is really needed,” Haeg said. “It offers another point of view — the perspective of final operation and maintenance of the building.”

Having O&M staff perform commissioning offered several benefits, however: Staff members brought to the process experience in maintaining similar buildings, they learned about commissioning first-hand — which will prove useful when they work with private commissioning service providers in the future, and they became familiar immediately with the new buildings they're responsible for maintaining.

Teague and two other members of the O&M staff spent a week commissioning the buildings in November 1997; Haeg was there part of the week. “It wouldn't have taken that long if commissioning had started earlier,” Teague said. “It would have made our time there more efficient.”

They recorded test results on the Commissioning Toolkit forms before and after problems were fixed, which provides documented verification of the performance of the buildings.

The controls and mechanical engineering contractors were on site several days during commissioning and corrected many deficiencies on the spot. “A lot of things got identified and fixed right then and there and never made it to the punch list,” Haeg said.

Wanting problems fixed before the close of construction — and before complaints plagued DAS staff some 250 miles away at its Salem headquarters — was a principal motivation for commissioning the buildings.

“If we would have done this project the ‘normal’ way — when we don’t do commissioning and deal with issues as they arise — it would have been a year of absolute misery for everyone, not to mention the dollars,” Haeg said. “It would have been four or five times what we spent on commissioning — the number of trips, the time. I can’t imagine what it would have been like without commissioning.”

Rx for Heating and Cooling Units: Open Before Use



One of the first things the commissioning team found was control wires rubbing against sheet metal edges in the rooftop package units that heat and cool the buildings.

“You could already see the wear on some of them,” Haeg said. “We inspected all 13 package units and added grommets to make sure there was no friction potential with any of the control wires. Because we were down there looking at everything systematically, we found it. Otherwise, we wouldn’t have known about the problem until the wires frayed and the unit failed.”

The Benefits of Commissioning

- Fewer system deficiencies when the building is turned over to the owner
- Decreased potential for liability related to indoor air quality
- Less employee absenteeism and complaint time
- Reduced tenant turnover
- Lower operation, maintenance and equipment replacement costs
- Average energy savings of 15 to 30 percent

Lieutenant Gary Knowles, forensic lab director, beside one of the rooftop heating and cooling units that was waiting to fail. Commissioning found and fixed control wires rubbing against sheet metal edges.



Phil Teague (right), supervisor of heating, ventilating and air-conditioning for the Oregon Department of Administrative Services, calibrates sensors in the Department of Human Resources building in Salem. Teague came to the State Police project with some commissioning experience: He helped a commissioning service provider commission an equipment retrofit at the state Employment Building.

Why Commission Your Building?

A study of 60 commercial buildings found:

- More than half suffered from control problems
- 40 percent had problems with heating, ventilation and air-conditioning equipment
- One-third had sensors that were not operating properly
- 15 percent of the buildings did not have the equipment specified
- One-quarter of them had energy management control systems, economizers or variable-speed drives that did not run properly

The Case of the Missing Drip Legs

Teague soon found another HVAC system failure waiting to happen: When he went to check drip legs for the natural gas supply lines, the drip legs weren't there. Teague had them installed where they belonged.

"We wouldn't have caught that until who knows when if we weren't there doing commissioning," Teague said. "Drip legs are important. They prevent moisture and sediment from getting in the regulator and gas trains on the units. Without them, moisture can freeze in the line and block gas flow, and the heat goes off in the building."

Releasing Air Imprisoned in the Boiler

Teague's check of the hot-water boiler for the lab uncovered that the expansion tank wasn't installed properly. The air separator was missing, air was trapped in the boiler, and the boiler was failing. Teague traced the problem to the blueprints. They didn't indicate clearly the type of expansion system required. Teague had the contractor install an air bleed above the boiler.

"Had we commissioned this at the design stage," Teague said, "we would have done it differently. We would have made sure an air separator was specified."

Smoking Out Indoor Air Quality Culprits

During his inspection of the boiler, Teague and his team climbed onto the roof to check the boiler stack, which extended just a short distance above the roof. They watched the smoke pattern: Smoke from the boiler stack flowed down onto the roof, was trapped by the roof parapet and entered the air intakes for the lab ventilation units.

"Depending on which way the wind was blowing, it went into a different air intake," Haeg said.

A five-foot extension was installed on the boiler stack to raise it above the level of the roof parapet.

"It would have been a month or so down the line before we would have been called about the problem," Haeg said. "Because we were down there, we were able to deal with it right away, before we got calls about people leaving work sick."

Arresting the Comfort Thieves

A direct-digital control energy-management system was installed to maintain safe air quality in the lab and to keep down energy costs. The computer supervising the system is at DAS headquarters in Salem. It allows remote monitoring and control of temperature in the lab.

The computer was showing lab temperature at a constant 72°F during working hours. But lab workers were complaining about drastic temperature swings. Teague and Haeg felt them when they were on-site, and readings they took in the lab verified that the temperature in the room would jump from 70 to 80 degrees, then down again — and quickly.

“We weren’t seeing the swings on the computer, but we were feeling them in the space,” Teague said.

They traced the problem in part to improper installation of the temperature sensor. The controls contractor had cut too big a hole in the wall for wiring and failed to seal around the sensor. As a result, it was sensing the temperature inside the wall, rather than the temperature inside the room.

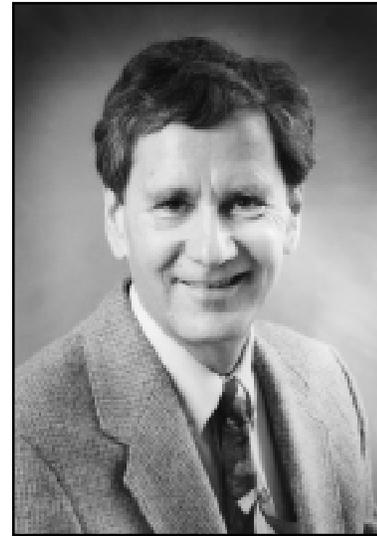
The problem was exacerbated by negative pressure in the attic, which was drawing cold outside air into the attic and down into the walls. Cool air also was dropping into the walls from unsealed attic return ducts for the air conditioning units. From the wall cavities the cool air was pulled into negatively-pressurized lab spaces. The problem was most noticeable right at the wall sensor.

“The system would heat the room to 80 degrees,” Teague said. “Then the sensor would say ‘Whoa,’ and turn on air-conditioning.”

An Exhaustive Search Finds Other Comfort Problems, Unsafe Indoor Air

Why was air pressure negative in the lab and attic? And even more disturbing, why were alarms on lab exhaust hoods continually set off?

Alarms meant exhaust flow through the hoods was insufficient, and lab staff was not protected from hood fumes. The problem would soon cease to grab attention: Lab technicians already had taken apart the exhaust hoods and taken a first stab at silencing the alarms, but had not yet been successful.



Tom Haeg, Department of Administrative Services, was the project manager for the State Police Headquarters construction. It was Haeg's first experience with commissioning.

“Most projects have these kind of issues. There are no shortcuts to getting buildings to work according to design. If you skip something, you’re going to pay. But the cost may be hidden.” — Tom Haeg



John Amish, criminalist, working at an exhaust hood in the forensic lab. Commissioning uncovered that constant-volume hoods had never been modified for variable-air volume, and exhaust hoods and ductwork hadn't been sealed.

“They would soon have figured out how to disable the alarms and gone about their business if we hadn’t been there to fix the problem,” Teague said.

Lab exhaust hoods, room exhaust and room supply are supposed to work together to maintain a constant static pressure in the lab. But Teague and Haeg discovered several problems with the system. Chief among them was that the constant-air volume hoods the State Police already owned and specified for modification to variable-air volume for the new lab had never been modified. The consequences for comfort and energy use were enormous. Teague estimates the oversight would have cost the State Police \$6,500 a year.

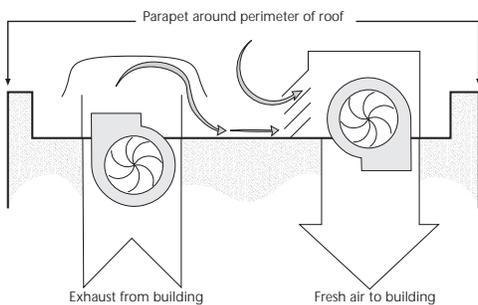
Another problem became evident after the commissioning team modified the hoods. “We smoked the whole area and watched airflows,” Teague said. “We found the hoods were pulling the entire building negative.”

They checked the 7,600 cfm fan that exhausted air from the general lab area and the four lab hoods. It was running full-tilt. Yet airflow through the system was insufficient to maintain safe exhaust volumes through the hoods. Meantime, lab hoods were drawing conditioned air from the room, and cold makeup air was drawn into the room from outside. The reason: The exhaust hoods and ductwork hadn’t been sealed.

“The mechanical designer didn’t realize that the hoods as they’re manufactured are not airtight,” Haeg said. “They needed to be sealed in this application.”

The commissioning team sealed the hoods and sealed ductwork from the hoods to the exhaust fan to ensure that all air handled by the fan was exhausted through the hoods, as intended.

“Had we not found the temperature swings and exhaust problems,” Teague said, “it would have been an issue that wouldn’t have been resolved for a year, especially being long distance. It would have been treated as a warranty issue. The contractor would have come out and said everything was fine. The air balancer balanced the system in this non-functioning mode. He would have said we just need a bigger exhaust fan. But we found we needed to seal the hoods and ductwork, and our testing so far indicates that we don’t need a bigger fan. We wouldn’t have found the problems, but we would have had enormous energy bills and indoor air quality problems.”



Weather protection on rooftop exhaust fans pushed exhaust from the autopsy and drying rooms onto the roof, where just a few feet away the contaminated exhaust was sucked into fresh air intakes.

More Evidence of Ventilation Problems

The new support services building had its own ventilation problems: Standard hooded exhaust fans for the drying and autopsy rooms were short-circuiting exhaust flow.

“They put evidence in the drying room that is wet or bloody, apply heat and exhaust the air,” Haeg said. “But the exhaust fan hood pushes the exhaust onto the roof. Right next to it is an air intake that’s bringing it back inside.”

The autopsy area had the same problem. “Sometimes they’re taking a saw to the bodies,” Haeg said, “and the particulates that were exhausted were being drawn right back inside through the air intake. If we weren’t commissioning the buildings, we wouldn’t have realized we had an inversion problem on the autopsy roof, so it never would have been fixed.”

The commissioning team changed the fan units so exhaust from the drying and autopsy rooms shoots straight out, Haeg said, away from the fresh air intakes.

Haeg discovered another problem with the autopsy area during commissioning: The medical examiner was overheated working in his Tyvek suit and needed room temperature reduced to 65°F during autopsies. Fixing the problem required an auxiliary cooling unit, working in unison with the unit already installed.

Getting Buildings That Work

“If we hadn’t commissioned the buildings, there would have been a tremendous amount of frustration and finger-pointing,” Haeg said. “It never would have ended, and the State Police would have wanted to hire someone else to maintain their buildings. They’re becoming satisfied because the comfort level is reasonable now.”

Commissioning the State Police buildings proved to Haeg and Teague the advantages of paying up-front to ensure building systems perform as intended — avoided equipment failure, increased comfort, reduced complaints, improved indoor air quality, avoided liability and energy savings.



Chief Deputy Medical Examiner Spencer Smith in the autopsy room. Commissioning identified and solved ventilation and comfort problems and protected the health and safety of staff.

Commissioning Resources

Building Commissioning Association—Northwest
Contact Rick Casault, president, by e-mail (casault@worldnet.att.net) or phone (206-325-5774).

- List of commissioning service providers

Oregon Office of Energy
Toll-free in Oregon: 1-800-221-8035; Salem/out of state: 503-378-4040

- Building commissioning Web site (www.cbs.state.or.us/external/ooe/cons/bldgcx.htm)
- Publications to help you get started (also on the Web site):

Commissioning for Better Buildings in Oregon

Commissioning Toolkit, a comprehensive guide through the commissioning process

- Loans and business tax credits for commissioning

Commissioning Oregon State Police Headquarters - Southern Oregon

Building use/size:	Forensic lab and offices - 20,000 ft ² ; Support services building - 5,000 ft ²
Location:	Central Point, Ore.
Building owner:	Oregon Department of Administrative Services
Tenant:	Oregon State Police
Type of commissioning:	New construction
Commissioning start:	After construction was substantially complete
Commissioner:	Department of Administrative Services staff
Systems commissioned:	643,000 Btu Weil-McLan natural gas boiler 15 Trane rooftop package units (natural gas/electricity), 4 to 10 tons Energy Management System: American Automatrix Direct Digital Control system Four Hamilton laboratory fume hoods modified to variable-volume, controlled by American Automatrix system Auto-Flow system, connected to a 7,600 cfm Trane exhaust fan 500 cfm Cook exhaust fan for drying room; 2,000 cfm Cook exhaust fan for autopsy room
Cost of commissioning:	168 staff hours
Energy savings:	\$6,500/year by correcting constant-volume exhaust system to variable-volume
Other benefits:	Dramatically increased comfort Significantly improved air quality; avoided liability; reduced absenteeism Reduced equipment failure Fewer occupant complaints

Oregon Office of Energy
625 Marion St. NE
Salem, OR 97310-0830
(503) 378-4040

Toll-free: 1-800-221-8035

Fax: (503) 373-7806

Web site: www.cbs.state.or.us/external/ooe



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