

Standards and Assessment Guide

Plumbing and Heating

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, 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.

Key Components

The guide is structured into several key components, each addressing critical aspects of the assessment process:

Assessment Principles and Objectives

- Emphasis on fairness, transparency, and objectivity in assessments.
- Alignment with global industry standards and best practices.

Assessment Methods and Tools

- Description of various assessment methods in Measurement and Judgement.
 - Guidance on the application of appropriate assessment tools and equipment (if applicable).

Criteria and Benchmarks

- Examples of assessment criteria and aspects for each skill, outlining the expected competencies and performance standards.
- Benchmarks for different levels of proficiency i.e. Judgement award range 0, 1, 2, 3 or Yes/No criteria alongside clear measurable descriptors.

Expert assessment requirements

- Completion of the Access Programme.
- Approved Curriculum Vitae (CV).
- Reaching **100%** Expert preparedness.
- Full participation of online and in-person Mandatory Assessment Training (MAT).
- Completion of practical assessment testing at the Competition.

Quality Assurance and Improvement

- Monitoring and evaluation: Ensuring assessments are carried out correctly and produce reliable results.
- Continuous improvement: Using feedback from Experts and Skill Competition Managers to enhance future assessments.
- Periodic review: Regularly updating processes to reflect current industry and WorldSkills standards.

Implementation

For effective implementation, this guide should be used for guidance purposes only and in parallel with the Technical Description for each skill. Experts are encouraged to familiarize themselves thoroughly with both the general guidelines and the particular requirements of their respective skill areas. Collaborative efforts between the Skill Management Team, Experts, and Competitors are vital for achieving the ultimate goal of global skills development.

Conclusion

The Standards and Assessment Guide embodies the commitment of the WorldSkills movement to nurturing talent and promoting the highest standards of vocational education and training worldwide. By providing clear and comprehensive guidance, we aim to empower Experts to conduct marking and assessment practices that are not only rigorous and equitable but also inspiring and transformative for all participants.

Thank you for your dedication to upholding these standards and contributing to the success of the WorldSkills Competition. Together, we can continue to champion skills excellence and celebrate the achievements of talented individuals from around the globe.

Skill 15 – Plumbing and Heating

Measurement

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

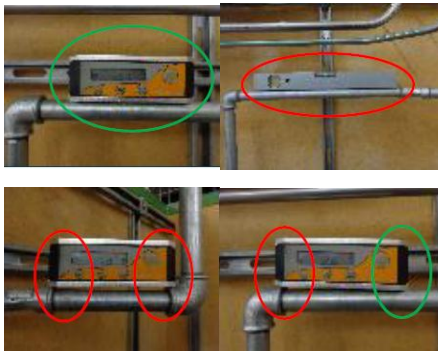
The total marks allocated to measurement marking may vary from competition to competition depending on the Test Project.

Not all the criteria will be used in the test project. This document is a library of criterion used for assessment and will be selected as appropriate for a specific test project.

The Competitor is **NOT** allowed access to this document in the competition area (see Competition Rules)

Aspect	WSOS section as per TD	Notes	Question	Descriptor Aspect	Points/marks
1.1 Dimension	04		Is the dimension correct and as specified on the drawing or test project specification, within tolerances allowed?	Dimension +/- 2 mm incl.	Full marks
				Dimension 2.01 to - 4 mm incl.	Half marks
				Dimension above 4 mm	Zero marks

1.2 Pressure test	05	Hot water, cold water, gas and heating pipes will be air tested to 200 kPa (2 bar) for 2 minutes. The pressure gauge used for pressure testing will have a full-scale deflection of 2 bar. - Valves to be left open when completed. - Pressure test is only able to be verifies if the section of pipe is complete. E.g. Hot or Cold section individually. All pressure testing must be completed in the competition time and witnessed by the Official team responsible for testing. Competitors can test on their own at any time and rectify faults prior to asking for the Official test - After a module has been completed and the pressure test has been finished, competitors may still adjust the dimensions, level, or plumb of the pipework	- Do the pipe/pipes systems have no leak. - A manufacturing fault of component supplied is not included. In the event of no spare component to replace faulty component competitor receives Pass mark.	Pass	Full marks
				Fail	Zero marks
			Did the Competitor open all the necessary valves to enable a full check of the pipework system to be carried out correctly?	Yes	Full marks
			(Any valves that are to be closed will be specified in test project document)	No	Zero marks
1.3 Bends and angles	04	All pipe bends are to be made with a proprietary tool. (pipe bender) There is to be NO free bending of tube.	Are machine bends made in angles 90°, 60°, 45°, 30° (if not given by the task) or by the given angle of the task? All pipe bends are to be made with	Angle 0° up to 1°	Full marks
				Angle more than 1° and up to 1.9°	Half marks

			a proprietary tool. (pipe bender, spring, pipe insert). All free bending will be marked as outside tolerance – Zero Marks not attempted.		
				Above 2°. All bends to be made using a proprietary bending tool. If bends made free without tool will be – zero marks	Zero Marks
1.4 Plumb and level	04	 Only a digital level will be used for plumb, level and gradients assessments. Plumb, level and gradients are always to taken on a straight piece of pipe.	Is the plumb, level or gradient as requested and within tolerance?	Gradient 0° up to 0.5°	Full marks
			ASSESSED WITH OWN LEVEL	Gradient above 0.6° and less than 1.0°	Half marks

				Gradient Above 1.0°	Zero Marks
1.5 Health and Safety: Googles and Safety glasses	01	- The competitor should wear safety glass at all times (or personal glasses meeting safety requirements) when carrying out a work activity. They should be in front of the eyes at all times except for cleaning. (not above eyes or on head). No warnings to be given. - The Cleaning of goggles and safety glasses, Competitor can clean the goggles and safety glasses at any time. Cleaning inside the Work Place means that the Competitor is not carrying out any other activity at the same time. Cleaning should take no more than 1min max. Experts on safety watch must list infringements and it must be by the specified experts assigned to the task of observing safety. Experts assigned can stop competitor working until safe work can resume	Each day: Has the Competitor worn the correct goggles and/or safety glasses correctly?	Yes	Full marks
				No	Zero marks
1.6 Health and Safety: Long sleeve	01	- No warning - Experts on safety watch must list infringements and it must be by the specified experts assigned to the task of observing safety. - Experts observing can step in and instruct competitor to wear long sleeves, to continue work. Experts assigned can stop competitor working until safe work can resume	Over each day: Has the Competitor worn the requested long sleeves when carrying out hot work?	Yes	Full marks
				No	Zero marks

1.7 Material Usage: additional material	01, 02	- Where a competitor requires more complete the project pipe it should be issued. - This may well be assessed by Module or by the overall project, this will be specified in the project brief. The minimum pipe that can be allocated is 1metre. All quantities thereafter are by 1metre units,	Does Competitor <u>NOT</u> require any more pipe?	YES	Full marks
			Marks reduced for more pipe.	1 m –2 m for Module	Zero marks
			Did the Competitor <u>NOT</u> need any additional Fittings?	YES	Full marks
			Marks reduce for extra fittings.	1 - 2 fittings for Module	Half marks
			Fittings will only be issued if sufficient stock. The IL has allowed 2 straight couplings per competitor.	More than 2 for Module	Zero marks

1.8 Handling: Steel pipes	04	 Normal holding (Green) with no slipping damage (Red) through a pipe vice or incorrect tool adjustment. Should only be 1 holding position with a pipe grip which is not included in this section unless pipe grip slips. Pipes which to have been changed by a special task are not allowed to be checked in this section as these may have two grip marks. Sometimes pipe gets damaged in transit these marks should be identified prior to the start of work when materials are issued. Transit marks are usually very different from the marks we are assessing, 	Is there no damage to the pipe?	Yes	Full marks
			Yes, no damage Full Marks Should only be 1 holding position with a pipe grip which is not included in this section unless pipe grip slips	No	Zero marks

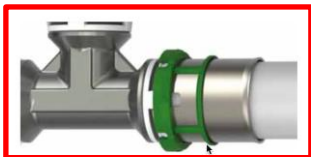
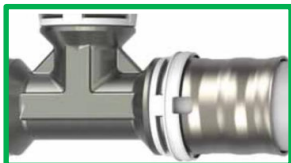
1.9 Handling: fittings and components	04	Valves components that have a polished finish, such as the chrome valves under the sinks. Or shower parts etc. Fittings, which have to be changed by a special task, are not allowed to be checked in this section	Is there no damage to the Fitting Chrome / galvanizing No damage full marks (yes)	Yes	Full marks
				No	Zero marks
1.10 Handling: fittings and valves with hexagonal faces	04	 Green OK  Red = Damaged by grips or spanner slipping	Is there no damage to the fittings/valves with hexagonal faces installed? Yes, no damage full Marks On hexagonal faces of a fitting has a spanner been used? leaving no marks or a pipe grip marks by use of incorrect tool or slipping marks due to incorrectly adjusted spanner leaving marks on the fitting. Observed from 0.5 m when assessed.	Yes	Full marks
				No	Zero marks

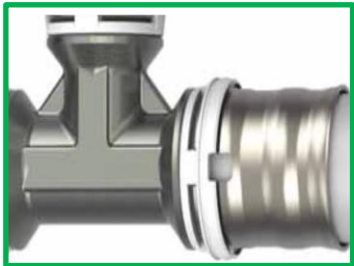
1.11 Excessive Thread sealant on manufacturers threads.	04	- The Expert could easily take away some sealant by hand and without tools. - Do not use fingernails to scratch at the sealant use only the skin pads of fingers to remove sealant. 	Is the thread sealant NOT excessive?	Yes	Full Marks
			Observed from 0.5 m when assessed.	No	Zero Marks
1.12 Handling: Sanitary Appliance	04	It is competitors' responsibility to check goods before start of competition	Are the sanitary appliances free from damage through the installation process?	Yes	Full marks
				No	Zero marks
1.13 Cleanliness: Cleanliness on the walls	02	- There should be no burning of the walls when soldering, - Workspace should be checked for marks and holes etc before starting work. Any found will be noted and marked by CE.			
			There are no burn marks on the walls.	Yes	Full marks

		• Constructions line on the wall are allowed as in industry		No	Zero marks
			There are no incorrect holes visible which are made by the competitor on the walls.	Yes	Full marks
				No	Zero marks
			On the workstation floor is there no pipe waste or debris. (work area to be left in a clean safe condition)? Yes = Clean Full Marks	Yes	Full marks
			All pipe offcuts to be close to the wall all tools stored away to prevent theft etc. Observed from outside the competitor work station	No	Zero marks

1.14 Cleanliness: Floor	02	Checked when the Competitor goes to the lunch/break and/or when they leave the workplace after the competition time in the evening.	Is the valve/pump installed in the correct flow direction?	Yes	Full marks
				No	Zero marks
1.15 All Valves/Pumps	04		Has the joint been properly prepared? i.e. – pipe cut square, deburred before flaring with no defective outside edge or lipping visible after flaring.	Yes	Full Marks
				No	Zero Marks
1.16 Flared Joints on copper pipe	04	 OK Flared Correctly	Has the flare been made to the correct size of pipe? Should not be under or over sized	Yes	Full Marks

		 Over Flared  Lip on outside edge of flare, not deburred  Damage to outside edge of flare over deburred.  Wrong flare size selection for pipe and not deburred Lines on pipe caused by flaring tool not included in this assessment		No	Zero Marks
			Is the fitting pressed correctly, with: A depth line on the pipe Pressed at right angles to the pipe, so no damage and correct pattern. Competitor MUST leave these production marks on the pipe and fitting	Yes	Full Marks
				No	Zero Marks

1.17 Pressed Fittings Copper pipe	04	  	Has the fitting been crimped correctly with correct press head used to give correct pattern. With visual control ring removed. (Pipe visible in inspection window not checked on this aspect)	Yes	Full Marks
				No	Zero Marks
1.18 Pressed Fittings Composite pipes	04	 NO  Yes	Has the pipe been cut straight and inserted to correct depth to be visible in all inspection windows of the fitting?	Yes	Full Marks
				No	Zero Marks
	04			Yes	Full marks

1.19 Pressed Fittings Composite pipes		 Yes, pipe Visible in inspection hole.	Is the Module complete and as per the drawing in allocated time shown on competitor timetable? If the competitor goes past their timetabled end time for the module and still working on the module Zero Marks.	No	Zero marks
1.20 Completion in allocated time AS PER DRAWING	01, 05	“As per the drawing” means: • It must have all the complexity in the task (bends etc.) and all the required features of the drawing. We are not checking dimensions, plumb level etc. • If there were supplement materials needed such as a connection etc. used to make some corrections, this Material is not a part of this assessment part. Where pipes terminate at floor level or top of workstation, they should be within 10 mm max.	Is the pipe fully inserted?	Dimension +/- 2 mm incl. More than 2mm	Full marks  No marks

					
1.21 Plug-in depth of electro fusion coupling	04	Please note: there is a 3 mm slip ring in the centre; this can be pulled out when drilling out	Are all pipe diameters as per drawing?	Yes	Full marks
				No	Zero marks
1.22 Project completion as requested: Pipe Diameter	05		Does the installation meet the specification of the manufacturer?	Yes	Full marks
				No	Zero marks
	03		The assessment will be objective based on a	Yes	Full Marks

1.23 Design: freestyle part of module		Where required, is the fixture installed as the manufacturer required.	number of aspects in the manufacturer's instructions that are possible to observe. It is not possible to include all the steps in this document as will guide competitor too much and will vary on equipment provided. But criterion will be clear in the CIS for the assessors.	No	Zero Marks
1.24 Manufacturer Module	01 06	Where the manufacturer has supplied equipment for a task the process in the manufacturer's instructions will form the assessment criterion. (This may vary from competition to competition and equipment supplied by manufacturer's)	Is the pipe fully engaged	Yes	Full marks
				No	Zero marks
1.25 WASTE PIPE: Push fit	05	Engagement: These criteria will be checked by cutting or drilling into an elbow or a tee After all other assessment.	It the rubber ring installed	Yes	Full marks
				No	Zero marks

1.26 WASTE PIPE: Push fit	05	Rubber ring: These criterions will be checked by cutting or drilling into an elbow or a tee After all other assessment.	Is the inserted end prepared correctly (chamfered)	Yes	Full marks
				No	Zero marks
1.27 WASTE PIPE: Push fit	05	Chamfer: These criterions will be checked by cutting or drilling into an elbow or a tee After all other assessment.			

Judgement

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 section in the table below is for all kind of resources: a link to a YouTube video or a website, a picture, a reference to a book, etc. It needs to be as detailed as possible.

Generic rules:

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

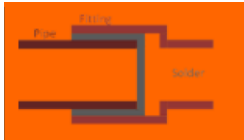
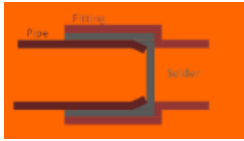
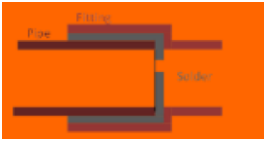
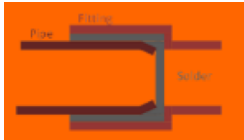
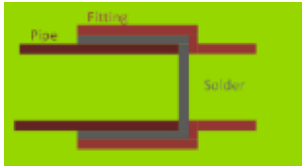
The deviation of the three Experts may not exceed ONE mark: As long as the three Experts judge within 1 mark, the result can be determined for entering into CIS tablet. If Experts have a larger deviation than 1, there must be brief discussion referenced to the descriptors, and a new vote.

Aspect – 2.1 SOLDERING: Copper, soft soldering outside

WSOS section as per TD	Points	Descriptor	Resource
04	0	- Solder is not visible all the way around the pipe/fitting - and/or too much solder is visible or there are more than 1 drop. - And/or the pipe and/or the fitting are not free of all soldering flux. (Small black dots are not flux; it is flux if you can clearly see that it has not been cleaned and the flux corrodes and eats away at the copper over time)	
	1	- Ø15-22 mm: more than 1 starting point is visible, or Ø28-35 mm: more than 2 starting points are visible, or the solder has run around the fitting during soldering - And 1 drop of solder is on the pipe and/or fitting. (Note: The flat starting point can be on either the pipe or the fitting! This is not a defect.)	
	2	- Ø15-22 mm only 1 starting point is visible or Ø28-35 mm only 2 starting points are visible or solder has run around the fitting during soldering - Or 1 drop of solder is on the pipe/fitting (Note: The flat starting point can be on either the pipe or the fitting! This is not a defect.)	
	3	None of the previously described defects are present Attention: 15-22 mm: only 1 flat start point is allowed 28-35 mm: 2 flat start points are allowed It is not allowed to be going around the fitting with the solder when soldering (Loading)	

Aspect 2.2 SOLDERING: Copper, soft soldering inside

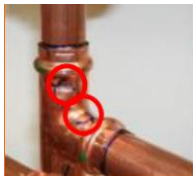
These criteria will be checked by cutting or drilling into an elbow or a tee After all other assessment.
It is also possible to check this position by endoscope/camera but is not recommended.

WSOS section as per TD	Points	Descriptor	Resource
04	0	The pipe is not completely inserted into the fitting	
	1	- The pipe end is not deburred. - And the solder is not visible all the way around the pipe and fitting.	 
	2	- The pipe end is not deburred. <u>Or</u> Inside of the Pipe/Fitting is not all around the pipe end solder visible.	 
	3	None of the previously described defects are present.	

Aspect 2.3 MACHINE BENDING: Copper, stainless steel, mild steel, pex and/or Multi-layer composite

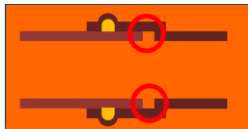
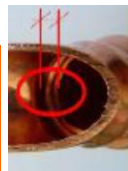
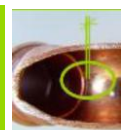
WSOS section as per TD	Points	Descriptor	Resource
04		- All pipe bends are to be made with a proprietary tool. (pipe bender, spring, pipe insert etc.). - There is to be NO free bending of pipe (without correct tool.)	
	0	There are more than 1-deformation or contusion visible.	
	1	- There is only 1- deformation or contusion visible. - Ensure that pipe flow is not restricted by the deformation (Example to be prepared at competition for MAT)	
	2	- There are production process markings visible. - The criterion for 0 &1 should not be present.	 
	3	- There are no production process markings for pipe bending visible after installation. - The criterion for 0,1 & 2 should not be present.	 

Aspect 2.4 PRESSING:

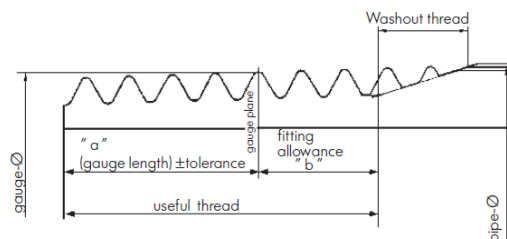
WSOS section as per TD	Points	Descriptor	Resource
04	0	The fitting is not pressed or not correctly pressed.	
	1	The insertion depth marking is not visible as per manufactures specifications.	
	2	There are no other markings other than the insertion depth marking on the Fitting or Pipe	
	3	None of the previously described defects are present.	

Aspect 2.5 PRESSING:

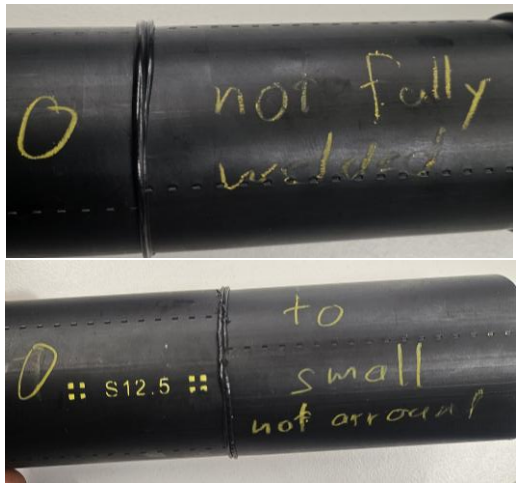
These criteria will be checked by cutting or drilling into an elbow or a Tee after all other assessment.
It is also a possible to check this position by endoscope/camera but is not recommended.

WSOS section as per TD	Points	Descriptor	Resource
04	0	- The pipe is not completely inserted into the fitting. and inside of the connection, the pipe end is restricted or not deburred	  
	1	The pipe is not completely inserted into the fitting.	 
	2	The pipe end is not deburred.	 
	3	None of the previously described defects are present.	 

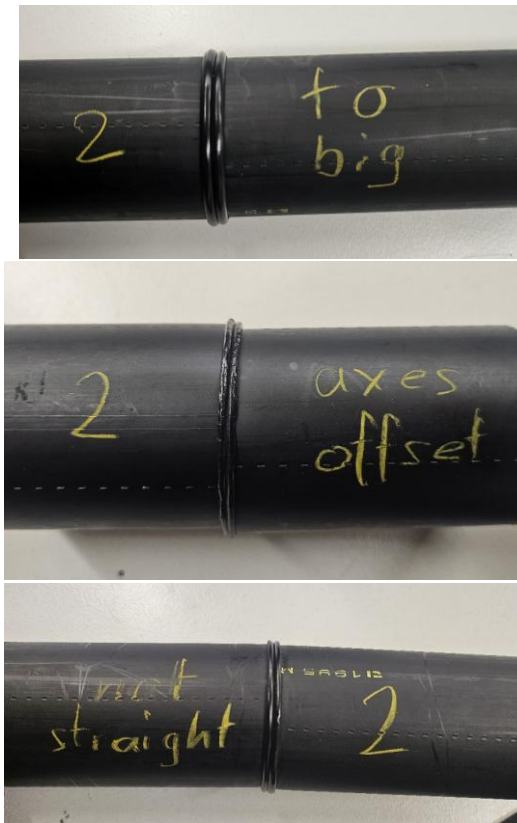
Aspect 2.6 THREADS: All metal threads manufactured by competitor

WSOS section as per TD	Points	Descriptor	Resource
04	0	There is less than 1 thread visible.	
	1	There are more than 2 threads visible.	
	2	- The Expert could easily take away some sealant by hand and without tools. - Do not use finger nails to scratch at the sealant only the skin pads of fingers to be used.	 
	3	None of the previously described defects are present. Only Washout showing. 	

Aspect 2.7 WASTE PIPE: butt welding

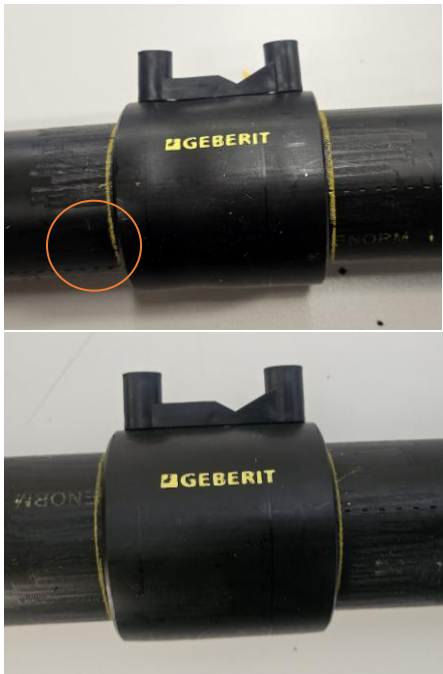
WSOS section as per TD	Points	Descriptor	Resource
04	0	One of the following faults is present • Not around welded • Big axis offset (an offset of wall thickness or more) • slipped in the clamping device Or all three of the following faults are present • Axis offset small • Not straight • To big	

			
	1	One of the following faults is present • To small Or two of the following faults are present • Axis offset small • Not straight • To big	

	2	One of the following faults is present • Axis offset small • Not straight • To big • Uneven bead size	
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	3	None of the previously described defects are present.	
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Aspect 2.8 WASTE PIPE: electro fusion coupling

WSOS section as per TD	Points	Descriptor	Resource
04	0	One of the following faults is present • Oxidation layer not removed • not welded • Big axis offset (welding under tension)	

	1	One of the following faults are present • Axs offset small • No marking	
	2	One of the following faults is present • Marking not around visible	

	3	None of the previously described defects are present.	
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Items used for assessment

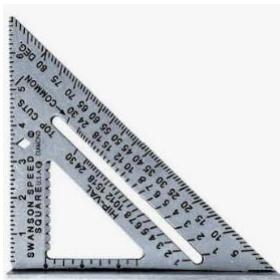
For Competitors

Compressor for pressure test



Laser for setting up datum lines



Levels for Gradient, Plumb and Level	
Square	
Ruler	

For Experts

Step drill for internal inspection

