THE UNIVERSITY OF BRITISH COLUMBIA

# Construction Process Guide

## Subject: Regulatory Requirements of Boilers, Pressure Vessels and Refrigeration Systems

CPG #: 03
Last revised: June 20, 2024 DRAFT
Pertinence: All construction projects at UBC
Audience for this guide: UBC Project Mangers, Contractors and Consultants
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Re: Permitting Requirements for Boilers, Pressure Vessels and Refrigeration Systems DRAFT

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### *Introduction*

Many boilers, pressure vessels, pressure piping systems and refrigeration systems at UBC are governed by the *Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation (BC Reg 104/2004)* [*BC BPVR Regulation*]. Technical Safety BC (TSBC) administers permits and lays out regulatory requirements in line with the *BC BPVR Regulation*.

We have observed that projects are not always aware of these requirements and this has resulted in additional operational costs and effort. For example, we have had to retroactively pull installation permits for equipment that was installed without them and then subsequently had to pay to fix deficiencies identified by the TSBC inspector.

This document has been prepared with the goal of adding clarity to what the regulatory requirements are when your project includes boilers, pressure vessels or refrigeration systems. Having a clear understanding of these requirements is critical to:

- Avoid making design decisions that trigger increased regulatory installation and operational effort and costs.
- Ensure that your project is within regulatory compliance and all the correct installation permits are in place.
- Highlighting BPV regulatory requirements when handing over assets to Building Operations.

Hopefully this document is a useful reference piece. The intention of this document is not to add any requirements on top of what is already required in British Columbia by law. There are likely errors and inconsistencies in this document. If you notice any of them, please let us know so that we can review and revise accordingly.

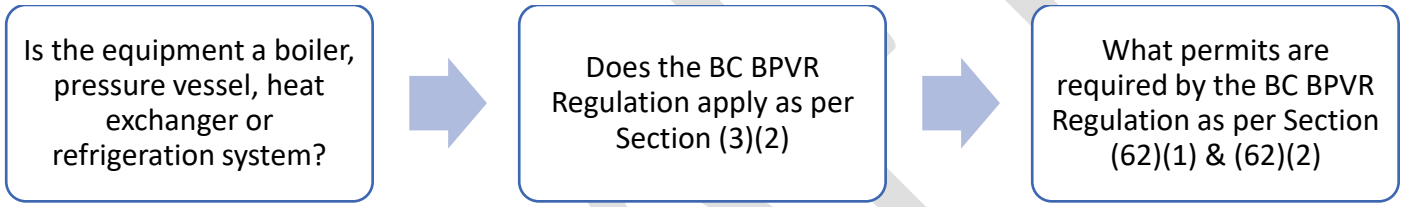
## *When are Permits Required?*

Section (62) of the *BC BPVR Regulation* describes broadly when permits are required.

> **62** (1) A person must have an installation permit to install, repair or alter any of the following:
>
> (a) a boiler;
>
> (b) a refrigeration system or part of a refrigeration system.
>
> (2) A person must hold an operating permit for each boiler, pressure vessel or refrigeration system.

Section (3)(2) of the *BC BPVR Regulation* describes exceptions, situations where the regulation does not apply. This section of the *BC BPVR Regulation* is referenced on the TSBC BPVR Permit Page as providing a list of equipment which does not require an installation permit however, it isn't quite that simple.

It is necessary to consider both section (62) and (3)(2) in determining what the permit requirements are.




The below table focuses on some of the sentences of section (3)(2) which commonly apply at UBC. The "simplified interpretation" column incorporates some of the BPVR definitions from the glossary of the regulation and focuses in on how these lines are commonly applied at UBC. In simplifying the meaning of each line some of the exceptions and details are lost. The reader of this document should always reference back to the *BC BPVR Regulation* which takes precedence above the below table in all cases.

| *BC BPVR Regulation: (3)(2) Despite subsection (1), this regulation does not apply to any of the following:* | *Simplified Interpretation* | *Permit Requirements (if the BC BPVR Regulation Applies per the cutoff sizes/capacities)* |
|---|---|---|
| (a) a power plant with a heating surface of 2 m2 or less; | A steam boiler where the relief is set >103kPa (15PSI) and the heating surface area is less than 2m2 or 20kW (if electric) | Installation permit<br>Operating permit |
| (b) a heating plant with a heating surface of 3 m2 or less; | A steam boiler where the relief is set ≤103kPa (15PSI) and the heating surface area is less than 3m2 or 30kW (if electric) | Installation permit<br>Operating permit |

| | | |
|---|---|---|
| (d) a low pressure thermal fluid plant with a heating surface of 3 m2 or less; | A hot water boiler or heat exchanger operating on a liquid where safeties are in place to prevent the boiler from operating should the temperature rise above the vapour point of the liquid at atmospheric pressure and the heating surface area is less than 3m2 or 30kW. For example, a 30kW hot water boiler with a high limit <100°C and temperature relief valves at 100°C | Installation permit<br>Operating permit |
| (e) a heating plant that has no valves or other obstruction to prevent circulation of fluid between the boiler and an expansion tank that is fully vented to the atmosphere; | A boiler which runs at atmospheric pressure | Installation permit<br>Operating permit |
| (g) a pressure vessel operating at and with relief valves set at a pressure of 103 kPa or less; | A pressure vessel operating with pressure reliefs ≤ 103kPa (15PSI) | Operating permit |
| (h) a pressure vessel not equipped with heating element that is constructed for the storage of water at a temperature of 65°C or less and a pressure of 1 720 kPa or less or has a diameter of 610 mm or less; | Tanks storing water ≤65°C and ≤1,720kPa (250PSI)<br>OR<br>Tanks storing water ≤65°C and with a diameter ≤610mm (24”) | Operating permit |
| (j) a refrigeration plant with a capacity of less than 5 kW prime mover nameplate rating; | A refrigeration system where the compressor motor power is less than 5kW (6.7HP). | Installation permit<br>Operating permit |
| (k) a cushion tank with a diameter of 610 mm or less that is constructed to operate at a working pressure of 207 kPa or less; | An expansion tank with a diameter ≤610mm (24”) where the pressure is below 207kPa (30PSI). | Operating permit |
| (l) a distribution main or service pipe as defined in the Gas Safety Regulation; | | N/A |

| | | |
|---|---|---|
| (m) piping and fittings external to the boiler proper in a low temperature, low pressure fluid plant or a heating plant; | Piping system connected to a boiler where we're heating a liquid with safeties to prevent it becoming a gas<br>OR<br>we're making steam ≤ 103kPa (15PSI) | If the working fluid is a liquid >159PSI or >121°C then the piping system is considered "pressure piping" by definition within the *BC BPVR Regulation*. See next line. |
| (n) a pressure piping system operating at and with a relief valve or valves set at 103 kPa or less; | Steam piping system operating ≤ 103kPa (15PSI) | For vapour >15PSI and >NPS 3 requires design registration, installation permit and operating permit. |
| (o) a water heater with a heat input of 120 kW or less; | Domestic hot water tank with an input ≤120kW | Installation Permit<br>Operating permit |
| (v) domestic water piping systems used in buildings or other structures; | Domestic water piping system in buildings | N/A |
| (w) medical gas piping systems. | Medical gas piping systems in building | N/A |

By placing equipment types in the first column of a table, permit requirements can be listed for some common equipment at UBC as per below.

| *Equipment* | *Permit Requirements* | *BC BPVR Reg (3)(2)* | *Exceptions* |
|---|---|---|---|
| Steam boiler > 15PSI | Installation permit<br>Operating permit | (3)(2)(a) | Below 2m2 gas or 20kW electric then no permits are required.<br>5th class plant triggered at 10m2 or 100kW electric* |
| Steam boiler < 15PSI | Installation permit<br>Operating permit | (3)(2)(b) | Below 3m2 gas or 30kW electric then no permits are required.<br>5th class plant triggered at 30m2 or 300kW electric*. |
| Hot water boiler | Installation permit<br>Operating permit | (3)(2)(d) | Below 3m2 gas or 30kW electric then no permits are required. |
| Heat exchanger where the heat is being transferred to water <100°C | Installation permit<br>Operating permit | (3)(2)(d) | Below 3m2 heating surface area then no permits are required. |

| | | | |
|---|---|---|---|
| Atmospheric Steam Generator (such as a stand-alone humidifier) | No permit required | (3)(2)(e) | If any valves are present between the boiler and the vent to atmosphere (such as the steam distribution manifold) then a permit is required. |
| Receivers (including compressed air) | Operating permit | (3)(2)(g) | Below 103kPa (15PSI).<br>Or if it's not a pressure vessel but rather it's a "Category H" fitting – commonly <600PSI, <42.5L. |
| Water storage tank ≤ 65°C | No permit required | (3)(2)(h) | Above 1,720kPA (250PSI) and 24" diameter triggers permit requirements. |
| Building level chillers and heatpumps | Installation permit<br>Operating permit | (3)(2)(j) | 5th class plant triggered at 200kW prime mover.* |
| Small tertiary refrigeration equipment < 5kW prime mover per circuit (this may work out to ~5RT per circuit) | No permit required | (3)(2)(j) | If ≥ 5kW prime mover per circuit (this may work out to ~5RT per circuit) then see next row. |
| Medium and large tertiary refrigeration equipment | Installation permit<br>Operating permit | (3)(2)(j) | If < 5kW prime mover per circuit (this may work out to ~5RT per circuit) |
| Expansion tanks | Operating permit | (3)(2)(k) | If ≤ 207kPa (30PSI) and ≤ 610mm (24") then no permit required. |
| Steam piping system >103kPa (15PSI) and >NPS 3 | Design Registration<br>Operating permit | (3)(2)(n) | If pressure or pipe size is lower then no permit required |
| Liquid piping system >NPS 3 and either >1100kPA (159PSI) or > 121°C | Design Registration<br>Operating permit | (3)(2)(n) | If pipe size or pressure and temperature are lower, then no permit required; except for UBC District Energy (see next line) |
| UBC Vancouver District Energy Piping System (all connected piping) | Design Registration<br>Operating permit | NA – UBC EWS Policy | Speak with UBC Energy and Water Services for more information on permitting requirements for piping connected to the District Energy System |
| Piping for most hydronic systems at UBC (temp<121C and pressure <159PSI) | No permit required | (3)(2)(n) | If temp is >121C or pressure >159PSI then you're piping is defined as "pressure piping" and permitting requirements may exist. |

| | | | |
|---|---|---|---|
| Domestic hotwater tank ≤120kW | No permit required | (3)(2)(o) | If >120kW then permit requirements exist |
| Domestic hotwater tank >120kW | Installation permit<br>Operating permit | (3)(2)(o) | If ≤120kW then permit requirements drop |

*5th class plants come with a significant regulatory burden in the form of much higher supervision requirements and more TSBC inspections. **Significant effort should be spent to design and install systems that avoid triggering a 5th class plant.**

### *Design Registration*

Section 84 of the BC BPVR Safety Regulation notes that a design registration is required whenever installing *pressure retaining equipment*. Pressure retaining equipment includes boilers, pressure vessels or pressure piping systems.

**Registration of boiler, pressure vessel, fitting and pressure piping design**

**84** (1) For this section, **"pressure retaining equipment"** means a boiler or pressure vessel, or pressure piping system.

(2) The design of all boilers, pressure vessels, fittings and pressure piping, to which this regulation applies, must be registered with a provincial safety manager.

(3) Subsection (2) does not apply to

(a) pressure piping that is NPS 3 or less or in a heating plant, or

As noted in the table in the previous section, projects need to apply for design registration whenever they are installing a “pressure piping system”; generally this is the case when NPS > 3 and either the pressure > 159PSI or the temperature > 121C.

Beyond this, projects need to be aware that all boilers and pressure vessels also require design registration. Typically boilers and pressure vessels (includes heat exchangers) in our market already have this design registration in place and it can be confirmed by verifying that the equipment has a CRN (Canadian Registration Number). However, designers should be wary of specialty equipment coming from other markets (Europe, Asia, United States, etc). Pressure retaining equipment which does not have a CRN may not be legally allowed to be installed in Canada.

Obtaining design registration retroactively is contrary to the safety regulation and can be very expensive/burdensome or impossible. It is not possible to obtain an operating permit for a piece of pressure retaining equipment without a CRN.

## *Avoiding Classified Boiler Plants*

Boiler plant classification is based of heating surface area in m2. This is a physical property of the heat exchanger in a gas boiler but does not translate well to electric boilers. For electric boilers the conversion is:

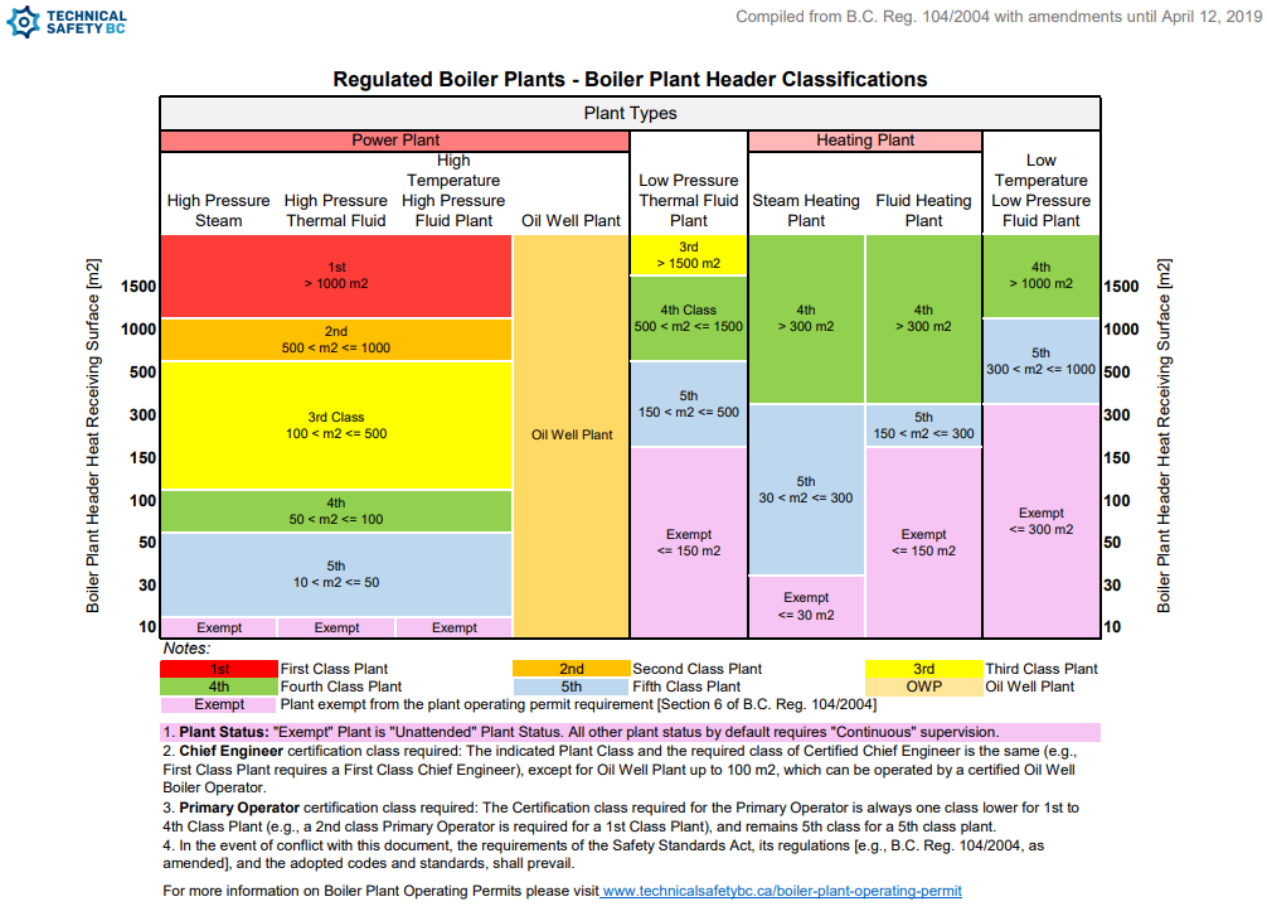
kW/10 = equivalent heating surface area in m2

This leads to the below cutoffs of total connected capacity per steam header:

| | < 15PSI | >15PSI |
|---|---|---|
| Gas | 30m2 | 10m2 |
| Electric | 300kW | 100kW |

An important result of this is that you get around 3x the capacity (lbs/hour of steam) out of a gas boiler (selected to minimize heating surface area) before hitting the cutoffs when compared to an electric boiler. This is a major challenge when designing low carbon steam systems that use electric boilers. UBC has adopted policies that severely limit the installation of gas boilers as a carbon reduction measure so utilizing electric steam boilers is a challenge that many UBC projects are faced with.

In the below graphic, we want to install systems which are in the exempt category as much as possible.




https://www.technicalsafetybc.ca/technologies/boilers-pressure-vessels/boiler-plant-classification

It is important to have a good understanding of the steam loads when sizing your steam plants. Clients / users (ex researchers) may not understand the implications of going with the slightly larger piece of steam equipment so it's important to educate them on the implications and work with them to reduce the steam capacity. Some particularly challenging pieces of equipment we've seen are:

- Bulk sterilizers or cage washers where a single piece of equipment may require more than 100kW of high-pressure steam generation with no path to avoid it. If this happens then detailed coordination and communication with operations is required during design.
- Retort that required slightly over 100kW however we were able to work with the client to intentionally undersize the steam generator. Resulting in a longer time for the equipment to come up to temp but avoiding a 5$^{th}$ class plant.

For steam it is often not easy to separate the loads and stay under the 5$^{th}$ plant cutoffs (100kW for high pressure). One approach is to have dedicated boilers/steam generators per piece of equipment and/or multiple piping systems within a building however this creates other issues including:

- Increased install cost
- Reduced redundancy
- Reduced maintenance flexibility to take a machine out of service for maintenance
- Significant cycling of the boiler going from very little load to very high load very quickly

Despite the above concerns, dedicated steam generation per piece of equipment can make sense – especially if the equipment can be specified with a steam generator – for example an autoclave that is supplied with a steam generator and where the steam generator is serviced by the same company that services the autoclave.

When electrifying humidification loads, it is common to install stand-alone humidifiers. These are not as reliable as central boilers but they simplify the design and pretty much remove the regulatory hurdles. Special care needs to be taken to how these units are controlled and commissioned to give us the greatest chance of reliable operation.

- Note that Vancouver water is very pure (low conductivity) this has compatibility issues with many humidifiers. Please review the specs of the equipment you're selecting and avoid electrode (aka cannister) style humidifiers.

### *Avoiding Classified Refrigeration Plants*

For refrigeration – make sure to select chillers (or heatpumps) where the total compressor power per refrigeration circuit is less than 200kW. This can be achieved with multiple chillers or multiple refrigeration circuits per chiller. Many large/high intensity buildings at UBC will require over 200kW of total prime mover. However, by the time your chillers are that large it makes sense to look at multiple machines and a setup that provides N-1 redundancy anyways. In conventional installs at UBC, it should always be possible to stay under 200kW prime mover per refrigeration circuit as long as the designer keeps this requirement in mind.

## *Process for Obtaining Operating Permits*

It is the responsibility of the installing contractor to apply for and pay for all necessary installation permits including getting all necessary inspections and all coordination with TSBC.

Operating permits are a little bit more complicated.

TSBC has informed UBC that for operating permits associated with installation permits that after they complete a final inspection that they will then automatically generate an operating permit and send it to UBC and begin billing UBC for it. This may include any related equipment that requires an operating permit such as an expansion tank – if the inspector is aware of it as part of their review process.

However, the above process is not rigorous; especially for equipment other than the actual boilers/refrigeration equipment related to the installation permit. In the case of stand-alone equipment installations that do not require an installation permit (for example, installing an expansion tank by itself), there is no automatic process by which UBC will receive an operating permit. UBC needs to apply for the operating permit directly – in order for this to happen, the project team needs to be aware of when they are installing regulated equipment and communicate the information to UBC such that UBC can then apply for the operating permit. The project team should also be aware that, when UBC applies for the operating permits, TSBC may decide to come out and inspect – if the inspector notes any installation deficiencies, UBC does expect the project team to address them.

## *Conclusion*

It is important that the design and contracting community is familiar with the permitting requirements of various equipment regulated by the *Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation (BC Reg 104/2004)*. The administration and execution of these requirements requires a major maintenance effort and permitting cost. Projects often overlook these requirements leading to un-necessary 5$^{th}$ class plants, and excessive quantities of equipment requiring registration. These assets are commonly overlooked when buildings are handed over to UBC Building Operations, which can lead to a failure to register equipment and regulatory non-compliance.

Projects must obtain all installation permits required by the *BC BPVR Regulation*. Projects must also be aware when installing any equipment regulated by the regulation and communicate to UBC Operations any equipment which requires an operating permit so that UBC Operations can obtain the operating permit.

Also note that the above only describes cases where a BPVR permit is required. However, it is common that additional permits will be required when installing BPVR regulated equipment:

- If installing a gas boiler it is likely that a TSBC Boiler Permit is required as well as a TSBC Gas Permit and a TSBC Electrical Permit.
- If installing an electric boiler, it is likely that a TSBC Boiler Permit is required as well as a TSBC Electrical Permit.
- If installing a refrigeration system, it is likely that a TSBC Refrigeration permit is required as well as a TSBC Electrical permit.

The regulatory requirements described in this document are not unique to UBC. Hopefully this document can serve as a useful tool for understating refrigeration and boiler pressure vessel requirements in British Columbia. This document is current as of summer, 2024 however these regulations are subject to change at anytime and are outside the control of UBC. Please do not hesitate to reach out with any content which you feel would add to this document or to identify any errors.

Sincerely,

Andrew Porritt, P.Eng
UBC Facilities