

*Standards and
Assessment Guide*

**Refrigeration and
Air Conditioning**

Introduction

Welcome to the Standards and Assessment Guide (SAG), a comprehensive resource designed to support excellence in assessment practices for all skills competitions hosted at the WorldSkills Competition. A key component of the SAG is the commitment to continuous improvement through ongoing review, ensuring that these guides consistently reflect the latest industry innovations and high standards of assessment in an open and transparent manner.

Purpose

The primary purpose of this guide is to provide a structured framework for the consistent and fair assessment of each skill competition. It aims to ensure that all assessments are conducted with a high degree of accuracy, reliability, and validity, and reflect global industry standards. By adhering to these guidelines, assessors can maintain the integrity of the competition and uphold the high standards associated with WorldSkills.

Note: this guide is not a replacement for the Marking Scheme and should only be used as a reference when required during the assessment process. Competitors are not allowed to have a copy of this SAG in the workshop in either digital or paper form.

Scope

This document covers general assessment practices applicable to a diverse range of industry sectors including:

- Manufacturing and Engineering Technology
- Information and Communication Technology
- Construction and Building Technology
- Transportation and Logistics
- Social and Personal Services
- Creative Arts and Fashion

Each skill competition has its unique requirements and benchmarks, which are detailed within sections of this guide. The consistency of assessment across each skill is the overarching principle, ensuring a unified approach to evaluating Competitor performance to the highest standards.

Skill 38 – Refrigeration and Air Conditioning

This document provides the standards for the assessment Aspects, which are identified as either Measurement or Judgement

Measurement (M)

Measurement is used to assess accuracy, precision, and other performance that can be measured objectively. It is used where ambiguity must be avoided.

The total marks allocated to measurement marking may vary from competition to competition depending on the Test Project.

The assessment group comprise three Expert + 1 Expert. It is forbidden for Experts to assess their own compatriot Competitor.

Judgement (J)

Judgement is used to assess the quality of performance about which there may be small differences of view when applying the external benchmarks.

The Resources column in the table below may include all kinds/formats of resources such as: a link to a YouTube video, a website link, an illustration, a photo, a reference to a book, and so on. It needs to be as detailed as possible to show the differentiation between 0, 1, 2, 3.

Generic rules:

The assessment group comprises three Experts plus one Expert who acts as the supervisor. The supervising Expert will replace an Expert in the marking group to prevent compatriot marking.

The difference of the three Experts' scores may not exceed 1. If this is the situation the Experts must re-score until there is a maximum difference of 1. As long as the three Experts judge within 1, the result can be entered into the CIS.

The total marks allocated to judgement marking may vary from competition to competition depending on the Test Project.

WorldSkills Occupational Standards (WSOS) sections per the Technical Description:

1. Work organization and management
2. Communication and interpersonal skills
3. Design refrigeration and air conditioning systems
4. Installation and maintenance of refrigeration and air conditioning
5. Commission refrigeration and air conditioning systems
6. Fault finding refrigeration and air conditioning systems

Standards and Assessment Guide Sections

- 1.** Copper Pipe Work
- 2.** Major Component Installation
- 3.** Refrigerant Flow Control Installation
- 4.** Electrical Cable Installation
- 5.** Electrical Testing and Fault Finding
- 6.** Pressure Testing
- 7.** Evacuation
- 8.** Refrigerant Charging
- 9.** Commissioning and Fault Finding
- 10.** Refrigerant Recovery
- 11.** Work Practices and Safety

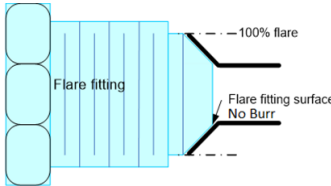
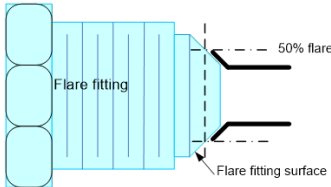
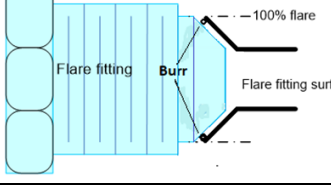
1. COPPER PIPE WORK

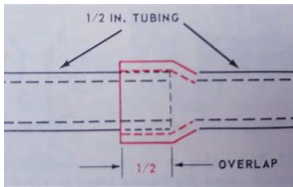
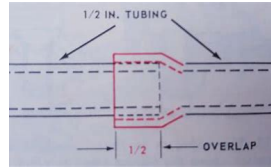
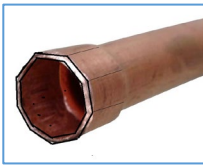
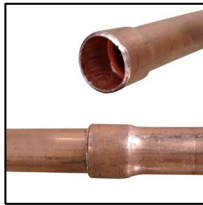
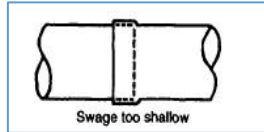
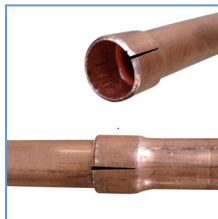
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.1 Pipe straightness	M	5	3	Performance wholly exceeds industry standard and is judged as excellent: • Tube is perfectly straight +/- 0 mm over 400mm when put against a straight edge		400 mm Straight edge or angle 2 and 4 mm feeler gauge
			2	Performance meets industry standards and surpasses that standard to some extent: • Tube is straight +/- 2 mm over 400mm when put against a straight edge		
			1	Performance meets industry standards: Tube is straight +/- 4 mm over 400mm when put against a straight edge		
			0	Performance below industry standards: • Tube is not straight , greater than 4mm deflection over 400mm when put against a straight edge		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.2 Vertical and horizontal pipe work – except horizontal suction lines	M	5	3	Performance wholly exceeds industry standard and is judged as excellent: spirit level bubble is at the centre		Spirit level
			2	Performance meets industry standards and surpasses that standard to some extent: spirit level bubble is within the inner lines but towards one end		
			1	Performance meets industry standards: spirit level bubble is within the outer lines or touching the line		
			0	Performance below industry standards: spirit level bubble is not within the lines		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.3 Horizontal suction line pipe work	M	5	3	Performance wholly exceeds industry standard and is judged as excellent: - pipework slopes 2mm in 400mm (1:200) pitch (+/-1mm) towards the compressor to allow for oil return, and - spirit level bubble is within the inner lines and slopes down toward compressor		- Spirit level 2mm feeler gauge
			2	Performance meets industry standards and surpasses that standard to some extent: - pipework slopes 2mm in 400mm (1:200) pitch (+/-1mm) towards the compressor to allow for oil return, and - spirit level bubble is within the outer lines		
			1	Performance meets industry standards: - pipework does not slope 2mm in 400mm (1:200) pitch (+/-1mm) towards the compressor to allow for oil return, and - spirit level bubble is at the centre, that is no slope at all.		
			0	Performance below industry standards: - pipework does not slope or exceeds 2mm in 400mm (1:200) pitch (+/-1mm) towards the compressor to allow for oil return or slopes away from compressor, or - spirit level bubble is not within the lines		

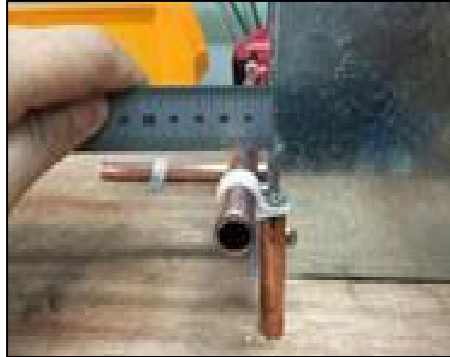
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.4 Pipe right angle bends	J	5	3	Performance wholly exceeds industry standard and is judged as excellent: No kinks, grooves or scratches on pipe, (marks or scratches caused by the bender's correct use are acceptable), correct bend angle ($90^\circ \pm 2^\circ$), diameter of the pipe is full and correct, and bend radius is less than 10 times the diameter of pipe.		- Digital Sliding T-Bevel Gauge & Protractor - Samples
			2	Performance meets industry standards and surpasses that standard to some extent: minor small kinks, grooves or scratches on pipe, but defects will not affect operation, correct angle ($90^\circ \pm 5^\circ$), correct diameter of the pipe, one blemish (marks caused by the bender's correct use are acceptable), and bend radius is less than 10 times the diameter of pipe.		
			1	Performance meets industry standards: small kinks, grooves or scratches on pipe, correct bend angle ($90^\circ \pm 5^\circ$), slightly reduced diameter of the pipe, two blemishes (marks caused by the bender's correct use are acceptable), and bend radius is less than 10 times the diameter of pipe.		
			0	Performance below industry standards: large kinks, grooves or scratches on pipe, bend angle not correct ($90^\circ \pm 5^\circ$), diameter of the pipe reduced, more than three blemishes (marks caused by the bender's correct use not included), or bend radius is more than 10 times the diameter	 	

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.5 Pipe flares	M	5	Yes	Performance meets industry standards: • flare is no more than 100% and no less than 75% of the flare fitting surface, and therefore, • Fits into hole in Go/No Go metal block, but does not slip through it, and • Has no burr or split on flare face	 	• Go/No Go metal block template • Samples 
			No	Performance below industry standards: • flare is more than 100% or less than 75% of the flare fitting surface, and therefore, • Does NOT fit into hole in Go/No Go metal block or slips through it, or • Has a burr or split on flare face	 	

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.6 Pipe swages	J	5	3	Performance wholly exceeds industry standard and is judged as excellent: no splits in the tube, - swage length at least the same as the tube diameter, and - inside circumference is smooth/circular, without swage head marks	 	- Rule - Feeler gauge - Samples
			2	Performance meets industry standards and surpasses that standard to some extent: no splits in the tube, - swage length at least the same as the tube diameter, and - inside circumference rough/staggered, from swaging in one action	 	
			1	Performance meets industry standards: no splits in the tube, - swage length at least the same as the tube diameter less 2mm, and - inside circumference rough/staggered, from swaging in one action		
			0	Performance below industry standards: split/s in the tube, - swage length is less than 2mm of the tube diameter, or - inside circumference rough/staggered, from swaging in one action	 	

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.7 Pipe supports/clamps/hangers	J	5	3	Performance wholly exceeds industry standard and is judged as excellent: • support is securely fastened to the pipework or mounting point, • supports the pipe work and limits the transfer of vibration, • spacing are no more than 400mm apart, and • where a straight length of pipework is less than 400mm, but a change in direction or component is installed, there is at least one pipe support located in either of the horizontal or vertical planes, no more than 400mm apart.	 	• Tape measure • Rule
			2	Performance meets industry standards and surpasses that standard to some extent: • support is securely fastened to the pipework or mounting point, • supports the pipe work and limits the transfer of vibration, • spacing are no more than 500mm apart, and • where a straight length of pipework is less than 400mm, but a change in direction or component is installed, there is at least one pipe support located in either of the horizontal or vertical planes, no more than 500mm apart.		

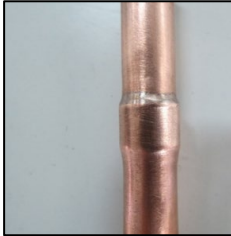
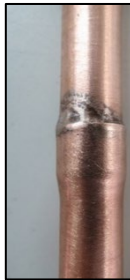
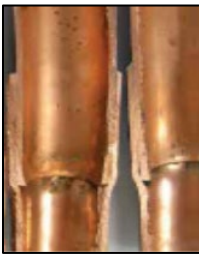
			1	Performance meets industry standards: • support is securely fastened to the pipework or mounting point, • supports the pipe work and limits the transfer of vibration		
			0	Performance below industry standards: • support is not securely fastened to the pipework or mounting point, • does not support the pipe work or limit the transfer of vibration, • fabrication of brackets or supports is from other materials, for example copper tube, or • pipe clamps are positioned over a brazed pipe fitting or in the radius of the bend.		

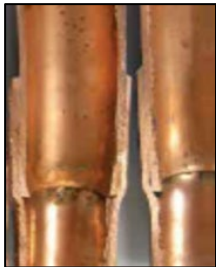
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.8 Pipework clearances, excluding insulation	M	5	Yes	Performance meets industry standards: there is at least 20 mm clearance between the pipework and other components and pipework, except for access penetrations where at least 5mm clearance is required		- Rule 20mm gauge/template /blocks
			No	Performance below industry standards: the clearance between the pipework and other components and pipework is less than 20 mm and for access penetrations less than 5mm.		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.9 Pipe Insulation	J	5	3	Performance wholly exceeds industry standard and is judged as excellent: - for Refrigeration systems, the suction pipe work is fully covered by the insulation after the pipework has been pressure tested and assessed, - for Reverse Cycle Air Conditioning Systems, both suction and liquid lines between the outdoor and indoor units is fully insulated per manufacturer's recommendations after the pipework has been pressure tested and assessed, - insulation surface is not damaged in any way, - where insulation has been cut and wrapped around pipe work, or where insulation sections joined together, the insulation is sealed using appropriate adhesive, - where the pipe supports are fitted over the insulation, the insulation is not overly compressed or deformed, and - the insulation is vapour sealed to the pipe work using appropriate adhesive.	  	
			2	Performance meets industry standards and surpasses that standard to some extent: - for Refrigeration systems, the suction pipe work is fully covered by the insulation after the pipework has been pressure tested and assessed, - for Reverse Cycle Air Conditioning Systems, both suction and liquid lines between the outdoor and indoor units is fully insulated per manufacturer's recommendations after the pipework has been pressure tested and assessed, - insulation surface has some minor damage, - where insulation has been cut and wrapped around pipe work, or where insulation sections joined		

				together, the insulation is mostly sealed using appropriate adhesive, • where the pipe supports are fitted over the insulation, the insulation is not overly compressed or deformed, and • the insulation is vapour sealed to the pipe work using appropriate adhesive.		
			1	Performance meets industry standards: • for Refrigeration systems, the suction pipe work is fully covered by the insulation before the pipework has been pressure tested and assessed, • for Reverse Cycle Air Conditioning Systems, both suction and liquid lines between the outdoor and indoor units is fully insulated per manufacturer's recommendations before the pipework has been pressure tested and assessed, • insulation surface has some minor damage, • where insulation has been cut and wrapped around pipe work, or where insulation sections joined together, the insulation is mostly sealed using appropriate adhesive, • where the pipe supports are fitted over the insulation, the insulation is not overly compressed or deformed, and • the insulation is vapour sealed to the pipe work using appropriate adhesive.		

			0	Performance below industry standards: - insulation is not fitted, sealed or has only sealed using electrical PVC or insulation tape, or - insulation is deformed or damaged	   
--	--	--	---	---	--

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
1.10 Copper tube brazed joints Notes: • Copper to copper brazed joints, a filler rod of at least 15% +/- 3% silver content must be used • Copper to brass or steel brazed joints, a filler rod of at least 45% +/- 3% silver content must be used	J	5	3	Performance wholly exceeds industry standard and is judged as excellent: • joint does not leak under pressure on first pressure test, • dry nitrogen was slowly bled through pipework during brazing, • correct brazing alloy used, • brazing ring is complete, even, smooth and sufficient with less than 2mm excess, and • no metal damage, over-heating, flux residue, or component scorching	 	• Samples
			2	Performance meets industry standards and surpasses that standard to some extent: • does not leak under pressure on first pressure test, • dry nitrogen was slowly bled through pipework during brazing, • correct brazing alloy used, • brazing alloy ring is complete, but not even or insufficient or more than 2mm excess, but less than 4mm, • no metal damage, no flux residue or component scorching, and • no over-heating of alloy.	  	

			1	Performance meets industry standards: • does not leak under pressure on first pressure test, • dry nitrogen was slowly bled through pipework during brazing, • correct brazing alloy used, • brazing alloy ring is complete, but not even or insufficient or more than 4mm excess, • no metal damage and no flux residue or component scorching, and • some over-heating of alloy (bubbles)	 	
			0	Performance below industry standards: • joint leaks under pressure, • dry nitrogen was NOT slowly bled through pipework during brazing, • incorrect brazing alloy used, • no complete ring or too much (blobs/runs in excess of 5mm) brazing alloy used, • brazing alloy not melted into joint, • metal damaged/burnt, flux residue, or component scorching.	 	

2. MAJOR COMPONENT INSTALLATION

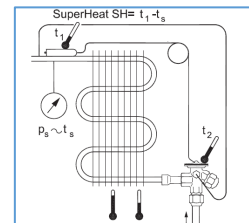
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
2.1 Compressor location	M	5	Yes	Performance meets industry standards: compressor is installed in specified orientation and location +/- 2 mm.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: compressor is NOT installed in specified orientation or location +/- 2 mm.		
2.2 Compressor mounting	J	5	Yes	Performance meets industry standards: - compressor is installed using mounting kit, and - securely fixed at 4 mounting points using correct fixing materials per manufacturer's instructions		Manufacturer's installation instructions
			No	Performance below industry standards: - compressor is NOT installed using mounting kit, or not securely fixed at 4 mounting points using correct fixing materials per manufacturer's instructions		
2.3 Air cooled condenser	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per manufacturer's instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per manufacturer's instructions.		

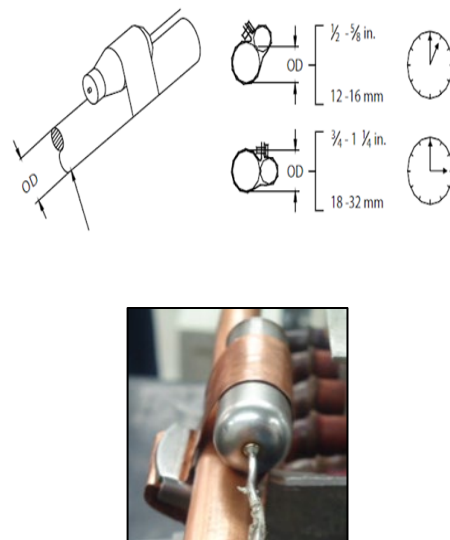
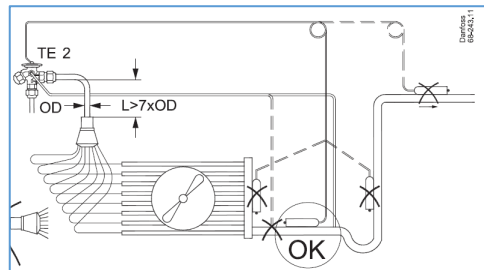
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
2.4 Bare pipe condenser	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per project instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per project instructions.		
2.5 Liquid receiver	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per project instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per project instructions.		
2.6 Fan forced evaporator	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per manufacturer's instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per manufacturer's instructions.		

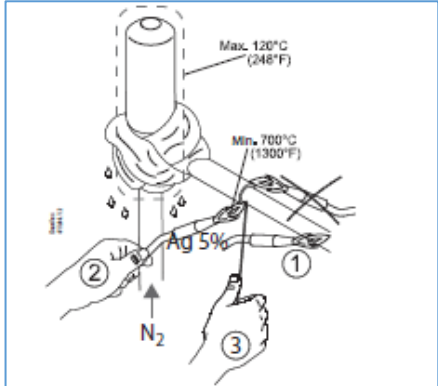
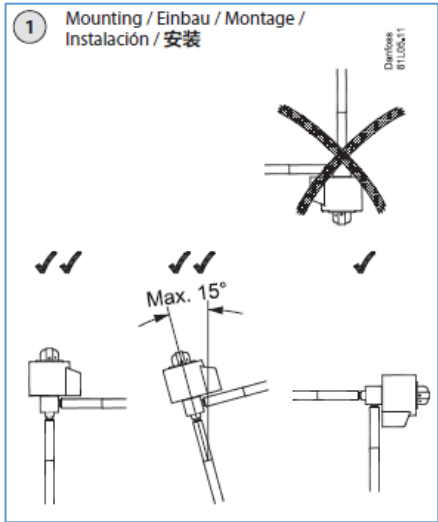
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
2.7 Bare pipe evaporator	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per project instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per project instructions.		
2.8 Suction accumulator	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, and - securely fixed using correct fixing materials per project instructions.		- System diagram - Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, or - securely fixed using correct fixing materials per project instructions.		
2.9 Electrical control box	M	5	Yes	Performance meets industry standards: It is: - installed in specified orientation and location +/- 2 mm, - installed level with spirit level bubble at its centre, and - securely fixed using correct fixing materials per project instructions.		- System diagram - Spirit level Rule - Tape measure - Template
			No	Performance below industry standards: It is NOT: - installed in specified orientation or location +/- 2 mm, - installed level with spirit level bubble at its centre, or		

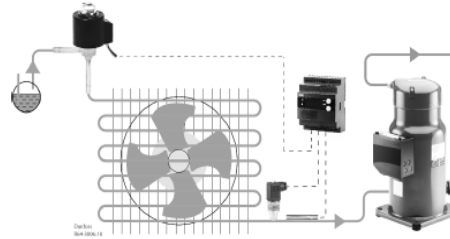
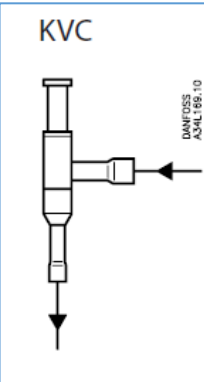
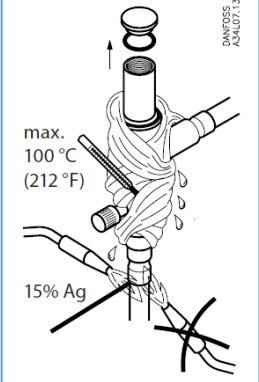
				securely fixed using correct fixing materials per project instructions.		
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
2.10 Pressure control	M	5	Yes	Performance meets industry standards: It is installed: - in specified orientation and location +/- 2 mm, - to provide access for testing and adjustment, and - securely fixed using correct fixing materials per manufacturer's instructions.		- System diagram - Rule - Tape measure - Template - Manufacturer's installation instructions
			No	Performance below industry standards: It is NOT installed: - in specified orientation or location +/- 2 mm, - to provide access for testing and adjustment, or - securely fixed using correct fixing materials per manufacturer's instructions.		

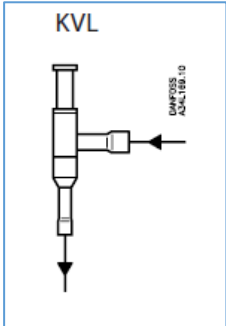
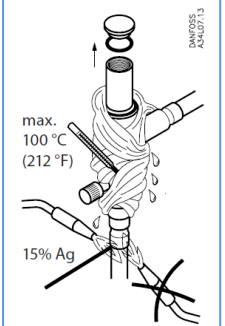
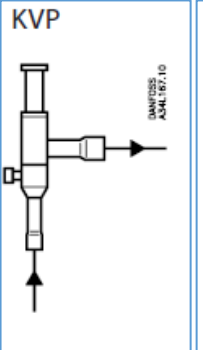
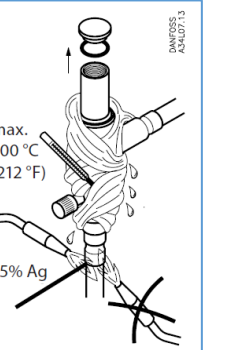
3. REFRIGERANT FLOW CONTROL INSTALLATION

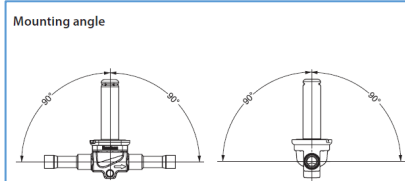
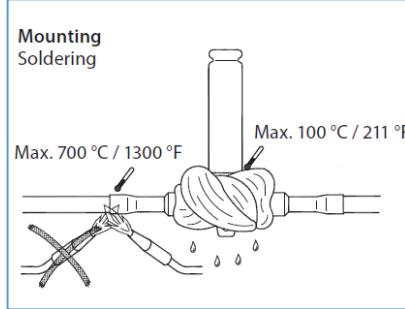
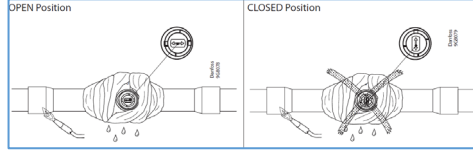
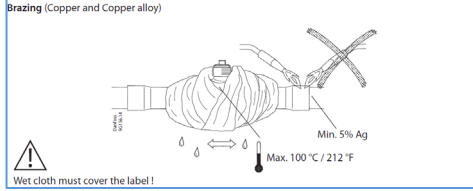
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.1 Thermostatic expansion valve body	M	5	Yes	Performance meets industry standards: It is installed - as per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - with the external equaliser line fitted to the outlet of the evaporator after the bulb, - label is readable	 	- System diagram - Manufacturers instructions
			No	Performance below industry standards: It is NOT installed - as per manufacturer instructions, or: - in the correct location in system, - with correct refrigerant flow, or - with the external equaliser line fitted to the outlet of the evaporator after the bulb, and - label is not readable		

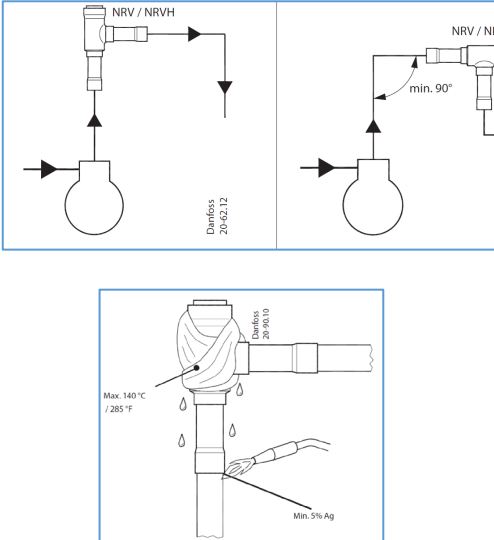
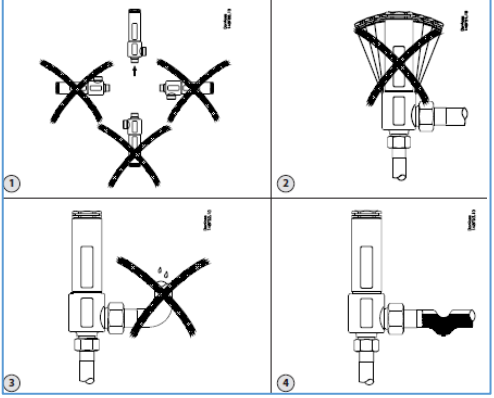
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.2 Thermostatic expansion valve bulb	M	5	Yes	Performance meets industry standards. It is installed: • as per manufacturer instructions or: • secured in the correct location in system, • before the external equaliser pipe if fitted, • at 1 or 11 o'clock position on 1/2" and 5/8" pipe, • insulated, and • with bulb capillary secured		• System diagram • Manufacturers instructions 
			No	Performance below industry standards: It is NOT installed: • as per manufacturer instructions, or is NOT: • secured in the correct location in system, • before the external equaliser pipe if fitted, • at 1 or 11 o'clock position on 1/2" and 5/8" pipe, • insulated, or • with bulb capillary not secured		

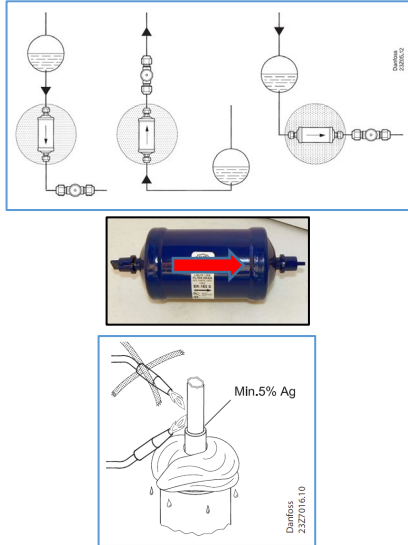
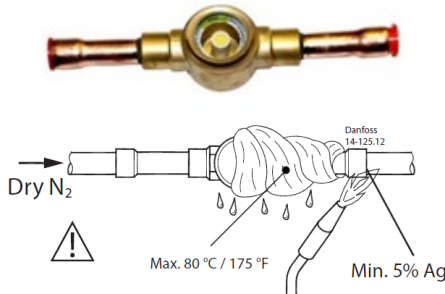
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.3 Electronic expansion valve body	M	5	Yes	Performance meets industry standards: It is installed: • per manufacturer instructions and: • in the correct location in system, • positioned in the correct vertical plan angle • with correct refrigerant flow, • wrapped in wet cloth before silver brazing, and • with dry nitrogen used during brazing,	 	• System diagram • Manufacturers instructions
			No	Performance below industry standards: It is NOT installed: • per manufacturer instructions, • in the correct location in system, • with correct flow, • positioned in the correct vertical plan angle • wrapped in wet cloth before silver brazing, or • with dry nitrogen used during brazing		

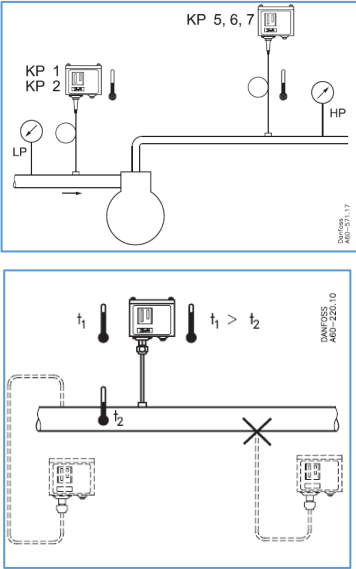
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.4 Electronic expansion valve temperature sensor	M	5	Yes	Performance meets industry standards. It is installed: • as per manufacturer instructions and: • securely in the correct location in system, • at 2 or 10 o'clock position on the pipe, and • insulated		• System diagram • Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: • as per manufacturer instructions, • secured in the correct location in system, • at 2 or 10 o'clock position on the pipe, or • insulated		
3.5 Hot gas bypass valve	M	5	Yes	Performance meets industry standards. It is installed • per manufacturer instructions and: • in the correct location in system, • with correct refrigerant flow, • with access for service and adjustment and • wrapped in wet cloth before silver brazing, and • with dry nitrogen used during brazing	 	• System diagram • Manufacturers instructions
			No	Performance below industry standards. It is NOT: • installed per manufacturer instructions, • in the correct location in system, • with correct flow, • clear access for service and adjustment, • wrapped in wet cloth before silver brazing, or • with dry nitrogen used during brazing. • brazed with incorrect alloy		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.6 Crankcase pressure regulator	M	5	Yes	Performance meets industry standards. It is installed - per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - with access for service and adjustment, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing.	 	- System diagram - Manufacturers instructions
			No	Performance below industry standards. It is NOT installed: - per manufacturer instructions, - in the correct location in system, - with correct flow, - with access for service and adjustment - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		
3.7 Evaporator pressure regulator	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - with access for service and adjustment, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing, and	 	- System diagram - Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions, - in the correct location in system, - with correct flow, - with access for service and adjustment, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing - brazed with incorrect alloy		

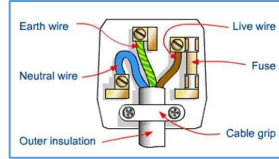
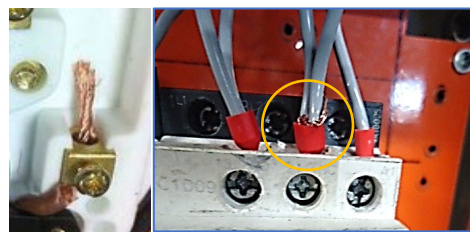
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.8 Solenoid valve	M	5	Yes	Performance meets industry standards. It is installed: - as per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - with the correct vertical mounting angle - wrapped in wet cloth before silver brazing		- System diagram - Manufacturers instructions
			No	Performance below industry standards. It is NOT installed: - as per manufacturer instructions - in the correct location in system, - with correct flow, - with the correct vertical mounting angle, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		
3.9 Ball valve	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - clear access for service operation, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing.		- System diagram - Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions, - in the correct location in system, - with correct flow, - with clear access for service operation, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.10 Check valve or non-return valve	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in system, - with correct refrigerant flow, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing.		- System diagram - Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions - in the correct location in system, - with correct flow, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		
3.11 Pressure relief valve	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in system, - with the correct vertical mounting angle, - with correct refrigerant flow, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing, and		- System diagram - Manufacturer's instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions, - in the correct location in system, - with correct flow, - with the correct vertical mounting angle, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		

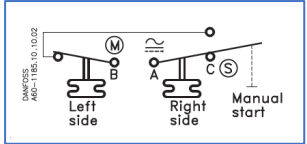
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.12 Liquid line filter dryer	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in the liquid line directly after the receiver and before any solenoid valve, sight glass and the expansion valve, - with correct refrigerant flow, - On a system with a liquid receiver, it can be any orientation (vertical or horizontal), - On a system without a liquid receiver, it must be installed with the outlet lower than its inlet, and - with dry nitrogen used during brazing.		- System diagram - Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions, - in the correct orientation or location in system, - with correct flow, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		
3.13 Sight glass	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location in the liquid line after the filter dryer and before the expansion valve, - with correct refrigerant flow, - wrapped in wet cloth before silver brazing, and - with dry nitrogen used during brazing.		- System diagram - Manufacturers instructions
			No	Performance below industry standards: It is NOT installed: - per manufacturer instructions, - in the correct location in system, - with correct flow, - wrapped in wet cloth before silver brazing, or - with dry nitrogen used during brazing. - brazed with incorrect alloy		

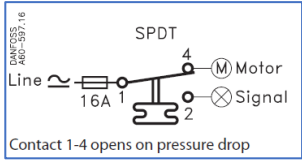
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.14 Suction line heat exchangers	M	5	Yes	Performance meets industry standards. It is installed: - per manufacturer instructions and: - in the correct location immediately following the evaporator, - with liquid & suction lines connected in counter flow, & - with dry nitrogen used during brazing,		- System diagram - Manufacturers instructions
			No	Performance below industry standards. it is NOT installed: - per manufacturer instructions, - in the correct location in system, - with liquid & suction lines connected in counter flow, or - with dry nitrogen used during brazing, - brazed with incorrect alloy		
3.15 Pressure control piping	M	5	Yes	Performance meets industry standards: The pressure control is piped: - per manufacturer instructions and: - Per project system diagram, - so that high-pressure safety control cannot be isolated, - so that high-pressure sensing point must be in the primary refrigerant flow circuit, and must always sense discharge pressure, - with access for service and adjustment, - so as not to trap oil in the connecting pipe work, - so that low-pressure sensing point must be installed in the primary refrigerant flow by flame brazing into the suction pipe work, and - if Schrader copper pipe fittings are used, they must not be inserted no more than 2mm into the pipe work.		- System diagram - Manufacturers instructions
			No	Performance below industry standards: The pressure control is NOT piped:		

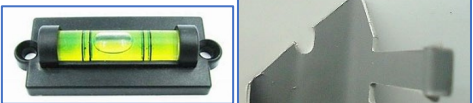
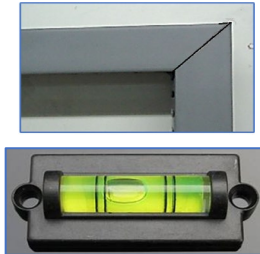
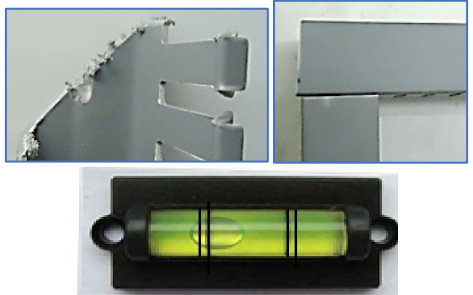
				• per manufacturer instructions, • per project system diagram, • into the correct location, or • with access for service and adjustment.		
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
3.16 Pressure gauge and its hand valve	M	5	Yes	Performance meets industry standards. They are installed • per manufacturer instructions and • in the correct location in system, • so that pressure sensing point must be in the primary refrigerant flow circuit, and must always sense pressure, • so as not to trap oil in the connecting pipe work, and • mounted securely.		• System diagram • Rule • Tape measure • Template • Manufacturer's installation instructions
			No	Performance below industry standards. They are NOT installed: • per manufacturer instructions, • in the correct location in system, • so that pressure sensing point must be in the primary refrigerant flow circuit, and must always sense pressure, or • mounted securely.		

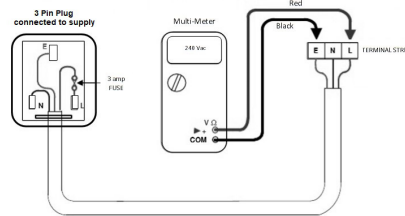
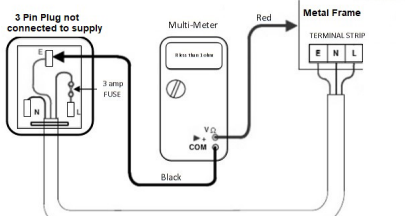
4. ELECTRICAL CABLE INSTALLATION						
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
4.1 Electrical supply plug	J	5	Yes	Performance meets industry standards: - The electrical supply is wired to the correct pins on the plug, - The stripped wires are securely fastened to the pins, with no exposed strands, and - The cable is securely fastened to the plug	 	- Manufacturer's installation instructions - Relevant Standard
			No	Performance below industry standards: - The electrical supply is NOT wired to the correct pins on the plug, - The stripped wires are NOT securely fastened to the pins, Major exposed strands, or - The cable is NOT securely fastened to the plug.	 	
4.2 Control board electrical supply	M	5	Yes	Performance meets industry standards: - The 220V supply is wired to the correct terminals, - The wiring is correctly and securely terminated, with no exposed strands, and - the cable is securely fastened.		Project circuit diagram
			No	Performance below industry standards: - The 220V supply is NOT wired to the correct terminals, - The wiring is NOT correctly and securely terminated, or - with major exposed strands.		

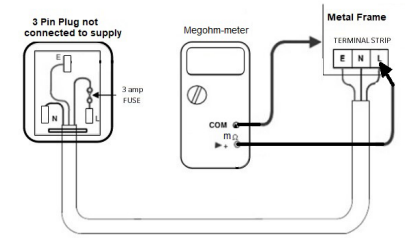
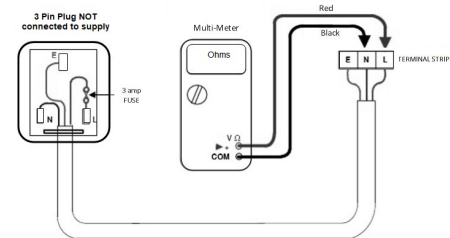
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
4.3 Compressor wiring	M	5	Yes	Performance meets industry standards: - The compressor is wired to correct terminals in control board and compressor starting kit, - The wiring is correctly and securely terminated - with no exposed strands, and - The cable is securely fastened.		- Project circuit diagram - Manufacturer's installation instructions
			No	Performance below industry standards: - The compressor is NOT wired to correct terminals in control board and compressor starting kit, - The wiring is NOT correctly and securely terminated, or - with major exposed strands.		
4.4 Condenser fan motor wiring	M	5	Yes	Performance meets industry standards: - The wiring is connected to the correct terminals of the motor and the control board, - The wiring is correctly and securely terminated - with no exposed strands, and - The cable is securely fastened.		- Project circuit diagram - Manufacturer's installation instructions
			No	Performance below industry standards: - The wiring is NOT wired to correct terminals of the motor and the control board, - The wiring is NOT correctly and securely terminated, - with major exposed strands, or - The cable is NOT securely fastened.		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
4.5 Solenoid valve	M	5	Yes	Performance meets industry standards: - The wiring is connected to the correct terminals of the valve coil and the control board, - The wiring is correctly and securely terminated, - with no exposed strands, and - The cable is securely fastened.		- Project circuit diagram - Manufacturer's installation instructions
			No	Performance below industry standards: - The wiring is NOT wired to correct terminals of the valve coil and the control board - The wiring is NOT correctly and securely terminated, or - with major exposed strands. - The cable is NOT securely fastened.		
4.6 Dual pressure control	M	5	Yes	Performance meets industry standards: - The wiring is connected to the correct terminals of the dual pressure control and the control board, - The wiring is correctly and securely terminated - with no exposed strands, and - The cable is securely fastened.	  	- Project circuit diagram - Manufacturer's installation instructions
			No	Performance below industry standards: - The wiring is NOT wired to correct terminals of the dual pressure control and the control board, - The wiring is NOT correctly and securely terminated, - With major exposed strands, or - The cable is NOT securely fastened.	 	

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
4.7 High pressure control	M	5	Yes	Performance meets industry standards: - The wiring is connected to the correct terminals of the high-pressure control and the control board, - The wiring is correctly and securely terminated with no exposed strands, and - The cable is securely fastened.	  	- Project circuit diagram - Manufacturer's installation instructions
			No	Performance below industry standards: - The compressor is NOT wired to correct terminals of the high-pressure control and the control board, - The wiring is NOT correctly and securely terminated, or - with major exposed strands.	 	

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
4.8 Cable duct (channel)	J	5	3	Performance meets industry standards and is judged as excellent: - The duct is installed securely vertically and horizontally with the spirit level bubble within the inner lines, - Cuts have a smooth finish without burrs, and - Corners are cut at 45° +/- 2°		- Project diagrams - Spirit level - Digital Sliding T-Bevel Gauge & Protractor 
			2	Performance meets industry standards and surpasses that standard to some extent: - The duct is installed securely vertically or horizontally with the spirit level bubble within the inner lines, - Cuts have a smooth finish without burrs, and - Corners are cut at 45° +/- 4°		
			1	Performance meets industry standards: - The duct is installed securely vertically or horizontally with the spirit level bubble within the outer lines, - Cuts have a smooth finish without burrs, and - Corners are cut at 45° +/- 4°		
			0	Performance below industry standards: - The duct is NOT installed securely vertically or horizontally with the spirit level bubble within the outer lines, - Cuts do NOT have a smooth finish without burrs, or - Corners are NOT cut at 45° +/- 4°		

5. ELECTRICAL TESTING AND FAULT FINDING						
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.1 Supply voltage to earth and/or neutral	M	5	Yes	Performance meets industry standards: • voltage was safely and accurately measured and records using a multi-meter, • selected appropriate voltage scale, • did not come in contact with supply voltage, and • did not trip the circuit breaker		• Voltmeter
			No	Performance below industry standards: • voltage was NOT safely and accurately measured and records using a multi-meter, • did not select appropriate voltage scale, • did come in contact with supply voltage, or • did trip the circuit breaker. • Did not use correct PPE.		
5.2 Earth continuity to control board and loads	M	5	Yes	Performance meets industry standards: • earth continuity of the power supply to the control board and loads was safely and accurately tested, recorded, less than 1 ohm, • isolated electrical supply • selected appropriate resistance scale, and • did not put fingers on the test probes during measurement		• Ohm-meter
			No	Performance below industry standards: • earth continuity of the power supply to the control board and loads was NOT safely and accurately tested, recorded, less than 1 ohm, • did not isolate electrical supply • did not select appropriate resistance scale, or • put fingers on the test probes during measurement		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.3 Earth leakage	M	6	Yes	Performance meets industry standards: • installation was safely and accurately tested and recorded for earth leakage using a Megohm-meter prior to energising, • the reading is at least 2 meg-ohm, • isolated electrical supply, • isolated and electronic components, • selected appropriate scale, and • did not put fingers on the test probes during measurement		• Megohm-meter
			No	Performance below industry standards: • installation was NOT safely and accurately tested and recorded for earth leakage using a Megohm-meter prior to energising • the reading is less than 2 meg-ohm • did not isolate electrical supply • did not isolate electronic components • did not select appropriate scale, and • put fingers on the test probes during measurement		
5.4 Short circuits	M	6	Yes	Performance meets industry standards: • installation was safely and accurately tested and recorded for shorts between active and neutral prior to energising and found to be at least 100 ohm, • isolated electrical supply, • selected appropriate resistance scale, and • did not put fingers on the test probes during measurement		• Ohm-meter
			No	Performance below industry standards: • installation was NOT safely and accurately tested and recorded for shorts between active and neutral prior to energising and found not to be at least 100 ohm, • did not isolate electrical supply, • did not select appropriate resistance scale, or		

				• put fingers on the test probes during measurement		
ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.5 Electrical resistance	M	6	Yes	Performance meets industry standards: • electrical resistance of a load component is safely and accurately measured and recorded, • isolated electrical supply, • selected appropriate resistance scale, and • did not put fingers on the test probes during measurement		• Ohm-meter
			No	Performance below industry standards: • electrical resistance of a load component is NOT safely and accurately measured and recorded, • did not isolate electrical supply, • did not select appropriate resistance scale, or • put fingers on the test probes during measurement		
5.6 Operating current	M	6	Yes	Performance meets industry standards: • operating current of a load component or circuit is safely and accurately measured and recorded, • selected appropriate amperage scale, • did not come in contact with supply voltage, and • did not trip the circuit breaker		• Tong-ammeter
			No	Performance below industry standards: • operating current of a load component or circuit is safely and accurately measured and recorded, • did come in contact with supply voltage, or • did trip the circuit breaker.		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.7 Electrical fault finding	M	6	3	Performance meets industry standards and is judged as excellent: • electrical circuit or component was safely tested for faults, and • electrical faults were identified within half of the maximum time permitted		• Multi-meter • Circui diagram
			2	Performance meets industry standards and surpasses that standard to some extent: • electrical circuit or component was safely tested for faults, and • electrical faults were identified within $\frac{3}{4}$ of the maximum time permitted		
			1	Performance meets industry standards: • electrical circuit or component was safely tested for faults, and • electrical faults were identified within the maximum time permitted		
			0	Performance below industry standards: • electrical circuit or component was NOT safely tested for faults, or • electrical faults were NOT identified		

5.8 Electrical fault repair						
			2	Performance meets industry standards and surpasses that standard to some extent: • electrical faulty circuit or component was safely repaired/replaced, and • electrical fault was rectified within half of the maximum time permitted		
			1	Performance meets industry standards: • electrical faulty circuit or component was safely repaired/replaced, and • electrical fault was rectified within half of the maximum time permitted		
			0	Performance below industry standards: • electrical faulty circuit or component was NOT safely repaired/replaced, or • electrical fault was NOT rectified within half of the maximum time permitted		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.9 Energising circuit	M	6	Yes	Performance meets industry standards: • circuit was energised safely the first time without blowing fuses/circuit breakers/etc, and • used appropriate PPE correctly		• Circuit breaker
			No	Performance below industry standards: • circuit was NOT energised safely the first time or it blew fuses/circuit breakers/etc, or • did not used appropriate PPE correctly		
5.10 Circuit's first operation	M	6	Yes	Performance meets industry standards: • circuit worked safely and correctly per circuit diagram the first time it was operated without wiring modifications, and • did not trip the circuit breaker • used appropriate PPE correctly		• Circuit diagram
			No	Performance below industry standards: • circuit did NOT work safely and correctly per circuit diagram the first time it was operated without wiring modifications, and • tripped the circuit breaker • did not used appropriate PPE correctly		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
5.11 Circuit's final operation	M	6	Yes	Performance meets industry standards: • circuit worked safely and correctly per circuit diagram after any necessary, if any modifications were completed, and • did not trip the circuit breaker • used appropriate PPE correctly		• Circuit diagram
			No	Performance below industry standards: • circuit did NOT work safely and correctly per circuit diagram after any necessary, if any modifications were completed, and • tripped the circuit breaker • did not used appropriate PPE correctly		

6. PRESSURE TESTING

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
6.1 Test Pressure	M	3	Yes	Performance meets industry standards: - The test pressure during all attempts met required standards and specifications, - Test pressure is equivalent to not less than 55°C saturation temperature and no more than 10% higher for the high-pressure side, if the high side can be isolated. - Test pressure is equivalent to not less than 32°C saturation temperature and no more than 10% higher for the low-pressure side		- Refrigerant type - Pressure /Temperature Chart
			No	Performance below industry standards: - The test pressure during all attempts does NOT meet required standards and specifications, - Test pressure is NOT equivalent to less than 55°C saturation temperature or over 10% higher for the high-pressure side, if the high side can be isolated. - Test pressure is NOT equivalent to less than 32°C saturation temperature or more than 10% higher for the low-pressure side		
6.2 System valves open	M	4	Yes	Performance meets industry standards: - All the appropriate valves were opened to ensure pressure testing of the entire system - These include service valves, solenoid valves, line valves, etc.		- Manifold gauges - System piping diagram
			No	Performance below industry standards: All the appropriate valves were NOT opened to ensure pressure testing of the entire system		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
6.3 Gauges fitted	M	4	Yes	Performance meets industry standards: • The gauges manifold and gauge lines correctly fitted to both sides of the system, if possible • The high-pressure gauge is connected to the high-pressure side of the system • The low-pressure gauge is connected to the low-pressure side of the system. • With services valves open to the system		• System piping diagram • Manifold gauges
			No	Performance below industry standards: • The gauges manifold and gauge lines NOT correctly fitted to both sides of the system, if possible • The high-pressure gauge is NOT connected to the high-pressure side of the system • The low-pressure gauge is NOT connected to the low-pressure side of the system • With services valves open to the system		
6.4 Dry Nitrogen added for pressure testing	M	4	Yes	Performance meets industry standards: • Dry Nitrogen was safely added to the system to the required test pressure in stages of approx. 50%, 75% and 100% • System was checked for leaks at each stage • Excessive pressure was not added to the system • No connecting hoses or fittings leaked		• Manifold gauges • Oxygen free nitrogen • System test pressure per Test Project requirements
			No	Performance below industry standards: • Dry Nitrogen was NOT safely added to the system to the required test pressure in stages of approx. 50%, 75% and 100% • System was NOT checked for leaks at each stage • Excessive pressure was added to the system • Connecting hoses or fittings leaked		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
6.5 Leak test	M	4	Yes	Performance meets industry standards: - the system was leak tested while under the required pressure using soap/water solution - location of all leaks were identified		Soup/water solution or leak test fluid
			No	Performance below industry standards: - the system was NOT leak tested or under the required test pressure using soap/water solution - location of all leaks were NOT identified		
6.6 First leak test	M	4	Yes	Performance meets industry standards: - There were No leaks were detected on FIRST pressure test - System pressure did not drop equivalent of 1K over a given period of time		Soup/water solution or leak test fluid
			No	Performance below industry standards: - There were leaks detected on FIRST pressure test - System pressure dropped equivalent of 1K over a given period of time		
6.8 Final leak test	M	4	Yes	Performance meets industry standards: - The system held the test pressure for required standing time (15 minutes) after any leaks were repaired - Test pressure did NOT drop more than equivalent of 1°C from the starting point in the fifteen (15) minutes after the system is isolated from the Nitrogen cylinder.	Example, 55°C saturation temperature on R134a = 1,390 kPa or 202 PSI 54°C saturation temperature on R134a = 1,354 kPa or 196 PSI - Therefore the pressure must no drop more than 1,390 kPa - 1,354 kPa = 36 kPa, - or 202 PSI - 196 PSI = 6PSI	- Soup/water solution or leak test fluid - Clock or stop watch
			No	Performance below industry standards:		

				• The system did NOT hold the test pressure for required standing time (15 minutes) after any leaks were repaired • Test pressure dropped more than equivalent of 1°C from the starting point in the fifteen (15) minutes after the system is isolated from the Nitrogen cylinder.		
6.9 Pressure release	M	4	Yes	Performance meets industry standards: • Dry Nitrogen was slowly and safely released from system at completion of pressure test • No gauge hoses swung around or excessive noise generated by the release of the Nitrogen		• Manifold gauges
			No	Performance below industry standards: • Dry Nitrogen did NOT slowly and safely release from system at completion of pressure test • Gauge hoses swung around or excessive noise generated by the release of the Nitrogen		

7. EVACUATION

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
7.1 System valves open	M	4	Yes	Performance meets industry standards: - All the appropriate valves were opened to ensure evacuation of the entire system - These include service valves, solenoid valves, line valves, etc.		- System piping diagram - Manifold gauges
			No	Performance below industry standards: All the appropriate valves were NOT opened to ensure evacuation of the entire system		
7.2 Vacuum pump and vacuum gauges connection	M	4	Yes	Performance meets industry standards: Vacuum pump and vacuum gauges were connected to the system correctly	Vacuum gauge must be installed so it could be isolated from the vacuum pump and still measure the system's pressure	- System piping diagram - Manifold gauges
			No	Performance below industry standards: Vacuum pump and vacuum gauges were NOT connected to the system correctly		
7.3 Vacuum pressure, first attempt	M	4	Yes	Performance meets industry standards: system reached the required vacuum level of at least 1000 microns on the first attempt		- Manifold gauges - Vacuum gauge
			No	Performance below industry standards: system did NOT reach the required vacuum level of at least 1000 microns on the first attempt		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
7.4 Vacuum holding pressure, first attempt	M	4	Yes	Performance meets industry standards: • system reached vacuum of at least 1000 microns and it did not rise to more than 1500 microns in 10 minutes when isolated from the vacuum pump, after the FIRST attempt		• Vacuum gauge • Manifold gauges • Clock or stop watch
			No	Performance below industry standards: • system did not achieve a vacuum of at least 1000 microns or it rose to more than 1500 microns in 10 minutes when isolated from the vacuum pump, after the FIRST attempt		
7.5 Final vacuum holding pressure	M	4	Yes	Performance meets industry standards: • system reached vacuum of at least 1000 microns and did not rise to above 1500 microns in 10 minutes when isolated from the vacuum pump, on the final attempt		• Vacuum gauge • Manifold gauges • Clock or stop watch
			No	Performance below industry standards: • system did NOT reach vacuum of at least 1000 microns or it rose to more than 1500 microns in 10 minutes when isolated from the vacuum pump, on the final attempt		

8. REFRIGERANT CHARGING

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
8.1 Gauge manifold connection	M	5	Yes	Performance meets industry standards: - gauge manifold was connected to both the high and low side access valves of the refrigeration system and refrigerant cylinder to charge the system with refrigerant - The gauge manifold and hoses must be evacuated not purged with refrigerant to remove the air where service valves are present. - The gauge manifold and hoses can be purged with vapour refrigerant to remove the air where service valves are NOT present.		- System piping diagram - Manifold gauges
			No	Performance below industry standards: - gauge manifold was NOT connected to both the high and low side access valves of the refrigeration system and refrigerant cylinder to charge the system with refrigerant - The gauge manifold and hoses were not evacuated to remove the air where service valves are present. - The gauge manifold and hoses can be purged with liquid refrigerant to remove the air where service valves are NOT present.		
8.2 Refrigerant cylinder weight	M	6	Yes	Performance meets industry standards: refrigerant cylinder weight was accurately measured and recorded correctly before charging started		- Manifold gauges - Refrigerant scale
			No	Performance below industry standards: refrigerant cylinder weight was NOT accurately measured and recorded correctly before charging started		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
8.3 Refrigeration system's valves	M	5	Yes	Performance meets industry standards: all refrigeration system's access and line valves were in correct position to charge the system with refrigerant		- System piping diagram - Manifold gauges
			No	Performance below industry standards: all refrigeration system's access and line valves were NOT in correct position to charge the system with refrigerant		
8.4 Adding liquid refrigerant	M	5	Yes	Performance meets industry standards: - liquid refrigerant was added to the liquid line only, or - liquid refrigerant is slowly added to the suction line to ensure it flashes of to a vapour, and - liquid refrigerant was added to the system using correct method with no or minimal loss of refrigerant to the atmosphere		Manifold gauges
			No	Performance below industry standards: - liquid refrigerant was not added to the liquid line only, or - liquid refrigerant was not slowly added to the suction line to ensure it flashes of to a vapour, and - liquid refrigerant was not added with no or minimal loss of refrigerant to the atmosphere		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
8.5 Adding vapour refrigerant	M	5	Yes	Performance meets industry standards: vapour of non-blend refrigerant was added to the system using correct method with no or minimal loss of refrigerant to the atmosphere		- Manifold gauges - Refrigerant scale
			No	Performance below industry standards: vapour of non-blend refrigerant was NOT added to the system using correct method or with loss of refrigerant to the atmosphere		
8.6 Final refrigerant quantity	M	5	Yes	Performance meets industry standards: - adequate refrigerant was added to the system to ensure its effective operation - total refrigerant quantity charged into system is as specified, +/- 2%		- Manifold gauges - Refrigerant scale
			No	Performance below industry standards: - Adequate refrigerant was NOT added to the system to ensure its effective operation - total refrigerant quantity charged into system was not as specified, +/- 2%		
8.7 Service gauge removal	M	5	Yes	Performance meets industry standards: - services gauges were removed from the system and the bottle after pumping down the system to reduce the pressure to 0-10kpa to ensure minimal loss of refrigerant, or - where service valves are present, back seat high side service valve, close cylinder valves and bleed high pressure back into suction to reduce pressure.		Manifold gauges
			No	Performance below industry standards: services gauges were NOT removed from the system and the bottle with no avoidable loss of refrigerant		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
8.8 Leak test	M	5	Yes	Performance meets industry standards: • electronic leak test was carried out during and after the charging of refrigerant and all leaks rectified		• Soup/water solution or leak test fluid • Electronic leak detector
			No	Performance below industry standards: • An electronic leak test was NOT carried out during and after the charging of refrigerant or leaks not rectified.		

9. COMMISSIONING AND FAULT FINDING

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
9.1 Refrigerant type	M	5	Yes	Performance meets industry standards: • refrigerant type was recorded correctly on the commissioning report		• System specifications
			No	Performance below industry standards: • refrigerant type was NOT recorded correctly on the commissioning report		
9.2 Refrigerant charge	M	5	Yes	Performance meets industry standards: • refrigerant charge was measured and recorded correctly on the commissioning report, +/- 2%		• System specifications
			No	Performance below industry standards: • refrigerant charge was NOT measured and recorded correctly on the commissioning report, +/- 2%		
9.3 Operating Temperatures	M	5	Yes	Performance meets industry standards: • dry bulb temperatures were measured and recorded correctly on commissioning report, +/- 1K		• Digital thermometer
			No	Performance below industry standards: • dry bulb temperature was NOT measured and recorded correctly on commissioning report, +/- 1K		
9.4 Operating pressures	M	5	Yes	Performance meets industry standards: • operating pressures was measured and recorded correctly on the commissioning report, +/- 5%		• Pressure gauges
			No	Performance below industry standards: • suction pressure was NOT measured and recorded correctly on the commissioning report, +/- 5%		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
9.5 Superheat	M	5	Yes	Performance meets industry standards: • superheat was determined and recorded correctly on the commissioning report, +/- 1K		- Digital thermometer - Pressure gauges
			No	Performance below industry standards: • superheat was NOT determined and recorded correctly on the commissioning report, +/- 1K		
9.6 Operating current	M	5	Yes	Performance meets industry standards: • operating current was measured and recorded correctly on the commissioning report, +/- 5%		Tong ammeter
			No	Performance below industry standards: • operating current was NOT measured and recorded correctly on the commissioning report, +/- 5%.		
9.7 Motor contactor overload setting	M	5	Yes	Performance meets industry standards: • motor contactor overload setting was determined, set and recorded correctly on the commissioning report, +/- 5%		Motor Full Load Amperage rating
			No	Performance below industry standards: motor contactor overload setting was determined set and recorded correctly on the commissioning report, +/- 5%		
9.8 Temperature control settings	M	5	Yes	Performance meets industry standards: • temperature control setting was determined, set and recorded correctly on the commissioning report, per the module specifications		System specifications
			No	Performance below industry standards: • temperature control setting was NOT determined, set and recorded correctly on the commissioning report, per the module specifications		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
9.9 Pressure control settings	M	5	Yes	Performance meets industry standards: pressure control settings were determined correctly, set and recorded correctly on the commissioning report, per the module specifications +/- 1K		System specifications
			No	Performance below industry standards: pressure control settings were NOT determined, set and recorded correctly on the commissioning report, per the module specifications +/- 1K		
9.10 Fitting service gauges to charged system	M	6	Yes	Performance meets industry standards: - gauge lines were connected to the correct service valves on the system, - where possible air was removed from the gauge lines and gauge manifold using a vacuum pump before the service valves were open to the gauges, and - Gauges lines and gauge manifold were leak tested.		Services gauges
			No	Performance below industry standards: - gauge lines were NOT connected to the correct service valves on the system, - when possible, air was NOT removed from the gauge lines and gauge manifold using a vacuum pump before the service valves were open to the gauges, or - Gauges lines and gauge manifold were NOT leak tested.		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	• ASSESSMENT TOOLS
9.11 Refrigeration fault finding	M	6	3	Performance meets industry standards and is judged as excellent: - refrigeration system or component was safely tested for faults - faults were identified within half of the maximum time permitted		System specifications and drawings
			2	Performance meets industry standards and surpasses that standard to some extent: - refrigeration system or component was safely tested for faults - faults were identified $\frac{3}{4}$ of the maximum time permitted		
			1	Performance meets industry standards: - refrigeration system or component was safely tested for faults - faults were identified within the maximum time permitted		
			0	Performance below industry standards: - refrigeration system or component was NOT safely tested for faults - faults were NOT identified		
9.12 Refrigeration fault repair	M	6	3	Performance meets industry standards and is judged as excellent: - refrigeration fault or component was safely repaired/replaced, and - refrigeration fault was rectified within half of the maximum time permitted		

			2	Performance meets industry standards and surpasses that standard to some extent: • refrigeration fault or component was safely repaired/replaced, and • refrigeration fault was rectified within half of the maximum time permitted		
			1	Performance meets industry standards: • refrigeration fault or component was safely repaired/replaced, and • refrigeration fault was rectified within half of the maximum time permitted		
			0	Performance below industry standards: • refrigeration fault or component was NOT safely repaired/replaced, or • refrigeration fault was NOT rectified within half of the maximum time permitted		

10. REFRIGERANT RECOVERY

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
10.1 Refrigerant cylinder selection	M	6	Yes	Performance meets industry standards: • correct refrigerant recovery cylinder was selected and used		
			No	Performance below industry standards: • correct refrigerant recovery cylinder was NOT selected and used		
10.2 Refrigerant cylinder weight	M	6	Yes	Performance meets industry standards: • refrigerant recovery cylinder was weighed and recorded correctly before recovery started		• Electronic scales
			No	Performance below industry standards: • refrigerant recovery cylinder was NOT weighed and recorded correctly before recovery started		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
10.3 Recovery system connections	M	6	Yes	Performance meets industry standards: refrigerant recovery cylinder, machine and lines were connected correctly the first time with minimal loss of refrigerant		Refrigerant recovery unit and cylinder
			No	Performance below industry standards: refrigerant recovery cylinder, machine and lines were NOT connected correctly the first time with minimal loss of refrigerant		
10.4 Refrigerant recovery	M	6	Yes	Performance meets industry standards: - the full refrigerant charge was recovered from the system using recovery equipment - system pressure/s were at atmospheric pressure or just below (0psi to -5psi/0Kpa to -35kPa) after recovery was completed		Refrigerant recovery unit and cylinder
			No	Performance below industry standards: - the full refrigerant charge was NOT recovered from the system using recovery equipment - system pressure/s were NOT at atmospheric pressure or just below (0psi to -5psi/0Kpa to -35kPa) after recovery was completed		
10.5 Refrigerant leak test	M	6	Yes	Performance meets industry standards: electronic leak detector was used to check for leaks during recovery of refrigerant		- Electronic leak detector - Soap water solution
			No	Performance below industry standards: electronic leak detector was NOT used to check for leaks during recovery of refrigerant		

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	• ASSESSMENT TOOLS
10.6 Disconnection of recovery equipment	M	6	Yes	Performance meets industry standards: • recovery equipment was disconnected with minimal loss of refrigerant and all service caps fitted		
			No	Performance below industry standards: • recovery equipment was NOT disconnected with minimal loss of refrigerant and all service caps were NOT fitted		
10.7 Recovered refrigerant quantity	M	6	Yes	Performance meets industry standards: • quantity of refrigerant recovered from the system was correctly recorded		
			No	Performance below industry standards: • quantity of refrigerant recovered from the system was NOT correctly recorded		

11. WORK PRACTICES AND SAFETY

ASPECT	ASPECT TYPE	WSOS section as per TD	SCORE	DESCRIPTOR	RESOURCE	ASSESSMENT TOOLS
11.1 Protective gloves	M	1		Number of times protective gloves were NOT worn and arms were NOT covered when exposed to heat sources		Competitors Work Practices and Safety record form
11.2 Protective eye wear	M	1		Number of times protective eye wear was NOT worn while brazing		
11.3 Tools and safe work practices	M	1		Number of times the competitor did NOT use the correct tools and safe work practices		
11.4 Brazing torches and regulators	M	1		Number of times the competitor's brazing torches and regulators were NOT left at atmospheric pressure during non-competition times		
11.5 Tool and equipment safety	M	1		The competitor's tools and equipment were in a safe condition on completion of module		