THE UNIVERSITY OF BRITISH COLUMBIA
Building Operations

University of British Columbia – Building Operations

To:	Mechanical Consultants who do work at UBC
From:	Andrew Porritt
CC:	UBC Technical Guidelines Review Committee
Date:	Apr 11, 2018
Re:	Changes to UBC Tech Guidelines for Rooftop Mechanical Equipment

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At the 2018 UBC Technical Guideline Steering Committee meeting, new guidelines were adopted for the installation of mechanical equipment installed outdoors, particularly on rooftops. UBC Building Operations requested this change due to concerns about the effect that this practice has on the overall lifecycle cost of buildings. Issues include:

- Reduced life expectancy of mechanical and electrical equipment exposed to the elements
- Increased chance of critical failure, for example freezing or sensors or actuators malfunctioning
- Increased maintenance cost through difficult access, lack of a good quality working surface, nowhere to stage materials and exposure to the elements
- Additional wear and tear of roofing surfaces which are not intended to be used as working surfaces
- Increased costs of re-roofing buildings due to all the additional equipment that needs to be lifted and additional elements that need to be incorporated into the roof
- Noise pollution including complaints from campus residents
- Less flexibility for making system changes
- Increased likelihood of roof leaks, particularly at pipe penetrations which are typically done poorly

The new guidelines intend to reduce the magnitude of equipment that is located on rooftops. Specific items which should not be installed on rooftops include: pumps, control valves, balancing valves, check valves, strainers, temperature, pressure and flow sensors, chemical feed pumps (for fluid coolers), variable speed drives, electrical disconnected, actuators, controllers. Isolation valves should also be minimized but are acceptable if they have valve stem extensions and are detailed so that minimal damage is done to piping insulation where they are installed.

Designs shall minimize the mechanical equipment, which is installed exposed on rooftops, and ensure that all equipment installed on rooftops is suitable for outdoor installation:

- *All buildings with a high density of rooftop mechanical equipment shall have fully enclosed mechanical penthouses to contain all air handlers, pumps, tanks, boilers, chillers, etc and where practical exhaust fans and mixing box's.*
- *Exposed piping on rooftops only include low point drains, high point air vents and manual isolation valves with valve stem extensions. Where additional piping accessories are required, a heated valve house shall be constructed. All pipes and electrical connections shall rise into this room and penetrate to the roof horizontally. All pumps, control valves, temperature sensors, strainers, etc shall be installed in this room.*
    - *The designer may determine how to execute this concept including putting it on the side of an elevator overrun, as a freestanding structure, built into custom air handling equipment or other concepts that maintain the same design intent.*
- *In situations where a "valve house" is not deemed necessary, insulated heating and cooling pipes shall not penetrate rooftops vertically with just a sleeve installed. A proper "dog house" shall be installed. This "dog house" shall have an overhang. Isolation valves may be installed under the overhang of the "dog house" provided that they have valve stem extensions so that the insulation is only minimally compromised.*

- *Small diameter pipes such as refrigerant pipes and gas pipes may penetrate the roof through a gooseneck provided that the gooseneck is counter flashed into the roof and that the gooseneck is sealed to prevent insects, rodents and birds from entering the building through these penetrations.*

As with all UBC Technical Guidelines, if projects wish to deviate from this procedure please submit a variance application with the scope of the change and the justification. Alternatively, I welcome industry feedback – do not hesitate to contact me to discuss the wording and make recommendations.

Please find attached two documents to further explain the need for this change to the construction practices at UBC:

- Appendix 1 – Sketch of Valve House concept
- Appendix 2 – Collection of photographs of poor installs at UBC.

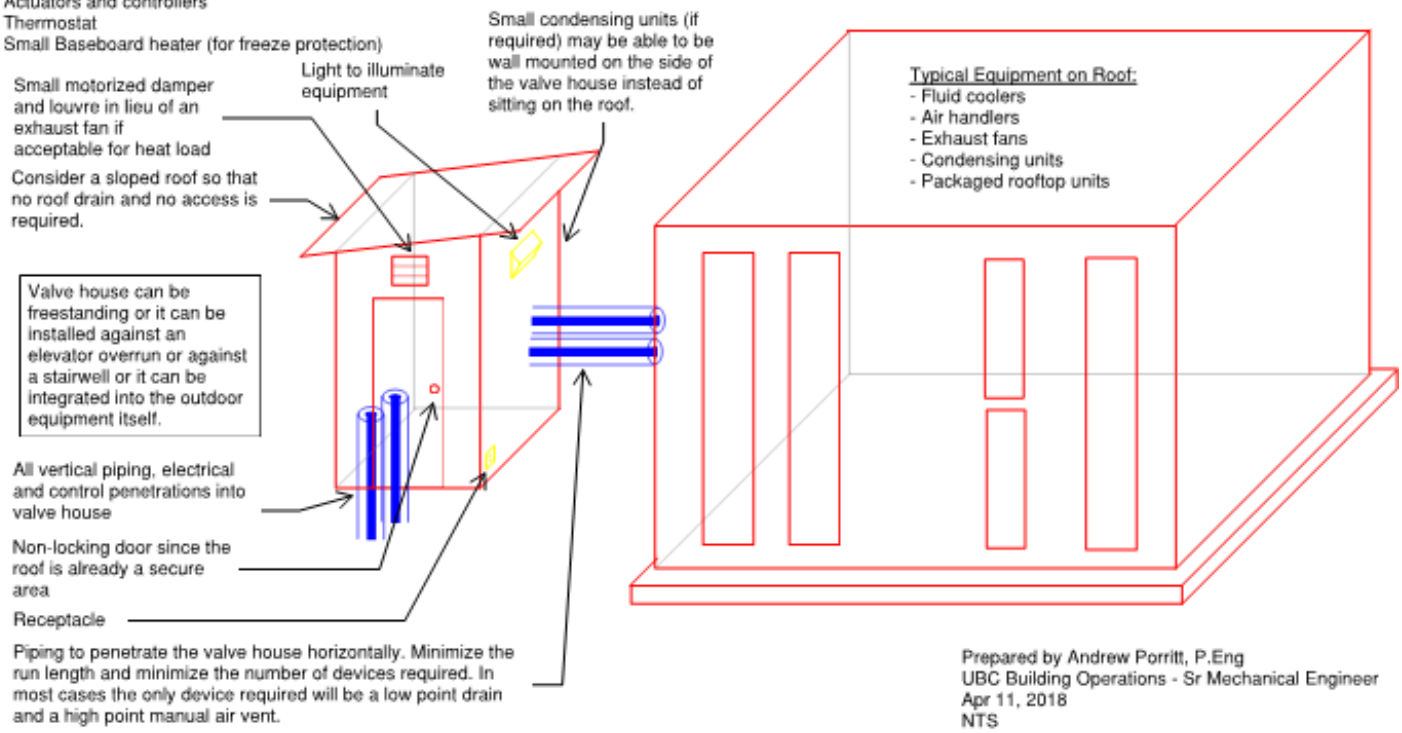
Sincerely,

Andrew Porritt, P. Eng.
Senior Mechanical Engineer, UBC Building Operations

Mechanical Rooftop Valve House

Typical Equipment in Valve House:
- Isolation valves, control valves, balancing valves
- Check valves, strainers
- Temp and pressure gauges and sight glasses
- Temp, pressure and flow sensors
- Pumps
- Low point drains, air vents
- Heat trace controller
- Chemical feed pump (for fluid coolers)
- Variable speed drives
- Electrical disconnects
- Piping
- Cabling and conduit
- Actuators and controllers
- Thermostat
- Small Baseboard heater (for freeze protection)

Notes:
1) The valve house concept is intended to be used on roofs where there is only minor amounts of rooftop mechanical equipment typical of SHH buildings, some non-research intensive arts buildings or research intensive buildings where most equipment is being located in lower level mechanical rooms.
2) If a building has more rooftop equipment then a fully enclosed mechanical room is required. Some indications of this are if there are multiple air handlers adjacent to each other, if the air handlers have humidification, if the air handlers have high performance filters, if tanks, boilers or chillers are being installed.
3) The execution of the concept will vary from job to job but the intent is to minimize mechanical roof penetrations (plumbing vents are the obvious exception) and move all but the largest mechanical equipment into a dry area. This may involve one or more valve houses, the below is a sample only and should not be applied rigidly to design.



Prepared by Andrew Porritt, P.Eng
UBC Building Operations - Sr Mechanical Engineer
Apr 11, 2018
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Appendix 2 – Collection of photographs of poor installs at UBC

The enclosed collection of photographs has been assembled to demonstrate the importance of installing penthouse mechanical rooms on most new buildings and making substantial efforts to minimize the number of roof penetrations. This is to reduce the overall lifecycle cost of our buildings. The lifetime of mechanical equipment, piping and fittings is reduced by being on the roof while the maintenance costs are increased. Locating mechanical equipment on roofs leads to additional roof penetrations (which often have poor installation details) and water ingress.

The photos were collected from eight buildings at UBC, most of them were completed in the last six years. They are reflective of other projects at UBC as well. They include work from various consultants and contractors. Some of the issues are design related, some are workmanship and most are a combination.

Sincerely,

Andrew Porritt, P. Eng.
Senior Mechanical Engineer, UBC Building Operations


Sloppy cabling


Seal tight entering outdoor junction box's and seal tight is breaking


Service heads not packed with steel wool or mineral wool so bees or birds can nest and in some cases get into the building

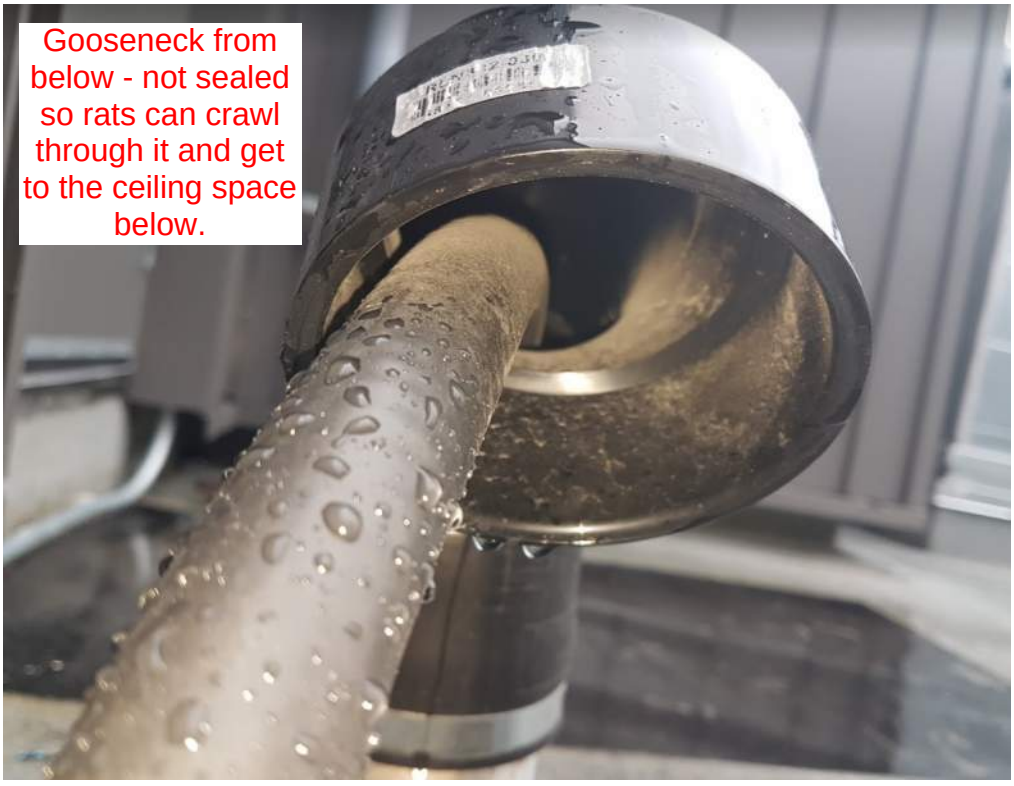
Valve handle penetration siliconed to prevent water from getting into the insulation below however now the valve can't be exercised without breaking the silicon

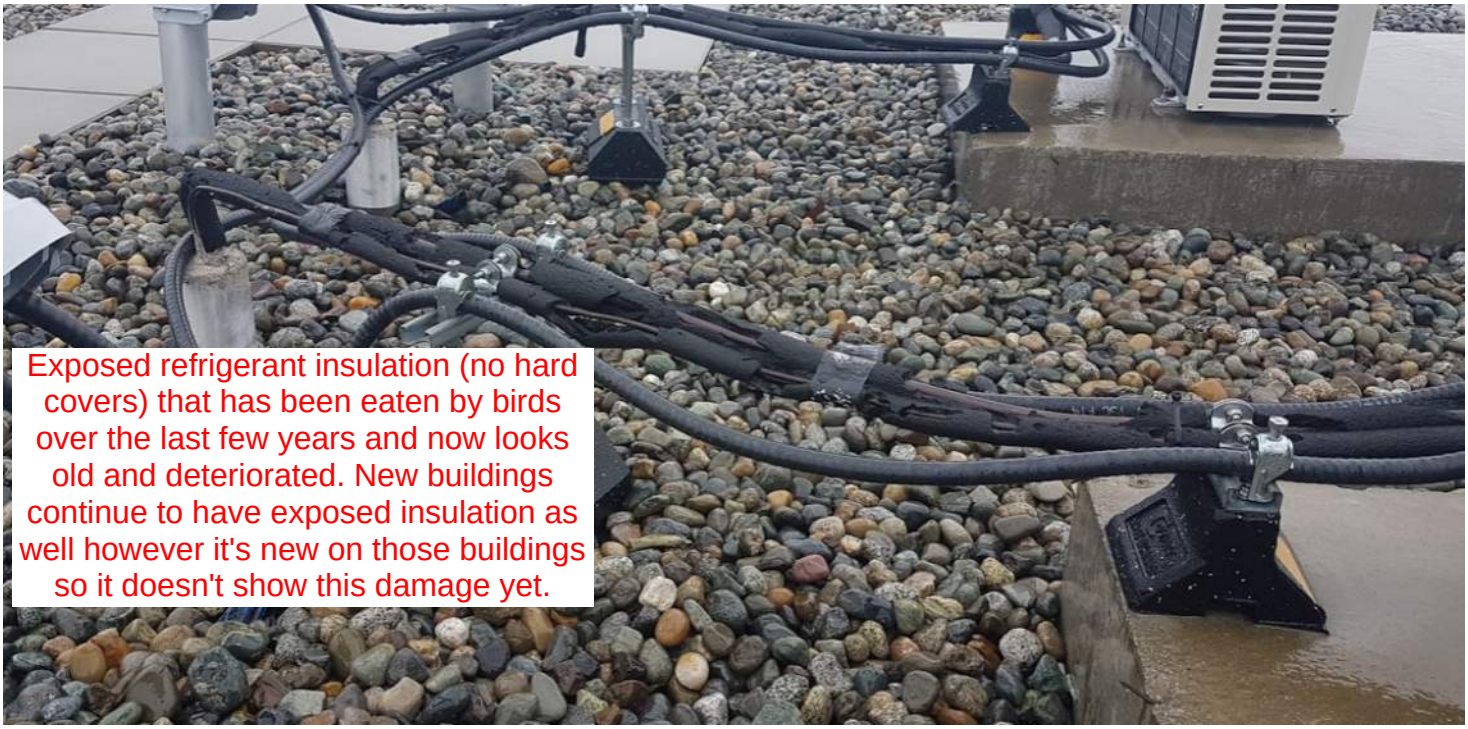
Spider web of cable on the roof


Roof penetration with plastic wrap over it

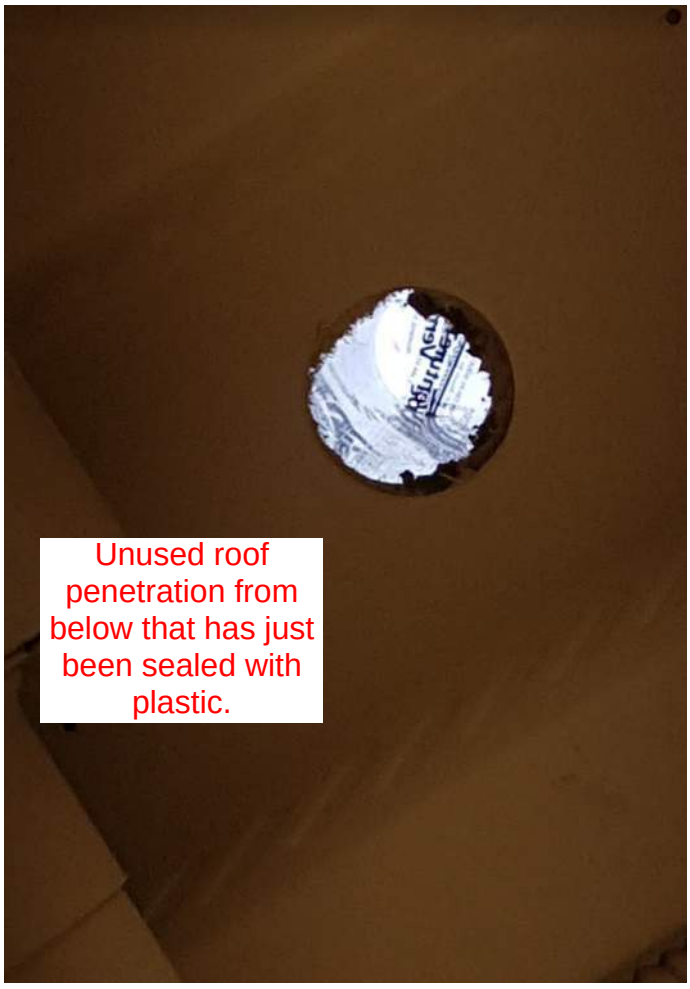

Penetration in insulation cover that allows water ingress


Refrigerant piping insulation exposed.
Goosenecks look okay from above - see next picture below

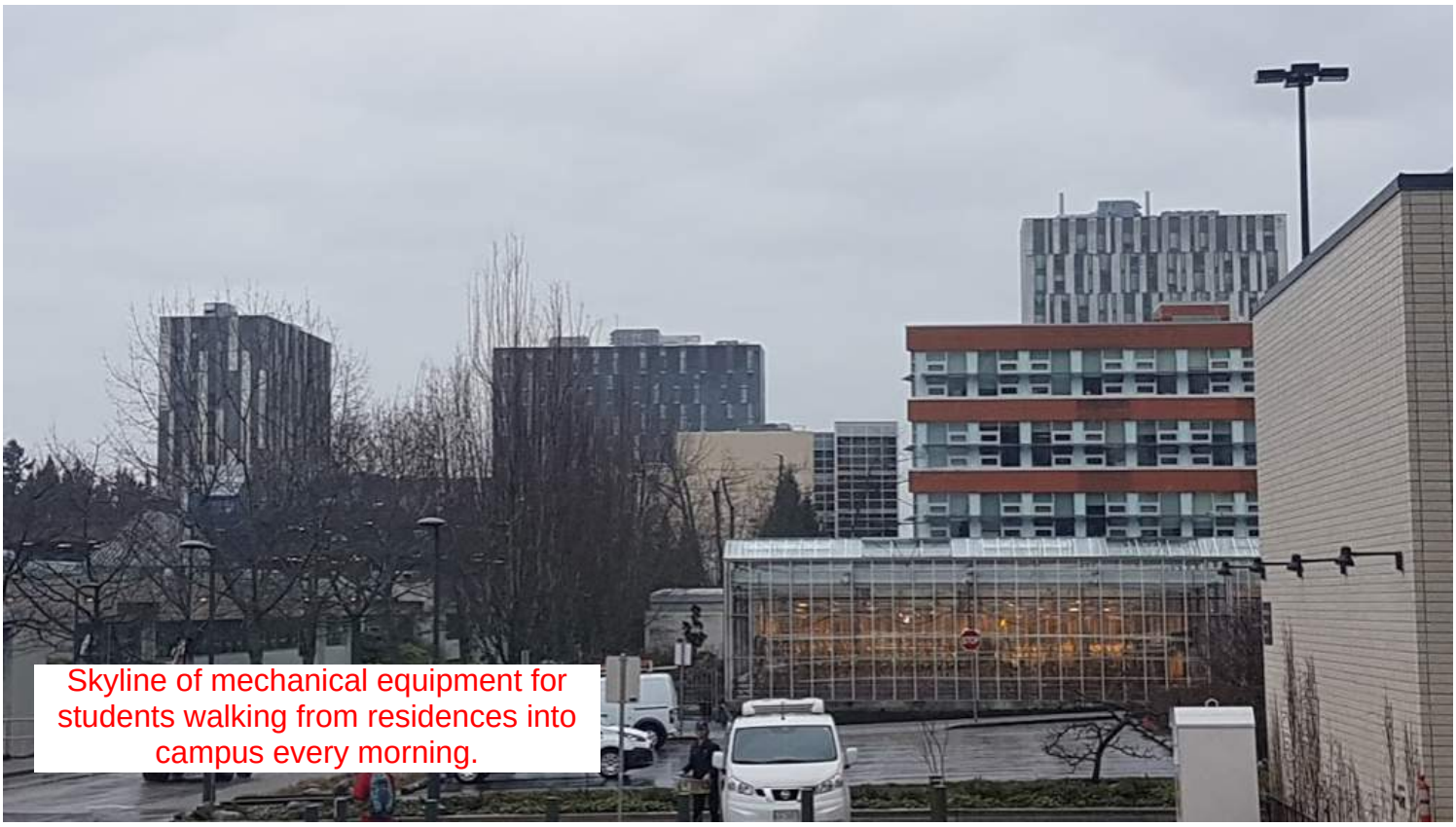

Gooseneck from below - not sealed so rats can crawl through it and get to the ceiling space below.



Exposed refrigerant insulation (no hard covers) that has been eaten by birds over the last few years and now looks old and deteriorated. New buildings continue to have exposed insulation as well however it's new on those buildings so it doesn't show this damage yet.



Unused roof penetration from below that has just been sealed with plastic.

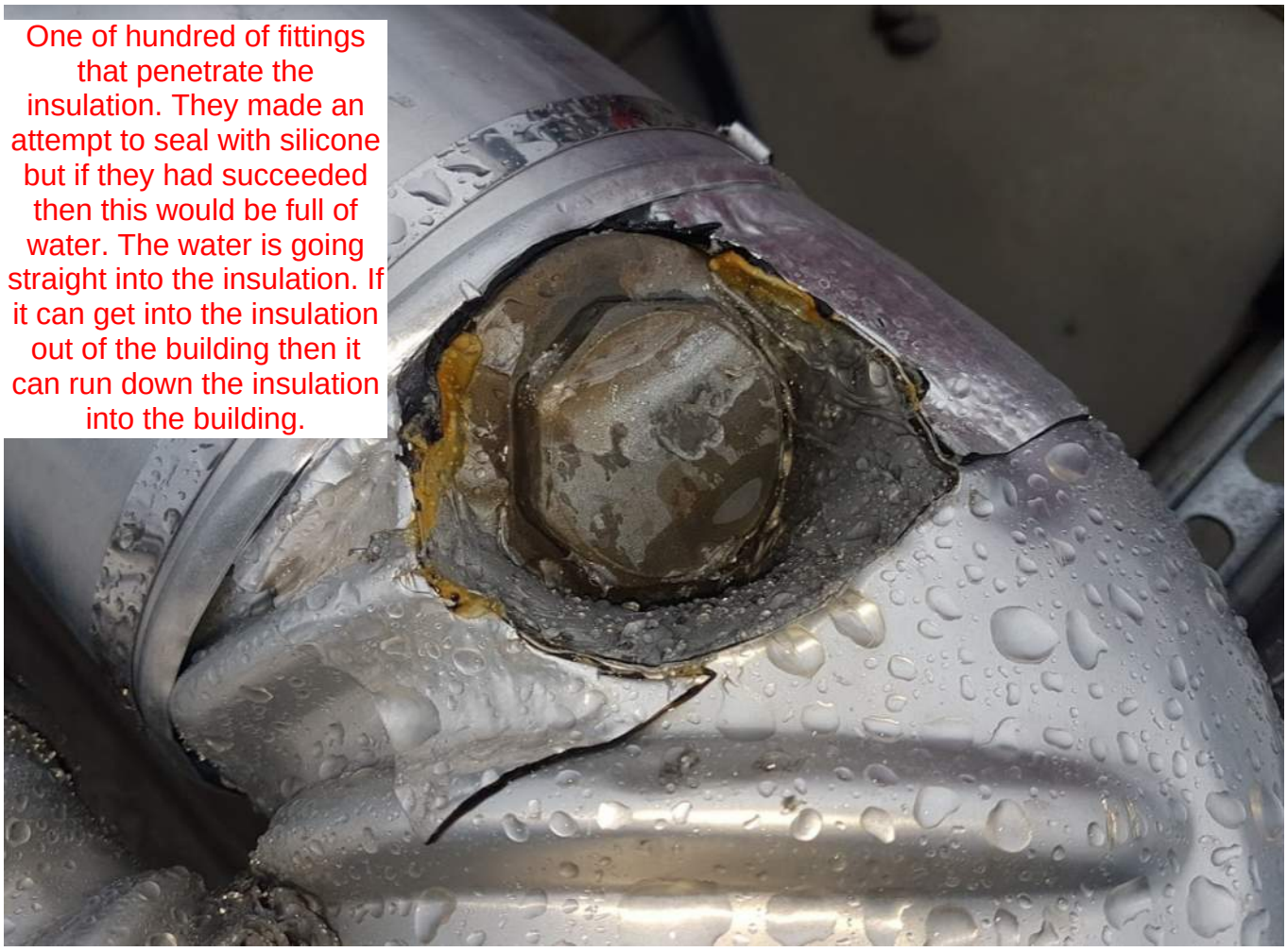


Skyline of mechanical equipment for students walking from residences into campus every morning.

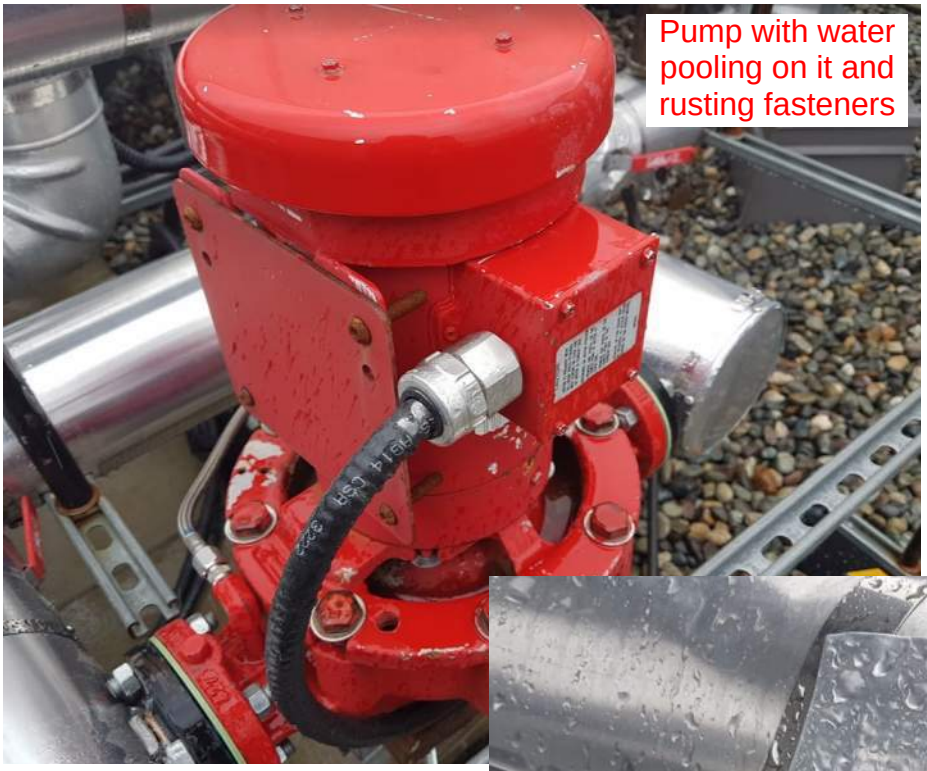
Service cap not filled, waiting for birds, bees or rodents.

Pipe insulation goes through roof penetration. Water can get into the pipe insulation and into the building. Remainder of penetration is filled with sealant and has water pooling on it.

One of hundred of fittings that penetrate the insulation. They made an attempt to seal with silicone but if they had succeeded then this would be full of water. The water is going straight into the insulation. If it can get into the insulation out of the building then it can run down the insulation into the building.




Rusting valve handles and more water penetrating into the insulation.


Pump with water pooling on it and rusting fasteners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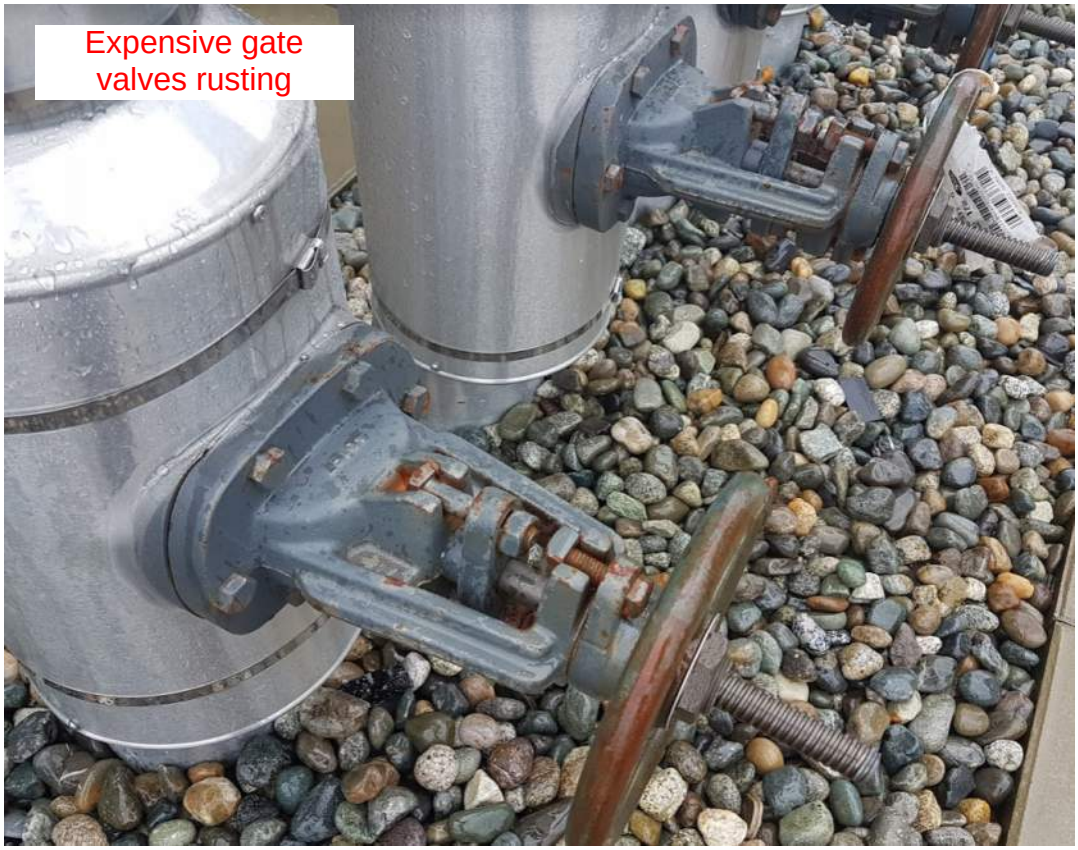
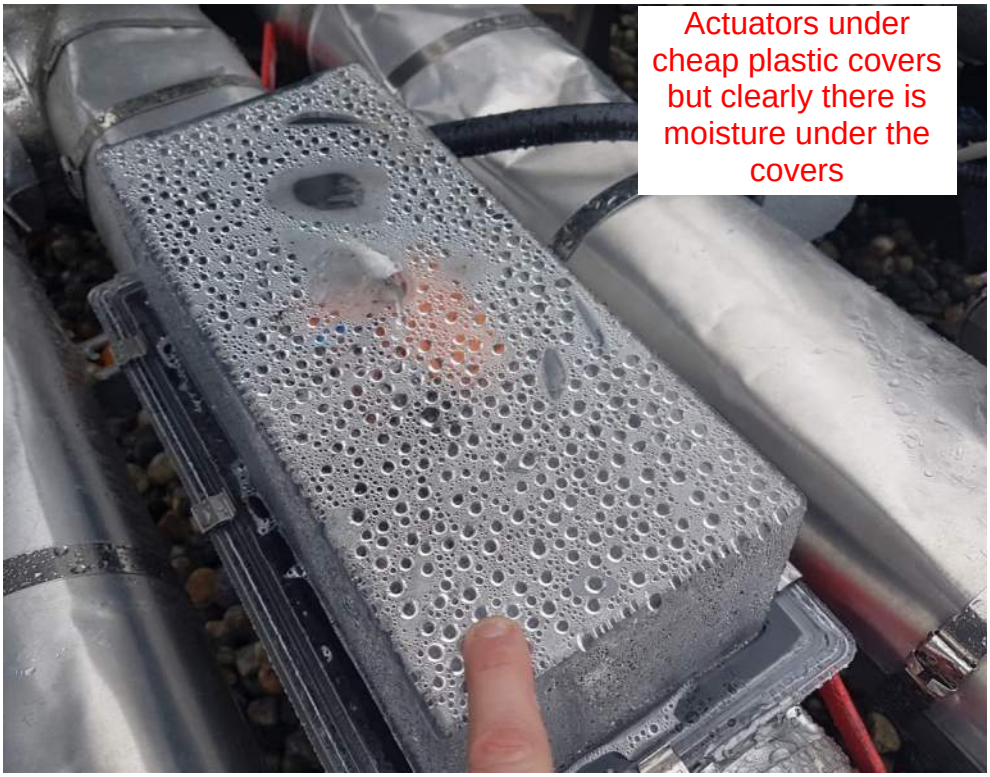
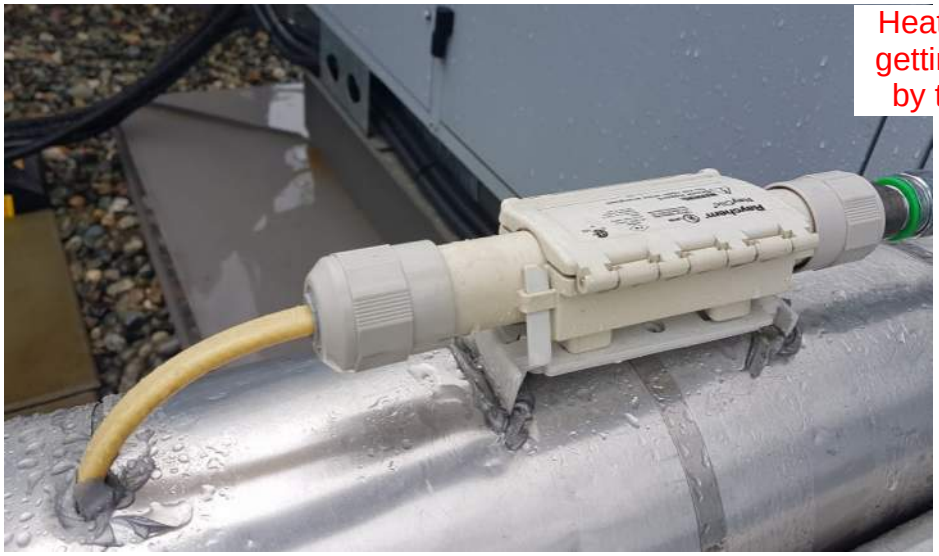
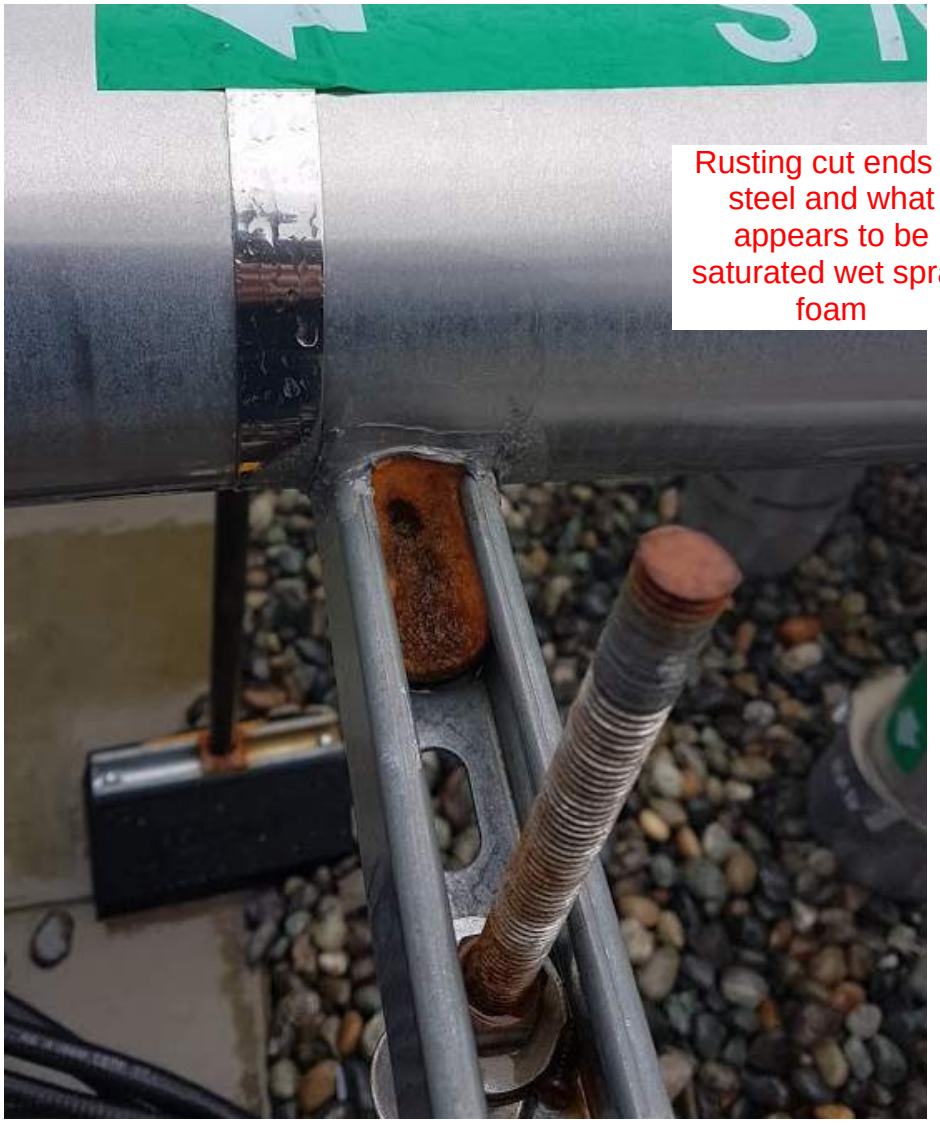

Expensive gate valves rusting


Actuators under cheap plastic covers but clearly there is moisture under the covers

This picture has it all
- Pumps exposed to the elements
- Penetrations in piping insulation such that water can get through
- Congested piping such that the insulation has been squashed by service people walking on it.
- Control valves sitting in their wet enclosures
- Pipe penetrations through the roof that take water down through insulation and then plug the rest of the pipe penetration hole with silicone.
- Rats nests of teck cables



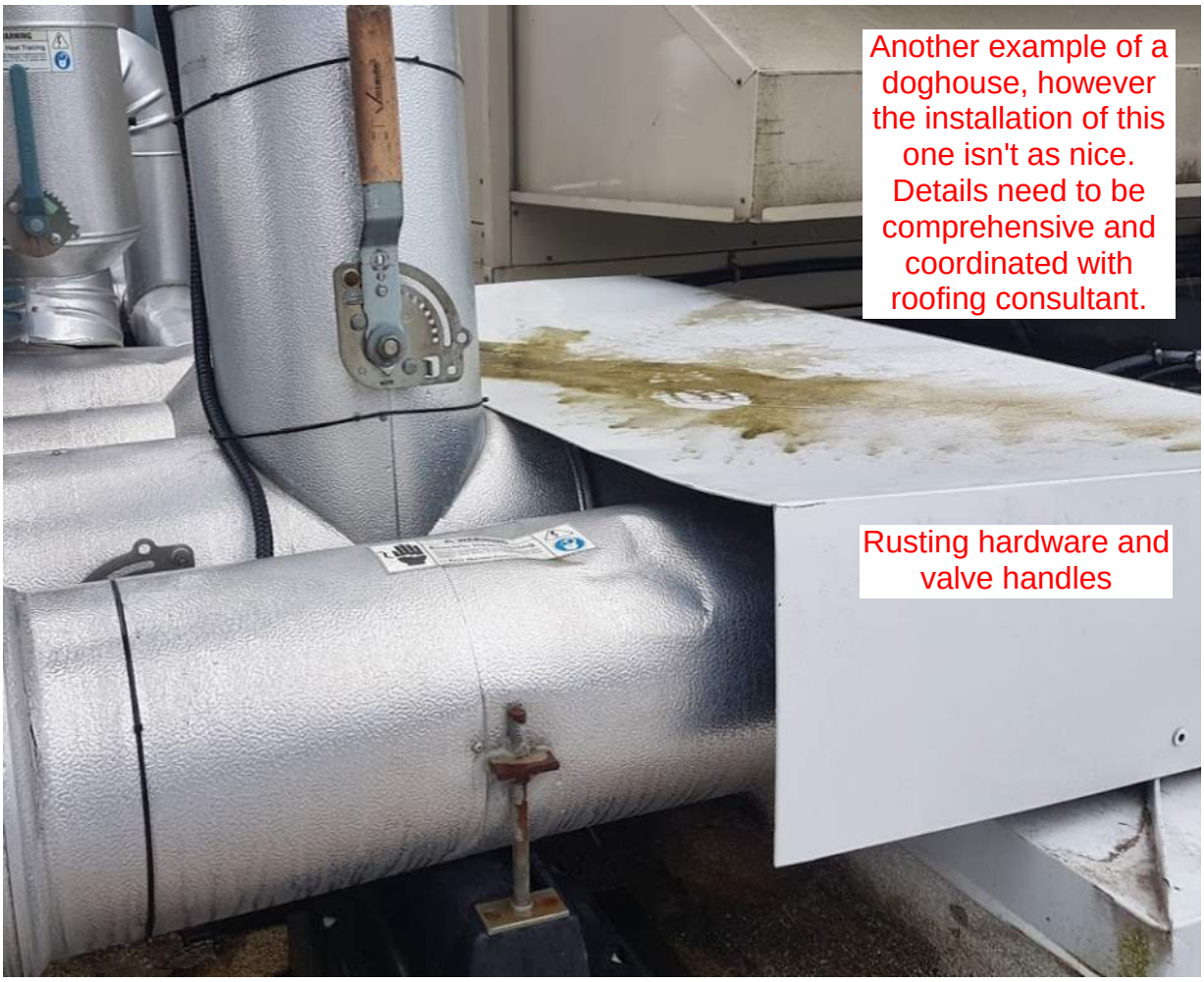
Heat trace which is getting deteriorated by the ultra violet



Rusting cut ends of steel and what appears to be saturated wet spray foam

Sealant holding water out of the building.

Doghouse for pipe penetrations is an improvement over detail on other buildings. This concept is closer to what should be built at UBC. However there is still room for improvement by sealing it so birds and rodents can't get into the doghouse.



Another example of a doghouse, however the installation of this one isn't as nice. Details need to be comprehensive and coordinated with roofing consultant.

Rusting hardware and valve handles

Rusting hardware - not appropriate for install outside

Algae and tech cable / sealtight everywhere.

Actuators are under in these big grey box's which is keeping them dry and may be required in some cases. Preference is that hte actuators are indoors but occasionally they may be required on roofs in which case the appropriate measures must be taken.

This pump body looks like it's three times its age. Pumps should be indoors.

Not sure when this insulation was exposed but it's good for viewers of this document to understand where the water is getting into.

All the fittings, pumps, actuators, sensors on this piping are very hard to access. As a result all of the insulation is damaged from people stepping on it. When it's wet out it's a particular challenge and slipping hazard to navigate this maze

Rusting valve handles

Unistrut jungle gym. An example of a project where the mechanical equipment was put outside but it wasn't appropriate.

Fans that are very hard to access for service

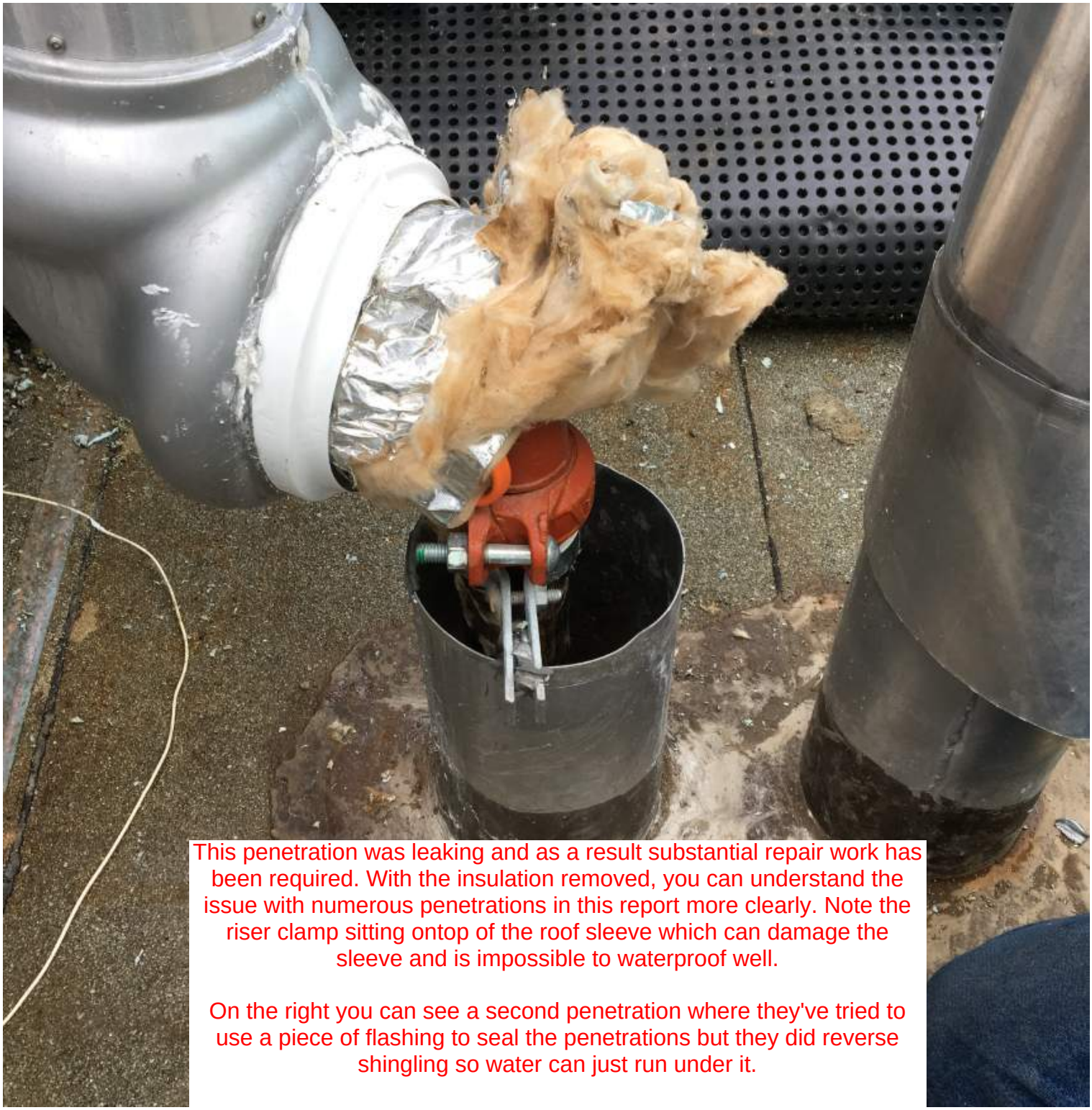
Rusting equipment supports on a very new building.

They had to build weatherproof cabinets for these variable frequency drives but these box's require additional though to access, ventilation and making sure they're safe for non-electrical qualified workers to access. Preference is that this equipment is indoors.


More silicone

Numerous ductwork and piping penetrations through the building envelope.

Looks like a mechanical room but there isn't a good work surface, anywhere to stage materials and it doesn't protect the equipment.



This penetration was leaking and as a result substantial repair work has been required. With the insulation removed, you can understand the issue with numerous penetrations in this report more clearly. Note the riser clamp sitting ontop of the roof sleeve which can damage the sleeve and is impossible to waterproof well.

On the right you can see a second penetration where they've tried to use a piece of flashing to seal the penetrations but they did reverse shingling so water can just run under it.


Riser clamps and reverse shingling - this can't be waterproofed like this.

Water can enter the insulation through multiple points - valves, seems in the insulation jacket, reverse shingled flashing.

As per previous photo, once the water is under the jacket insulation, there's nothing stopping it from entering the building.

If you have to rise up with pipe to a roof vertically then this is a pretty good example of a doghouse to ensure that the penetration is well sealed. A minor improvement would be if it had a small overhang so that the valve handles were undercover.

This shaft over run made sure that the penetrations were all horizontal. This is better for waterproofing and also allows access to the shaft if needed to add additional duct runs.

When large amounts of equipment is on roofs, the increased foot traffic damages the roofs and leads to shorter lifetime of the roof.

Rigging equipment is required to service rooftop equipment and using this equipment on roofs slows the work down and risks damage to the roof.

As far as rooftop ductwork goes this is quite well installed but think about the additional effort that's going to be required to re-roof this building in 25 years.

This is the direction we want to move. This custom air handler has a vestibule which houses all the pipe penetrations, pumps, VFDs, coil connections, etc. Future buildings should have this or something similar. For example, building a small rooftop mechanical shed beside a piece of equipment is acceptable and encouraged.

Snow inhibiting access, possible safety issue to service the fans, vfd's and disconnects accessed from this rooftop walkway.