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國際技能競賽冷凍空調職類競賽標準

Refrigeration and Air Conditioning Competition Standards 2019

冷凍空調系統
競賽標準 2019

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1 PIPE WORK INSTALLATION STANDARD 管路安裝標準

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.

本部份用以確保管路安裝程序之標準化，以提供給選手所完成管路安裝工作的一個客觀評分標準，至於焊接標準則列於於第 3 部份說明。

1.1 Pipe Work Bend Radius 管路彎曲半徑

1.1.1 Minimum radius 最小彎曲半徑

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.

銅管最小的彎曲半徑應不小於指定的彎管器能彎的範圍。彎曲半徑要確保管路沒有扭曲、扁平或減少管內徑的寬度

1.1.2 Maximum radius 最大彎曲半徑

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

例如: （最大） （最大） （最大）

銅管的最大彎曲半徑應可使冷媒在被彎曲管自由流動，因此符合標準的最大的半徑應不超過被彎曲管路直徑的 10 倍。

1.2 Pipe work quality 管路加工品質

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

對於可接受的管路施工將會以以下描述進行:

1.2.1 Acceptable pipe work 可接受的管路施工

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.

所有垂直水平管路用水平儀量時皆要垂直(可接受的誤差會在水平尺上標註)或其他可接受的方法，包括雷射校準。安裝斜管時必須要直且不能偏離整個主長度。

所有水平的回流吸入管可以每 4m 下降 20mm(1:200)朝向壓縮機以便回油

1.2.2 Unacceptable pipe work 不可接受的管路施工

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.

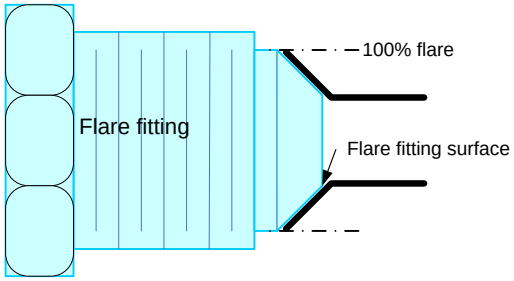
未達到 1.1 的標準要求使銅管彎曲或扭曲

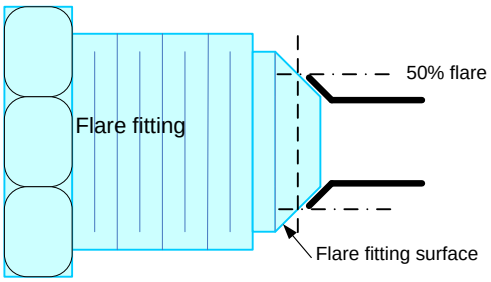
In addition, pipe work that is not contained within the boundaries of the equipment enclosure or prevent access to equipment that requires service or adjustment such as isolation/control valves and pressure switches.

此外，管路施工不包含在設備圍封內部或需要維修或調整的部分，例如隔離器/控制閥或是壓力開關

1.3 Pipe work connections 管件連接

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.
為減少冷媒洩漏，所有的喇叭管件接頭一定在組裝完成前先上油。銅管喇叭口不可大於 100 %衝孔接合面，也不可小於接合面的 50 %。





1.4 Oil return and oil pipe traps 回油管及 U 型回油彎管

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.
回流 U 型管僅於低冷媒流速及需要協助回油才需要，任何有需要回流 U 型管處均須於測試計畫書及設備圖說詳細描述

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.
U 形彎管須安裝在蒸發器之後。（指冷凍系統）如果壓縮機的安裝位置低於蒸發器，回流管應依照 1.2 標準下降朝向壓縮器使油能回流。

1.5 Pipe supports/clamps/hangers 管架/快速夾/吊架

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.
所有管路系統之安裝均需以固定架或吊架支撐以限制震動之傳遞。管路固定架之安裝間距不得大於 400mm，當管路總長小於 400mm 時，則應安裝至少一個固定架於此水平、垂直或斜管件上。快速鉗夾(clamp)不得用於固定黃銅管件

1.6 Pipe Insulation 管路保溫

1.6.1 Refrigeration Systems 冷凍系統

Suction pipe work must be fully covered by the insulation. 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.
吸入管須全部保溫；保溫材表面不得有任何損傷。包覆於管件之保溫材其切割處及接合處均需使用接著劑密封

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.
管路固定架在固定保溫管材時須採取保護措施,不得壓縮到保溫材或使變形,最後固定方式將在競賽時由主辦國依現有資材決定。保溫材表面不得有任何損傷。包覆於管件之保溫材其切割處及接合處均需進行黏合。操作溫度低於 0℃(32°F)之管件保溫須以適合的黏劑進行氣密黏合。

1.6.2 Air Conditioning Systems 空調系統

Both Suction and Liquid lines are to be insulated strictly as per manufacturer's recommendations. And follow the pipe insulation standard 1.6.1
回流管及液管應嚴格地(確實地)按照製造商建議及管件保溫標準進行保溫。

1.6.3 Unacceptable insulation 不合格的保溫

Insulation that has only been sealed by using electrical PVC tape or Insulation tape, insulation that is deformed or damaged.
只以 PVC 電工膠帶、絕緣膠帶黏合而成之變形或破壞的保溫。

1.7 Condensate drain piping 冷凝水排水管

1.7.1 Refrigeration Systems 冷凍系統

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.
所有冷凝水管線應安裝 U 形存水彎，以防止廢氣或蟲子進入冷藏空間。U 形存水彎以蒸氣屏障區隔冷凍空間與外在的空間。

1.7.2 Air Conditioners and Heat Pumps 空調或熱泵

Condensate drains for air conditioning systems are to be installed strictly as per the manufacturer's recommendations.
空調系統的冷凝水排水管線應確實按製造商的建議裝置。

1.8 Pipe work connection onto refrigeration evaporators 連接至冷凍系統蒸發器的配管

The evaporator should be connected so as the refrigerant and secondary refrigerant (propylene glycol) are counter flow to each other.
蒸發器之連結要使冷媒及二次冷媒(丙二醇)能夠對流。

2 COMPONENT LOCATIONS STANDARD 組件配置標準

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

本部份說明用以確保組件配置之標準化，並提供選手所安裝組件的客觀評分標準。

2.1 Expansion valves 膨脹閥

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.

膨脹閥必須依製造商的操作手冊安裝，一般皆裝在盡可能靠近蒸發器盤管入口（低壓容器）之液管上，以利維修與試車。

2.1.1 Thermostatic Expansion valves (TEV) 感溫式膨脹閥

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 equalised expansion valves must have the pressure equalising 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.

感溫球要盡量越靠近蒸發器盤管出口管上固定越好。膨脹閥必須依製造商的操作手冊安裝，膨脹閥之安裝位置以安裝在蒸發器內部固定座為最好，而安裝在冷凍空間內但在蒸發器外部固定座亦可適用。或是在冷凍空間之外部一般皆裝在盡可能靠近蒸發器盤管入口之液管上，以利維修與試車。外部均壓式膨脹閥需連接均壓管至感溫球之後的入口液管上。就最大 1 1/8" 之管件,感溫球安裝位置要介於 8-12 或 4-12 點鐘方向。超過此管徑則參照廠商製造手冊安裝。

2.1.2 Electronic Expansion valves (EEV) 電子式膨脹閥

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.

如 2.1 所述，電子式膨脹閥必須依製造商的操作指南安裝，溫度感測器必須固定，不可因振動而鬆動。

如 2.1 所述，電子式膨脹閥必須依製造商的操作指南安裝，溫度感測器必須固定，不可因振動而鬆動。

2.2 Solenoid Valves 電磁閥

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.

電磁閥須依製造商的操作手冊安裝，一般電磁閥依冷媒流動方向安裝。液管電磁閥必須安裝在膨脹閥之前。為避免濕氣損壞電磁線圈，電磁閥必須安裝在蒸發器外殼外。

2.3 Evaporator Pressure Regulating valves (EPR) 蒸發器壓力調節閥

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.

若有多個蒸發器用於不同的操作溫度，則蒸發器壓力調節閥應安裝於最高蒸發壓力的蒸發器回流管出口上。

2.4 Crankcase Pressure Regulating valves (CPR) 曲軸箱壓力調節閥

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

曲軸箱壓力調節閥安裝緊隨於壓縮機回流管維修閥前的回流管上。

2.5 Non Return valves (NRV) Suction Line / Hot-Gas Line 逆止閥 回流管/熱氣管

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.

在一雙溫冷凍系統中安裝二個蒸發器且共用同一壓縮機，當高蒸發壓力的蒸發器可能轉移為低蒸發壓力的蒸發器時，管路需安裝逆止閥。

根據製造商的操作指南，逆止閥需安裝在緊鄰低蒸發壓力的蒸發器的後方回流管上。

在熱氣旁路管路部分，逆止閥將以三通管方式裝於靠近蒸發器的入口管路

2.6 Filter Dryer 乾燥過濾器

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.

乾燥過濾器必須以膨脹閥箭頭流向安裝。在非臨界填充系統中，乾燥過濾器可為任何方向(垂直、水平或斜線)，它必須安裝在液管上，而液管位於儲液器之後、電磁閥、視窗和膨脹閥之前。在臨界填充系統，乾燥過濾器的安裝需提供冷媒自由流動。

2.7 Sight glass 視窗

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.

依據製造商的操作手冊，具濕度指示器的視窗須安裝在電磁閥之後、膨脹閥之前的液管上。

2.8 Suction Line Heat exchangers 吸氣管熱交換器

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.

吸氣管熱交換器要緊隨蒸發器安裝,可視個別適用狀況安裝於冷凍空間之內部或外部。蒸發器之連結要使冷媒和空氣側做逆流熱交換

2.9 Suction Accumulators 氣管液氣分離器

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.

氣管液氣分離器需依製造商操作手冊安裝於連至壓縮機之回流管上。若為毛細管系統則可安裝於蒸發器出口。加熱器有可能需要被安裝於液氣分離器，此類情形則加熱器不披覆

2.10 Oil Separator 油分離器

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.

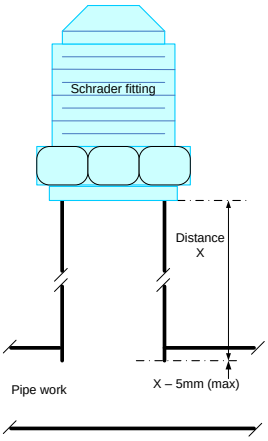
如系統需安裝油分離器，則須依製造商操作手冊，安裝在壓縮機和冷凝器之間的排出管上。

2.11 Pressure Control Switches 高低壓開關

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

壓力控制開關須裝在設備周邊範圍內，並提供測試和校準用維修口。

2.12 Pressure control monitoring location & Schrader fitting points 壓力控制之監測點位置與頂針閥



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

所有壓力控制之監測點須在每一個一次冷媒迴路

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.

為確保遵守安全衛生規定及減少冷媒排放量，應安裝高壓安全控制裝置以確保壓力開關不被獨立開來。頂針閥閥針及壓板不能連接於高壓開關。

The high pressure sensing point must be installed as per primary refrigerant flow circuit, and must sense discharge pressure at all times. Where no service fittings are present, the sensing point must be located in the discharge line between the compressor and the condenser.

高壓量測點應設於壓縮機排放端或高壓液管但須隨時能偵測排放壓力。在此並沒有維修管件，偵測點應在壓縮機和冷凝器間之吐出管

The low pressure sensing point must be installed as per primary refrigerant flow. The low pressure sensing point must be made by flame brazing into the suction pipe work entering the compressor.

低壓偵測點須位於壓縮機吸入端維修閥或軸箱壓力調節閥管件。此處未裝維修閥，此處低壓偵測點須以¼’’ (6mm)之燒焊銅管連接至吸入管進入壓縮機

If Schrader copper pipe fittings are used, they must not be cut down. The maximum inserted pipe depth to be no more than 5mm into the pipe work.

使用頂針閥連接管時不得進行裁切，最大插入管身長度不得大於 5mm(如右圖)

3 FLAME BRAZING STANDARD 火焰銲接標準

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.

競賽過程中，選手與裁判必須提高警覺確保用火安全。冷凍職類競賽的選手與裁判必須遵守風險評估控制措施。

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:

焊接的裝配必須配合使用目的，在競賽開始前，皆須通過安全操作測試。進行銲接工作時，須全程穿戴以下安全裝備：

- Long sleeve fire retardant clothing / coveralls 長袖防火服／工作服
- Gloves specifically designed for flame brazing 銲接專用手套
- Safety glasses that include wrap around protection or goggles 安全護目鏡

Quality of joints 銲接點品質

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

銅與銅或不同金屬銲接，須使用與母材拉力強度相當的銲料

3.1.1 Acceptable joint 可接受的銲接點

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.

本項目目的為測試參賽者操作銲接設備與材料、銲接金屬的能力。所有接頭與組件皆不可過熱或灼熱。銲接點必須完全填滿周遭，不可在周圍出現凹陷。

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.

在火焰銲接時，氮氣必須流經加工管件。選手須注意使管件出口未加蓋狀態，使氮氣排出。

3.1.3 Unacceptable joints 不可接受的銲接點

- Where a joint leaks refrigerant or oil 銲接處出現冷媒或油洩漏
- Where a brazing drip is observed greater than 2mm. 銲淚明顯超過 2mm
- Where a brazed joint is marked or pitted due to excessive heat 接頭過熱導致銲接處出現凹洞或痕跡

4 PRESSURE TESTING STANDARDS 壓力測試標準

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.

這個標準建立是為了確認世界技能競賽冷凍空調比賽安全的工作標準及系統完整性(避免系統破裂)

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.

本部份涵蓋測試設備的高壓側與低壓側，包括已絕緣組裝管件在接合點密封前的測試。

4.1 Procedures 程序

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

進行壓力測試前，所有壓力釋放裝置皆須隔離

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

壓力測試不得超過設備銘板標註之最大測試壓力。

High and low side test pressures may require isolation of certain components.

Competitor must ensure all valves are open for the pipe work section under test.

測試高壓側與低壓側時，可能需要隔離某些特定組件。選手必須確定所有閥門皆已打開，可以對管路進行壓測。

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

使用比最大壓力調節器多承受 20%壓力的管線，將無氧氮氣連接到管路。

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

測量系統的氮氣壓力，須使用經過校準的氮氣壓力調節器（見圖）

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.

氮氣壓力測試的溫度必須與管路在壓力下的標準溫度相符，例如:

- For the low side pressure test it will be 32°C 低壓側測試為 32˚C
- For high side water cooled pressure test it will be 43°C 高壓側水冷壓力測試為 43˚C
- For high side air cooled system pressure test it will be between 45°C and 55°C and will be confirmed in each individual test project by the Chief Expert
  高壓側氣冷壓力測試為介於 45˚C 至 55˚之間，且須經由裁判長針對個別測試計畫進行確認

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.

壓力之決定可藉由應用上列冷媒壓力溫度關係值參考，選手須將壓力錶所顯示之系統測試壓力記錄下來。

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.

萬一低壓側元件接觸到高壓側壓力導致熱氣除霜、熱氣通過或系統逆循環現象，則整個系統將進行量測。

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.

競賽區內不期望有不同環境溫度存在。因此超過 15 分鐘之壓降將被視為壓力測試失敗。此外各連結點之測試將依照 6.1 壓力測試標準進行。

If pressure does not hold, it is the responsibility of the competitor to solve the problem without the assistance from an expert.

如果站壓無法維持住，選手須在沒有裁判協助的狀況下解決問題

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.

完成測試後，氮氣須在控制下慢慢釋出，以避免造成觀眾、裁判、其他人員及選手本身之危險

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

競賽場地不會有溫度差別的問題。所以壓力測試如果在 15 分鐘內超過下降幅度就算失敗。

若壓力不能保持，選手必須不靠裁判協助，自行解決問題。測試結束時，須慢慢釋放氮氣，以免對自身或他人產生危害。測驗結束時，必須將氮氣筒與調節器從管路系統移除。

5 EVACUATION STANDARDS 抽真空標準

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.

壓力測試通過後，須進行冷凍系統抽真空。抽真空的目的在於確定沒有任何溼氣與非冷凝液，因為它們皆會影響系統操作的效度。

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

競賽僅須採深抽真空法，描述如下：

5.1 Deep evacuation method 深抽真空法

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.

使用適宜的真空泵浦，將系統壓力減小到 130 帕的絕對壓力（1,000 微米水銀柱），並將真空泵浦隔離站空十分 鐘。須在與系統相隔一段距離之處放置真空計，確保整個系統皆已達到真空。

The system evacuation will not be accepted if the vacuum raises over 1000 microns in the ten minutes period.

在十分鐘之內如果真空度提高超過 1000 微米，抽真空將不被接受

6 LEAK TESTING METHODS 檢漏測試方法

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.

為確保冷凍系統完整一致，盡量減少含氟氣體的排放與環境危害，以下為標準檢漏測試方法：

6.1 Fluid Solution leak detection 肥皂水檢漏

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.

完成壓力測試後，選手必須以產業認可的溶液探漏。使用肥皂和水溶液時，選手必須證明混合液在最大測試壓力會「冒泡」。

6.2 Electronic leak detection 電子檢漏

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.

測試冷媒在充灌過程或系統在設計條件運作時，須使用電子檢漏儀探漏。此外，冷凍系統系統關機、壓力達到平衡時，必須進行探漏測試。電子檢漏儀至少應可量測出每年 5 公克的鹵素氣體洩漏。

7 REFRIGERANT HANDLING 冷媒操作

7.1 Charging systems 系統充填

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.

HFC 純質冷媒或混合冷媒須以液態方式充填，經稱重後充填入系統。加入／或移除系統的冷媒類型與重量紀錄須貼示在冷凍系統上。

7.2 Deliberate venting of refrigerants 任意排放冷媒

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:

任意排放冷媒會對環境造成傷害，應小心避免。須使用適當的冷媒回收系統，以適當的容器盛裝。不可避免的冷媒損失在 7.3 詳述，以下情形是不允許的：

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

進行冷媒系統判斷，或修理／更換組件時，將過剩的冷媒排放至大氣。

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

從冷凍系統排放不凝結氣體時，將冷媒一併排放至大氣。

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

以冷媒作為清潔或壓力測試的流體

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

系統洩漏冷媒，未經檢查及修理即添加冷媒。

7.3 Unavoidable loss of refrigerants 不可避免的冷媒損失

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

進行下列工作時，必須將冷媒洩漏至空氣中的量減到最少

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

從洩漏的密封處、接點、襯墊和龜裂的管件所產生的冷媒。須找出洩漏處且完全排除洩漏狀況。

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.

為防止壓力達到危險等級，從釋放閥、破裂盤和可溶栓排放至大氣之冷媒。應儘可能將這些安全裝置的排氣排入系統或至另一個工作系統。

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

正常冷媒回收過程中，溶入冷凍油內的冷媒。

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.

連接和拆接管件過程中，從充填軟管和管件洩漏少量冷媒。不再使用充填軟管和管件時，須將其密封。

7.4 Safe Handling of refrigerants 冷媒安全操作

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.

本標準目的在於確保選手、裁判、其他參與人員、臨近試驗區的參觀者之安全。

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.

處理冷媒時，應全程穿戴安全裝備。除了以下清單，主辦國亦可要求特定的衣著或材料。

- Long sleeve shirt 長袖襯衫
- Long pants or coveralls 長褲或工作褲
- Gloves that will resist low temperatures of -80ºC 耐冷-80℃的手套
- Safety glasses that include wrap around protection or goggles 安全眼鏡／護目鏡

8 CARE OF OILS 使用冷凍油注意事項

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.

永續發展是競賽的一個價值觀。所以這個標準是確認可能性與實際性而做的。 選手使用品質良好的油。冷凍及真空泵浦儲油器不用時一定要密封。

9 ELECTRICAL SAFETY 電氣(用電)安全

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

不可在已通電的設備進行任何操作。例如，不可用絕緣螺絲起子栓緊接線端子。

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

測試已通電的電子組件時，須全程穿戴電氣安全手套，手套須符合主辦國安全標準。

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.

所有接頭都應以套環端子安全鎖緊。從垂直角度看，接線端子不可有導線露出。

The installed electrical system must be checked by an expert 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.

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

進行電氣系統安裝測試前，安裝完成的電氣系統皆須由裁判檢查。選手必須確保測試儀器已測試及設定正確，在系統電氣測試之前。裁判負責監督電力測試，並在選手工作表簽名。

9.1 Earth continuity test 接地連續性測試

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.

此測試目的為確保所有安裝的組件皆有連續性接地。進行系統供電前，選手須執行接地連續性測試，由裁判在場確認。（※供電前必須做接地測試、短路或斷路測試）

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

必須是連續性的電路測試且電阻最大值為 5 歐姆

9.2 Polarity test 極性測試

Polarity test ensures live and neutral are not crossed in the circuit.

Safety switches must be in the made position to enable this test.

極性測試為確保活線與中性線沒有相交。為便於測試，安全開關必須放在規定位置。

9.3 Insulation resistance test 絕緣電阻測試

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

此測試可確保電源線未與接地線連接。

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.

選手進行測試前，必須確認系統並非在真空狀態下，且電氣元件皆已隔離。

Test result must not be less than 1 mega ohm. 測試結果不能小於 1MΩ

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

若有不符標準的測試，選手必須不靠裁判協助，自行解決問題

10 COMMISSIONING AND SET UP 試車與設定

Commissioning and set up

The Test Project will be selected to use a refrigerant that ensures positive pressure for all operational controls. 測試計畫使用的冷媒應確保所有操作控制皆為正壓

10.1 High Pressure Cut out 高壓切出設定

The high pressure cut out safety switch setting is to be determined and set at 0.9 x maximum allowable pressure (MAP). The maximum allowable pressure (MAP) for a sealed RAC system to operate on the high side is given at a temperature equivalent to between 45°C and 55°C for air cooled condensers and 43°C for water cooled condensers. Exact values to be confirmed for each test project by Chief Expert as per Procedures section 4.1

高壓切出設定值定於 0.9 倍最大容許壓力(MAP)。就密閉冷凍空調系統在高壓側之最大容許壓力,氣冷式冷凝器其對等溫度應介於 45℃和 55℃之間,水冷式為 43℃,確實值將依照程序 4.1 項由裁判長確認後決定。

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

低壓切出設定用以當成溫控裝置

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.

低壓切出設定值應在 2℃之溫控遲滯範圍之內,而切入設定值應為控制溫度加上遲滯溫度

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.

例如:需求溫度控制為-10℃, 遲滯溫度為 2℃,需求切入設定值應在-9℃, 切出設定值應為-11℃, 則低壓切出設定值將為對應於-13℃之飽和蒸汽壓,而低壓切入設定值將為對應於-9℃

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

低壓切出開關當為安全裝置

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 above 0 Barg but no more than 0.15 Barg. The cut in value must be set as per standard 10.2

例如:為避免冷媒洩漏或泵集時對壓縮系統的損害,所以低壓切出設定應介於 0-0.15BAR 錶壓

10.1.1 Pressure regulating devices 壓力調整裝置

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

壓力調整裝置如蒸發器壓力調節閥及曲軸箱壓力調節閥,其設定應遵照測試計畫之設計條件。

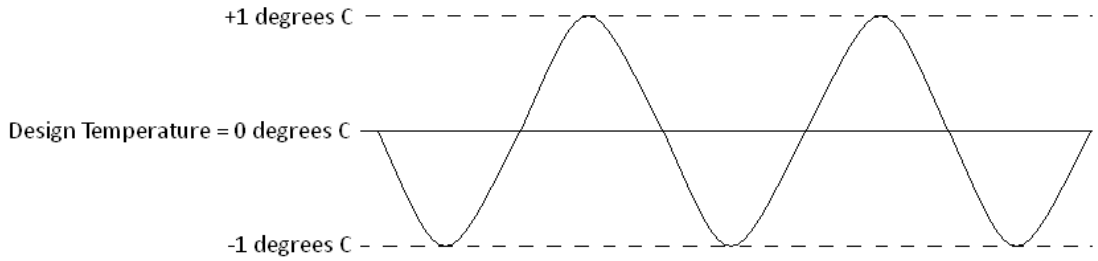
10.1.2 Temperature Control devices 溫度控制裝置

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.

溫度控制裝置如:電子及機械式溫度控制器之設定要符合規定設計溫度。此外設計溫度之+/-溫度設定亦應符合設計規定

例如:當需求設計溫度為 0℃或-1℃時,系統之設計溫度如下圖所示



11 GENERAL SAFETY & EQUIPMENT 一般安全性與裝備

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

所有時間必須遵從當地健康和安全性標準

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.

每日競賽前需進行風險管理評估。任何風險一經評估發現則需隔離或矯正。

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

每個工作區都應有寬敞的通道，並清楚張貼疏散方法及主辦國職業安全衛生要求。

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

大會的安全官員、急救站與急救設備應有清楚標示。

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

滅火器的適用滅火類型須清楚標示和設置

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

若有裁判或選手受傷，無論傷勢輕重，皆應記錄於急救登記。

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

選手應使用符合標準的個人防護設備