

TRAINER MANUAL

Practical Exercise B\_PE\_1\_Brazing procedure qualification “commercial RAC”

Level 1

<p><b>Objectives:</b></p>	<p>Participants gain skills in:</p> <ol style="list-style-type: none"> <li>1. Brazing of copper piping and components for RAC</li> <li>2. Executing brazing procedure qualification</li> <li>3. Observation and application of measures for occupational safety, environmental protection and rational use of material resources and energy. Use of occupational health and safety and accident prevention regulations.</li> <li>4. Planning and controlling structured work processes, controlling and evaluating work results             <ol style="list-style-type: none"> <li>4.1 Preparing workstation with consideration of the work task</li> <li>4.2 Planning and defining work steps and procedures</li> <li>4.3 Teamwork for the manufacturing of the “brazing test specimen” is not permitted</li> <li>4.4 Read and interpret written technical information related to the work task</li> <li>4.5 Select and use appropriate equipment &amp; tools</li> <li>4.6 Demonstrate knowledge and skills for joining of copper tubes by brazing under inert gas</li> <li>4.7 Checking, evaluating and documenting work results through target and actual value comparisons</li> <li>4.8 Write a report about pressure testing of the specimen</li> </ol> </li> <li>5. Maintenance and servicing of tools &amp; equipment             <ol style="list-style-type: none"> <li>5.1 Cleaning, maintaining and preserving tools &amp; equipment</li> </ol> </li> </ol>
<p><b>Duration:</b></p> <p><b>Material:</b></p>	<p>600 minutes</p> <p>Whiteboard/Blackboard or handout of exercise description</p> <ol style="list-style-type: none"> <li>a. B_PE1_HO Work description</li> <li>b. B_HO_Permit to Work – hot work</li> <li>c. B_HO_brazing specimen RAC</li> <li>d. B_HO_MSDS_propane</li> <li>e. B_HO_MSDS_oxygen</li> <li>f. B_HO_MSDS_nitrogen</li> <li>g. B_HO_O2-N2 pressure regulator user manual example</li> <li>h. B_HO_flux FH-10</li> </ol>
<p><b>Tools &amp; equipment:</b></p>	<ol style="list-style-type: none"> <li>i. 4 x Work task specific consumables</li> <li>j. 4 x brazing equipment propane/oxygen</li> <li>k. 4 x N<sub>2</sub> gas cylinder (T50) with pressure regulator and cart</li> <li>l. 4 x work bench with vice</li> <li>m. 4 x set of generic tools (metal ruler, tube cutter, reamer, ...)</li> <li>n. 4 x set of bending tools ¼” &amp; 3/8”</li> <li>o. 4 x set of flaring tools</li> <li>p. 4 x set of torque wrenches (open end spanner)</li> <li>q. 4 x set of tube quick connectors ¼”</li> <li>r. 4 x Pinch-off plier</li> <li>s. 4 x Heavy duty hack-saw</li> </ol> <p>According to separate specified bill of materials</p>
<p><b>Workshop arrangements</b></p>	<p>Workshop is arranged for up to sixteen (16) participants. Provision of four (4) workstations for metal treatment (brazing) and four (4) complete sets of tubing tools and brazing units.</p>

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	Sufficient workshop ventilation (natural or forced ventilation) for about 5 air-changes per hour must be secured at the location
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The brazing procedure qualification test includes:

1. The manufacturing of the brazing specimen according to the dimensioned component drawing and given materials.
2. Compliance with all specified dimensions.
3. Brazing under inert gas (N<sub>2</sub>)
4. Pressure testing with N<sub>2</sub> (water bath immersion test)
5. Sealing of the process tube ¼"



Figure 1: Brazing specimen RAC

**List of consumables for one brazing test specimen**

Brazing test specimen RAC				
#	Qty	Unit	Description	Remarks
1	0.5	m	Copper tube annealed 6 x 1mm or 1/4" (for test specimen) ASTM B280	0.5m per specimen
2	0.5	m	Copper tube annealed 10 x 1mm or 3/8" (for test specimen) ASTM B280	0.5m per specimen
3	1	m	Copper tube annealed 18 x 1mm or 3/4" (for test specimen) ASTM B280	1m per specimen
4	1	pc	Reducing flare union SAE ¼" x 3/8"	1 per specimen

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5	1	pc	Flare nut 3/8" (10mm) SAE	1 per specimen
6	1	pc	Flare nut 1/4" (6mm) SAE	1 per specimen
7	1	pc	Copper Tee 18 x 18 x 18 mm (or 3/4")	1 per specimen
8	3	pc	Copper caps 18 mm (3/4")	3 per specimen

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Session Overview – Work Description				
TIME	CONTENT	OBJECTIVES	TRAINING MATERIAL	DESCRIPTION OF TRAINING SESSION AND TRAINER NOTES
30'	1. Participants briefing 2. General safety briefing	Participants: <ul style="list-style-type: none"> <li>• Understand the given work-task</li> <li>• Are familiar with the required safety arrangements</li> <li>• Are familiar with the local conditions</li> </ul>	<ul style="list-style-type: none"> <li>• B_PE1_HO Work description</li> <li>• B_HO_Permit to Work – hot work</li> <li>• B_HO_brazing specimen RAC</li> <li>• B_HO_MSDS_propane</li> <li>• B_HO_MSDS_oxygen</li> <li>• B_HO_MSDS_nitrogen</li> <li>• B_HO_flux FH-10</li> <li>• B_HO_O2-N2 pressure regulator user manual example</li> </ul>	<u>Plenary</u> <ul style="list-style-type: none"> <li>• Trainer explains work task and executes safety briefing</li> <li>• Trainees obtain permit of work</li> <li>• Teamwork is not permitted.</li> </ul>
530'	<b>Manufacturing work according to documentation provided</b> Filling of check-list while executing work-steps: <ul style="list-style-type: none"> <li>• Obtain permit of work, execute risk assessment</li> <li>• Undertake worksite preparation, tools, equipment and PPE check (having risk assessment in mind)</li> <li>• Safeguard the workshop area and inform involved parties</li> <li>• Prepare practical exercise according to technical drawing</li> </ul>	Participants: <ul style="list-style-type: none"> <li>• Learn to understand, verify and apply the subject matters of brazing technologies (copper/copper)</li> <li>• Obtain knowledge how to execute a risk assessment at work site</li> <li>• Learn how to get familiar with using PPE</li> <li>• Obtain knowledge and skills for the operation of</li> </ul>	Tools and equipment as specified <ul style="list-style-type: none"> <li>• 4 x Work task specific consumables</li> <li>• 4 x brazing equipment propane/oxygen</li> <li>• 4 x N2 gas cylinder (T50) with pressure regulator and cart</li> <li>• 4 x work bench with vice</li> </ul>	Trainer observes work routine and gives instructions to participants if they have questions. Trainer grants permit of work. Trainer evaluates work according to outlined criteria with the help of an assessment sheet.  <u>Group of 16 participants at four workstations:</u> <ul style="list-style-type: none"> <li>• All authorisation was obtained</li> <li>• Work area is safeguarded</li> <li>• Appropriate PPE is selected in line with the job requirements</li> <li>• Workplace arrangements are structured and in clean conditions</li> <li>• All necessary tools are in safe conditions and well arranged</li> </ul>

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TIME	CONTENT	OBJECTIVES	TRAINING MATERIAL	DESCRIPTION OF TRAINING SESSION AND TRAINER NOTES
	<ul style="list-style-type: none"> <li>• Execute brazing test trials according to trainer’s advice</li> <li>• Carry out bending, flaring and brazing tasks (test specimen)</li> <li>• T-piece is brazed from three directions (from the top, from the side, from underneath). This requires no changes of fixation of the specimen during brazing, if once selected.</li> <li>• Braze the specimen under inert gas provision</li> <li>• Perform pressure test using OFDN limited up to 12 bar / execute leak test</li> <li>• Confirm leak-free conditions with trainer</li> <li>• Seal process tube (6 mm / ¼”) under OFDN pressure</li> <li>• Cleaning, maintaining and preserving of tools, practical exercise and work-place</li> <li>• Hand over the practical exercise to the trainer</li> </ul>	<ul style="list-style-type: none"> <li>• brazing and pressure testing equipment</li> <li>• Learn to understand and apply the use of tools and equipment according to the user manuals and relevant safety codes</li> <li>• Obtain knowledge and skills for the use of combustion gases, oxidising gases and gases for pressure testing</li> <li>• how to use OFDN gas in order to carry out flushing of the refrigerant circuit during brazing (inert gas brazing)</li> <li>• Prepare and practice up to 5 brazing trial work pieces</li> <li>• Pressure test report generating</li> </ul>	<ul style="list-style-type: none"> <li>• 4 x set of generic tools (metal ruler, tube cutter, reamer, ...)</li> <li>• 4 x set of bending tools ¼” &amp; 3/8”</li> <li>• 4 x set of flaring tools</li> <li>• 4 x set of torque wrenches (open end spanner)</li> <li>• 4 x set of tube quick connectors ¼”</li> <li>• 4 x Pinch-off plier</li> <li>• 4 x Heavy duty hack-saw</li> </ul> <p>According to separate specified bill of materials</p>	<ul style="list-style-type: none"> <li>• Work instructions and technical plans/drawings are interpreted as per job requirements</li> <li>• Pipes are correctly prepared by straightening, cutting, deburring, cleaning</li> <li>• Flaring prepared according to trade standards</li> <li>• Brazing test specimen made according to the provided dimensions of component drawing</li> <li>• Brazing performed under inert gas protection (OFDN)</li> <li>• Pressure test and test for leakages executed</li> <li>• Process tube appropriately sealed under OFDN pressure</li> <li>• Specimen is cleaned and marked</li> <li>• Work area correctly cleaned up</li> <li>• Pressure testing certificate of the test specimen handed over</li> </ul> <p><u>Competency must be assessed through:</u></p> <ul style="list-style-type: none"> <li>• Direct observation</li> <li>• Demonstration</li> <li>• Questions related to required knowledge</li> <li>• Competency is assessed at the work place</li> </ul> <p><u>Assessment requires evidence in form of:</u></p> <ul style="list-style-type: none"> <li>• Conducted survey of workplace preparation</li> <li>• Conducted the relevant risk assessment</li> <li>• Ensured continuous OHS measures</li> <li>• Brazed the specimen under inert gas</li> </ul>

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TIME	CONTENT	OBJECTIVES	TRAINING MATERIAL	DESCRIPTION OF TRAINING SESSION AND TRAINER NOTES
				<ul style="list-style-type: none"> <li>• Joints are not overheated, joint gaps are filled correctly</li> <li>• T-piece is brazed from three directions (from the top, from the side, from underneath). This requires no changes of fixation of the specimen during brazing, if once selected.</li> <li>• All measures according to the drawing</li> <li>• Tested the specimen tightness with OFDN (protocol)</li> <li>• Process tube is correctly sealed under pressure</li> <li>• Test specimen is tight</li> <li>• Specimen is cleaned</li> </ul>
<b>600 min</b>	Total time			