Refrigeration and Air Conditioning Competition Standards 2020 Vancouver

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1 PIPE WORK INSTALLATION STANDARD

This section is to ensure standardisation of all pipe work installed and to provide objective marking of all installation work performed by competitors. The standard for flame brazing is covered in section 3.

1.1 Pipe Work Bend Radius

1.1.1 Minimum radius

The minimum radius of copper pipe should be no less than the specified pipe bending tool can produce. The radius will ensure the formed pipe work is not kinked, flattened or reduces the internal diameter of the formed pipe work.

1.1.2 Maximum radius

The maximum radius of copper pipe should be a radius that ensures free flow of refrigerant through the formed pipe work. Therefore, the maximum radius accepted in this standard should be not more than 10 times the diameter of the pipe being bent.

E.g.: 6mm pipe = 60mm, 9mm pipe = 90mm, 12mm pipe = 120mm

1.2 Pipe work quality

For the purpose of this standard acceptable pipe work will be regarded as follows for:

1.2.1 Acceptable pipe work

All vertical and horizontal pipe work is to be directly vertical when measured by spirit level (acceptable tolerance will be that as indicated on the spirit level) or other acceptable means including laser alignment. Where diagonal pipe work is installed it must be straight and without deviation across the entire length.

All horizontal pipe work in the suction line is to have a 20mm in 4m (1:200) pitch (+/-2mm) towards the compressor to allow for oil return.

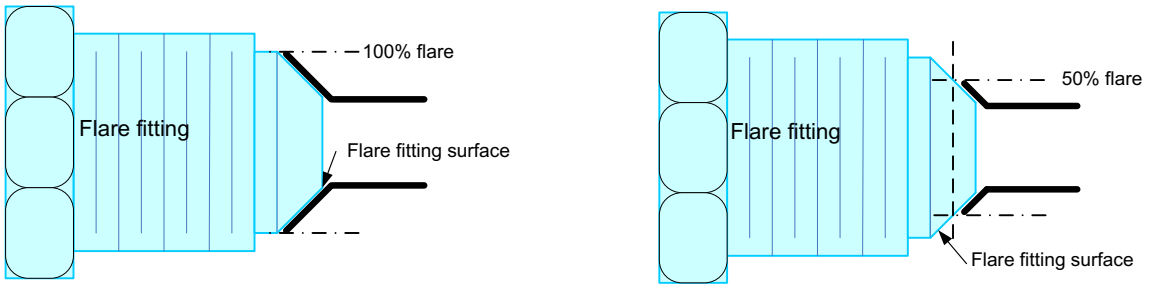
1.2.2 Unacceptable pipe work

For the purpose of this standard unacceptable pipe work will be that which has kinks or bends that are not as described in 1.1 above.

In addition, pipe work that is not contained within the boundaries of the equipment enclosure or prevent access to equipment that requires service or adjustment such as isolation/control valves and pressure switches.

1.3 Pipe work connections

To promote the reduction of refrigerant leaks, all flare pipe connections must have an application of oil prior to final assembly.
Flared copper must be no more than 100% and no less than 50% of the flare fitting surface.



1.3.1 Cutting and Preparing for joints

All piping/tubing must be cut square with an approved tool and must be reamed to prevent pressure loss and turbulence and witnessed by a judge.

1.4 Oil return and oil pipe traps

Suction line pipe work oil traps are only required where low refrigerant velocities are present and additional means is required to aid oil return. Any test project requiring oil traps will be clearly stated in the test project and equipment drawings.

Oil traps should be located at the outlet of the evaporator. If the compressor is below the evaporator the suction return line pipe work should be pitched (see standard 1.2) toward the compressor to allow for oil return.

1.5 Pipe supports/clamps/hangers

Any pipe work supports/hangers provided must be installed to offer support for the pipe work and to limit the transfer of vibration. The spacing of pipe supports will be of equal lengths no more than 400mm apart. Where pipework length is less than 400mm then a minimum of one pipe support located in either of the horizontal, vertical or diagonal planes is required. Pipe clamps must not be positioned over a brazed pipe fitting.

1.6 Pipe Insulation

1.6.1 Refrigeration Systems

Suction pipe work must be fully covered by the insulation to the Evaporator. The insulation surface must not be damaged in any way. Where insulation has been cut and wrapped around pipe work, or where insulation sections join together the insulation must be sealed using appropriate adhesive.

Pipe supports must be fitted with some form of protection to the insulation so as not to compress or deform the insulation, final mounting method will depend on resources available in host country and to be finalised at competition. Where pipe temperatures operate below zero Centigrade or 32 degrees Fahrenheit insulation must be vapour sealed to the pipe work using appropriate adhesive.

1.6.2 Air Conditioning Systems

Both Suction and Liquid lines are to be insulated strictly as per manufacturer's recommendations. And follow the pipe insulation standard 1.6.1

1.6.3 Unacceptable insulation

Insulation that has only been sealed by using electrical PVC tape, duct tape, or Insulation tape, insulation that is deformed or damaged.

1.7 Condensate drain piping

1.7.1 Refrigeration Systems

A 'U' trap must be installed in all refrigeration condensate drains to prevent the possibility of fumes or vermin from entering the refrigerated space. This trap will be constructed to provide a vapour barrier between the refrigerated space and the outside space.

1.7.2 Air Conditioners and Heat Pumps

Condensate drains for air conditioning systems are to be installed strictly as per the manufacturer's recommendations.

1.8 Pipe work connection onto refrigeration evaporators

The evaporator should be connected so as the refrigerant and secondary refrigerant (propylene glycol) are counter flow to each other.

2 COMPONENT LOCATIONS STANDARD

This section is to ensure standardisation of all component positions and to provide objective marking of all components installed by competitors.

2.1 Expansion valves

The expansion valve must be installed according to manufacturer's instructions. Typically meaning; in the liquid line, as close to the evaporator coil inlet (low pressure vessel) as is practical for service and commissioning.

2.1.1 Thermostatic Expansion valves (TEV)

The sensing bulb is to be fastened to the suction line as close to the evaporator pipe work outlet as is possible. The expansion valve may be installed within the evaporator housing (which is preferable), external of the evaporator housing but still within the refrigerated space (where it is applicable) or external or of the refrigerated space (where applicable). Externally equalized expansion valves must have the pressure equalizing line connected to the suction line immediately after the bulb. The bulb is to be located on a horizontal section (preferable) of the suction line immediately after the evaporator, in a position corresponding to between 12 o'clock and 8 or 4 o'clock positions for pipe sizing up to a maximum of 1 and 1/8", for all pipes above this diameter refer to expansion valve manufacturer's recommendations.

2.1.2 Electronic Expansion valves (EEV)

An EEV must be installed as per the manufacturer's instructions and as per the above standard 2.1, except that temperature sensors are to be fixed and not able to vibrate loose.

Unacceptable locations for the sensors or sensing bulb would be after a suction line heat exchanger or close to any other component.

2.2 Solenoid Valves

Solenoid valves are to be installed according to manufacturer's instructions. Typically solenoid valves must be installed in the direction of flow of the refrigerant. Liquid line solenoid valves should be installed before expansion valves. To avoid moisture damage to the electric coil the valve must be installed outside of the evaporator casing.

2.3 Evaporator Pressure Regulating valves (EPR)

Where multiple evaporators are used at different operating temperatures, the EPR valve is to be installed at the outlet (suction pipe) of the evaporator(s) with the highest evaporating pressure.

2.4 Crankcase Pressure Regulating valves (CPR)

The CPR valve is to be installed in the suction line immediately before the compressor suction service valve.

2.5 Non Return valves (NRV) Suction Line / Hot-Gas Line

NRV are to be installed whenever there is the possibility of high evaporating pressure migrating to a low evaporating pressure evaporator in a two temperature refrigeration system where two evaporators are fitted, and utilising one common compressor.

The NRV must be located in the suction line immediately after the low evaporating pressure evaporator and as per the manufacturer's instructions.

On hot-gas by-pass line, NRV will be fitted using a tee–piece and positioned close to the connection to evaporator inlet pipe.

2.6 Filter Dryer

The filter dryer must be installed with the flow arrow in the direction of the expansion valve. On a non-critical charge system, the filter drier can have any orientation (vertical, horizontal or diagonal) it must be installed in the liquid line directly after the receiver and before any solenoid valve, sight glass and the expansion valve. On a critical charge system it should be installed to provide free flow of refrigerant without acting as a liquid receiver/collector.

2.7 Sight glass

The sight glass with moisture indicator must be installed in the liquid line after the solenoid valve before the expansion valve and as per manufacturer's instructions.

2.8 Suction Line Heat exchangers

Where suction line heat exchangers are fitted, they must be installed immediately following the evaporator and may be inside or outside of the refrigerated compartment as applicable to each individual installation. The liquid and suction should be arranged to be counter flow.

2.9 Suction Accumulators

Suction accumulators must be installed in the correct orientation as per the manufacturer's instructions in the suction return line to the compressor. On capillary systems they can be located at the outlet of the evaporator. Heaters may be required to be installed on suction accumulators; in this instance insulation is not to cover any of the heater elements.

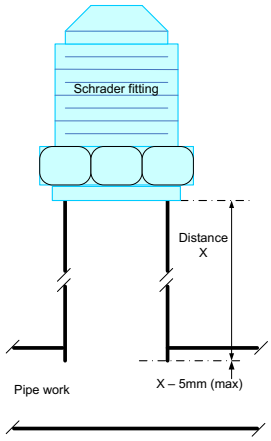
2.10 Oil Separator

Oil separators, if fitted to systems will be installed as per the manufacturer's instructions and be located in the discharge line between the compressor and condenser.

2.11 Pressure Control Switches

Pressure control devices must be fitted within the equipment boundaries and ensure that service access is provided for testing and calibration

2.12 Pressure control monitoring location & Schrader fitting points



For the purpose of this standard all pressure control monitoring points will be as per primary refrigerant flow circuit.

To ensure compliance with health & safety and reduction of emissions, any high-pressure safety controls must be installed to ensure the pressure switch cannot be isolated. Schrader valve cores and depressors cannot be used to connect high pressure switches.

The high-pressure sensing point must be installed as per primary refrigerant flow circuit, and must sense discharge pressure at all times. The sensing point must be located in the discharge line between the compressor and the condenser and located as per supplied drawing and/or demo trainer, if supplied. Only approved fittings shall be used.

The low-pressure sensing point must be installed as per primary refrigerant flow and located as per supplied drawing and/or demo trainer, if supplied. Only approved fittings shall be used.

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3 FLAME BRAZING STANDARD

At all times the competitors and experts must be vigilant to ensure the risk of fire is prevented. Competitors and experts must follow the risk assessment control measures for the refrigeration skill competition.

3.1 Equipment and clothing

All flame brazing equipment must be fit for purpose and have been tested for safe operation prior to the competition starting. The following safety clothing must be worn throughout any flame brazing activity:

- Long sleeve fire retardant clothing / coveralls
- Gloves specifically designed for flame brazing
- Safety glasses that include wrap around protection or goggles

Quality of joints

Copper to copper or dissimilar metals will require an applicable solder to withstand the same tensile strength as the parent metals.

3.1.1 Acceptable joint

The flame brazing activity aims to test the competitor's efficient use of flame brazing equipment and materials when joining two metals together. Components should not suffer excessive heat or scorching.

The standard of joint must be completely filled all around and have no raised marks or depressions around the circumference.

3.1.2 Use of Nitrogen during flame brazing

Nitrogen must be purged through the pipe work during flame brazing.

The competitor is to indicate where a pipe outlet is uncapped to allow Nitrogen exhaust.

3.1.3 Unacceptable joints

- Where a joint leaks refrigerant or oil
- Where a brazing drip is observed greater than 2mm.
- Where a brazed joint is marked or pitted due to excessive heat

4 PRESSURE TESTING STANDARDS

This standard has been developed for the sole purpose of ensuring both safe working practice and system integrity (avoid system rupture) during the World skills refrigeration and air conditioning test project competition.

This standard covers testing of high side and low side equipment and includes fabricated pipe work assemblies that have been insulated but before the joints and ends are sealed.

4.1 Procedures

Gauge manifolds to be pressure tested prior to any system pressure testing to 100 psig nitrogen for 15 minutes and witnessed by a judge

All pressure relief devices are to be isolated during pressure testing.

Pressure testing must not exceed the maximum test pressure of the nameplate on the manufactured equipment.

High and low side test pressures may require isolation of certain components.
Competitor must ensure all valves are open for the pipe/tubing work section under test.

Oxygen Free Nitrogen (OFN) is connected to the pipe work assembly using test hoses suitable to handle the maximum regulator pressure plus 20%.

A calibrated Nitrogen pressure regulator must be used to measure the pressure of the Nitrogen in the system (see diagram).

The Nitrogen pressure test must be carried out according to the temperatures that are equivalent to the standard air temperature reference for the pipe work section under pressure e.g.

- For the low side pressure test it will be 21°C/70°F
- For high side water cooled pressure test it will be 21°C/70°F
- For high side air cooled system pressure test it will be 21°C/70°F and will be confirmed in each individual test project by the Judge

The pressure will be determined by pressure/temperature relationship of the refrigerant to be used when applied to the above values. The system test pressure as indicated on the regulator or gauge will be recorded by the competitor and witnessed by a judge.

Should low side components be exposed to high side pressures as in a hot gas defrost, hot gas by-pass or reverse cycle systems then the entire system will be required to be tested as the high side.

The competition area is not expected to suffer a difference in temperature. Therefore the pressure test will be regarded as failed if the test pressure drops over a 15 minute time period. In addition a leak test of all joints is recommended as per 6.1 leak testing methods.
If pressure does not hold, it is the responsibility of the competitor to solve the problem without the assistance from an expert.

On completion of the test, the Nitrogen must be released in a slow and controlled manner so that it does not endanger themselves, spectators, experts or others in the area.

The Nitrogen cylinder and regulator must be disconnected from the system after the test.

5 EVACUATION STANDARDS

Evacuation of the refrigeration system will be required after pressure testing is performed to the standard. The purpose of evacuation is to ensure the complete removal of any moisture and any other non-condensable fluids that may affect efficient and reliable system operation.

Vacuum pump operation to be verified prior to the evacuation process to ensure pump vacuum will reach 1000 microns or below and witnessed by a judge that test has taken place.

The Test Project will only require the deep evacuation method described as follows:

5.1 Deep evacuation method

Using a suitable vacuum pump, the system pressure will be reduced to a minimum vacuum of 130 Pascal Absolute (1,000 microns of mercury) and left to stand isolated from the vacuum pump for a period of ten minutes. A vacuum gauge must be fitted to a remote part of the system to ensure the complete system vacuum is achieved.

The system evacuation will not be accepted if the vacuum rises over a value of 1000 microns in the ten minutes period.

6 LEAK TESTING METHODS

To ensure the refrigeration system integrity, and minimise the risk of environmental damage from emission of Fluorinated gases, the following two methods will be the accepted standard for leak testing.

6.1 Fluid Solution leak detection

When the appropriate test pressure for the device being tested is achieved, the competitor must use an industry approved leak detection solution. Where soap and water solution is used the competitor must prove the solution mixture will ‘bubble up’ at the maximum test pressure.

6.2 Electronic leak detection

Electronic leak detectors must be used to test for refrigerant leaks during charging process and when the system is operating at design conditions. In addition, the refrigeration system must be leak tested when the complete system is switched off and system pressures have equalised. Electronic leak detectors must be suitable to measure at least 5 grams of F gas per year.

7 REFRIGERANT HANDLING

7.1 Charging systems

HFC pure or blended refrigerants must be liquid charged and weighed into the system being charged. A record of the type and weight of refrigerant added and/or removed from the system must be attached to the refrigeration system.

7.2 Deliberate venting of refrigerants

Deliberate venting of refrigerants is damaging to our environment and must be prevented at all times. Refrigerant must be recovered using suitable refrigerant recovery system to the appropriate container. Unavoidable loss of refrigerant is detailed in section 7.3. The following situations will not be allowed:

7.2.1 The venting of surplus refrigerant from a system to atmosphere during decommissioning or repair/replacement of a component.

7.2.2 Venting of refrigerant charge to atmosphere when purging non condensable gas from a refrigeration system.

7.2.3 Using refrigerant as a fluid for cleaning or for pressure testing.

7.2.4 Adding refrigerant to a system that has a recognised refrigerant leak, before examining and repairing the refrigerant leak.

7.3 Unavoidable loss of refrigerants

The loss of refrigerant to atmosphere must be kept to a minimum. The following examples describe where unavoidable losses may occur:

7.3.1 Loss of refrigerant from leaking seals, joints, gaskets and cracked pipes. The leak(s) must be located and completely eliminated.

7.3.2 Loss of refrigerant from relief valves, bursting discs and fusible plugs discharging to the atmosphere to protect against dangerous pressure levels. Where possible these safety devices should be vented back into the system or to another working system.

7.3.3 Loss of refrigerant dissolved in oil, this should be minimised during the normal process of refrigerant recovery.

7.3.4 Loss of small quantities of refrigerant from charging hoses and pipes which occurs in the normal process of connecting and disconnecting. Charging hoses and pipes should be sealed at each end when not in use.

7.4 Safe Handling of refrigerants

The primary objective is to ensure the safety of competitors, technical experts and others involved in the refrigeration Test Project, plus visitors in the vicinity and close proximity of the test area.

Safety clothing must be worn when handling refrigerant fluids. The Host may request specific work wear or materials in addition to the following list of work wear.

- Long sleeve shirt
- Long pants or coveralls
- Gloves that will resist low temperatures of -80^{o}C
- Safety glasses that include wrap around protection or goggles

8 CARE OF OILS

Sustainability is one of the competition values. The purpose of this standard is to ensure that where ever possible and practical to do so, competitors take care of the quality of the oils they are using.

Refrigeration and Vacuum pump oil containers must remain sealed when not in use.

9 ELECTRICAL SAFETY

There must be no working on live (energized) equipment . For example using an insulated screwdriver to tighten a live electrical terminal is not allowed.

Approved Electrical Safety Gloves must be worn at all times when testing live (energized) electrical components. The gloves must meet the Host safety standards.

All connections will be terminated securely and with the use of ferrule terminals. No bare conductors can be on show when viewed from ninety degree (90º) angle to the terminal.

The installed electrical system must be checked by a NTC prior to the competitor performing the electrical installation tests.

The competitor must ensure the test instrument is tested and set correctly prior to electrical testing of the system.

NTC Committee members are responsible for the supervision of electrical testing and must sign the appropriate test box on the competitor's work sheet.

9.1 Earth continuity test

This test aims to ensure the installation has continuous earth bonding of all components.
The competitor must perform an earth continuity test in the presence of the technical expert (judge) before applying the voltage power supply to the system.

There must be a continuous circuit measured to a maximum value of 5 ohms resistance.

9.2 Polarity test

Polarity test ensures live and neutral are not crossed in the circuit.
Safety switches must be in the made position to enable this test.

9.3 Insulation resistance test

This test ensures the power cables are not conductive to earth.

Care must be taken to ensure the system is not in vacuum state, and electronic components are isolated before the test can be performed by the competitor.

Where any test fails to pass the standard, the competitor is required to solve the problem without guidance from the NTC.

9.4 Electrical Connections

All connections using twist style Marrette connectors shall have all wires twisted in the direction of the installed marrette using linesman pliers as per the Canadian Electrical Code

No. 31 – 2 #14 gauge wires No. 33 - 3-4 #14 gauge wires No. 35 - more than 4 #14 gauge wires

There shall be no exposed copper wire when viewed at a 90 degree angle

Wires shall not be twisted on the exterior of the connection

All crimp style connectors to be installed using an approved crimping tool.

These connections shall have no exposed copper at the insulation end and not to exceed the stop plate on the stripped end

Proper colour coded connections must be used Yellow-10/12 Gauge wire, Blue 14 Gauge wire, and Red/Pink 18-22 Gauge wire

10 COMMISSIONING AND SET UP

Commissioning and set up

The Test Project will be selected to use a refrigerant that ensures positive pressure for all operational controls.

10.1 High Pressure Cut out

The high pressure cut out safety switch setting is to be 30 degrees Fahrenheit higher than the SCT (saturated condensing temperature) and witnessed by a judge

10.1.1 Where a Low Pressure cut out switch is used as a temperature control device.

The cut out setting must be at 2ºC below the dead band of the control temperature and the cut in setting must be at the control temperature plus any dead band.

For example: When the required control temperature is -10°C with a 2°C dead band the required cut in is -9°C and required cut-out is -11°C , the Low Pressure cut out setting will be the saturation pressure equivalent to -13ºC and the Low pressure cut in setting will be equivalent to -9°C.

10.3 Where a Low Pressure cut out switch is used as a safety device.

To prevent harm to the compressor system from loss of refrigerant or to achieve a suitable pump down, the switch should be set to stop the compressor between 2 to 5 PSI. The cut in value must be set at 50% of the SST (saturated suction temperature)

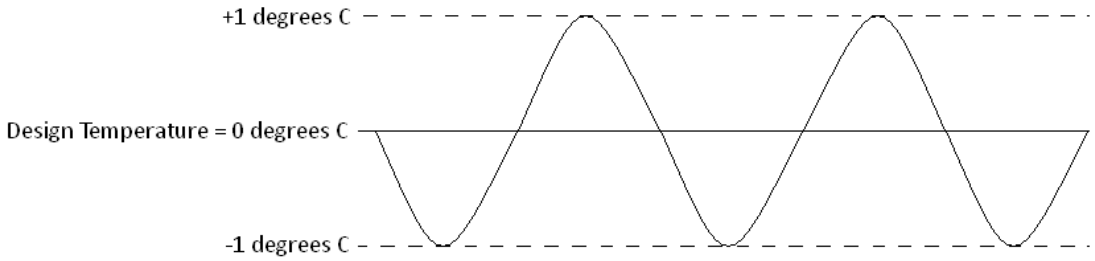
10.1.2 Pressure regulating devices

Pressure control devices e.g. evaporator pressure regulators and crankcase pressure regulators must be set to the design conditions specified within the Test Project.

10.1.3 Temperature Control devices

Temperature control devices e.g. electronic and mechanical thermostats must be set to satisfy the design temperature specified, in addition a value + and – the design temperature should be specified and any temperature controllers used should be set to satisfy these specifications.

For example a required design temperature of 0°C + or – 1°C should be set to cycle temperature as set-out in the below diagram.



11 GENERAL SAFETY & EQUIPMENT

Compliance with local health and safety standards must prevail at all times.

A risk management assessment must be carried out each day prior to the start of competition. Any hazards identified during these risk assessments must be isolated and rectified immediately.

There must be an evacuation procedure, along with the host country's health & safety requirements posted within easy access of each work area.

The nominated safety officer along with first aid station and first aid equipment should be clearly defined.

Fire extinguishers suitable for the type of risks must be clearly identified and located.

Any injuries sustained by either experts or candidates must be recorded in the first aid register regardless of the degree of injury.

Competitors must use the appropriate personal protective equipment (PPE) as and when required,