# NATIONAL COUNCIL FOR TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

**FEBRUARY 2023**

**PROPOSED OCCUPATIONAL STANDARDS**

**OCCUPATION: WELDING ENGINEER**

**LEVEL: NTA 8**

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## ABBREVIATIONS

| | |
|---|---|
| **APW** | All Position Welding |
| **AW** | Automatic Welding |
| **CBET** | Competency Based Education and Training |
| **ERW** | Electric Resistance Welding |
| **FLOW** | Flow Welding |
| **FS** | Furnace Soldering |
| **GMAW** | Gas Metal Arc Welding |
| **NACTVET** | National Council for Technical and Vocational Education and Training |
| **NOS** | National Occupational Standards |
| **OPW** | Overhead Position Welding |
| **OS** | Occupational Standards |
| **QIM** | Quality Inspection and Management |
| **RW** | Robot Welding |
| **SAW** | Submerged Arc Welding |
| **SMAW** | Shielded Metal Arc Welding |
| **TIG** | Tungsten-arc Inert-Gas Welding |
| **TS** | TStorch Soldering |
| **TET** | Technical Education and Training |
| **TVET** | Technical and Vocational Education and Training |
| **WPM** | Welding Production Management |

**WPQ** Welding Procedure Qualification

**WPS** Welding Procedure Specification

**WT** Welding Technology

## GLOSSARY OF TERMS

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|---|---|
| **Circumstantial Knowledge:** | Detailed knowledge, which allows the decision-making in regard to different circumstances and cross cutting issues. |
| **Competence:** | The ability to use knowledge, understanding, practical, and thinking skills to perform effectively to the workplace standards required in employment. |
| **Competency:** | A description of the ability one possesses when able to perform a given occupational task effectively and efficiently. |
| **Competency-based Education:** | An instructional programme that derives its content from validated tasks and bases assessment on the learner's performance. |
| **Curriculum:** | A description or composite of statements about "what is to be learned" by the trainee/student in a particular instructional programme; a product that states the "intended learning outcomes". |
| **Educational/Training Programme:** | The complete curriculum and instruction (what and how) that is designed to prepare a person for employment in a job or other particular performance situation. |
| **Occupation:** | A specific position requiring the performance of specific tasks – essentially the same tasks are performed by all employees having the same title. (Example: baker) |
| **Occupational Area:** | This is a broad grouping of related jobs. (Example: food service) |
| **Occupational Standards:** | Specific requirements of competences people are expected to demonstrate in a particular occupational area, including knowledge and relevant attitudes. They also act as a performance tool of assessment of the prescribed outcomes. |
| **Occupational/Job analysis:** | A process used to identify the tasks that are important to employees in any given occupation. |

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| **Performance Criteria:** | Indicate expected end results or outcomes in the form of evaluative statements. |
| **Skills:** | The ability to perform occupational tasks with a high degree of proficiency within a given occupation. Skill is conceived of as a composite of three completely interdependent components: cognitive, affective, and psychomotor. |
| **Standards:** | A set of statements, which if proved true under working conditions, means that an individual is meeting an expected level and type of performance. |
| **Task Analysis:** | The process of analysing each task to determine the steps, circumstantial knowledge, attitudes, performance standards, tools and materials needed, as well as safety concerns required for the employees performing it. |
| **Task:** | A work activity that has a definite beginning and ending, is observable or measurable, and consists of two or more definite steps that leads to a product, service, or decision. |
| **Underpinning Knowledge:** | Crucial knowledge that an individual must acquire in order to demonstrate competences that are associated in performing a given task. |
| **Verification Process:** | The process of having experts review and confirm the importance of the task (competency) statements identified through occupational analysis. Other questions, such as the degree of task learning difficulty are also frequently asked. This process is also sometimes referred to as validation. |
| **Occupational Competence:** | The application of knowledge and skills that consistently meet the standards required by the work context. |

## 1.0. INTRODUCTION

Technical Education and Training (TET) is one of the most important education sub-sectors in Tanzania, responsible for developing a skilled workforce to support the country's industrialization economic agenda. Tanzania's *Development Vision 2025* intends to raise the country's economy to a middle-income status. This requires a skilled workforce that is aligned with the needs of the public and private sectors of the economy. The National Council for Technical Education has begun the job of drafting Occupational Standards that will eventually be adopted as National Occupational Standards for TET in order to ensure that it meets the needs of the labour market and the country's economic agenda.

National Occupational Standards (NOS) are performance criteria that are matched with labour market demands. Each National Occupation Standard describes functions, performance standards, and knowledge/understanding for one important function or task. They combine skills, knowledge, and attitudes to describe best practice. They are useful tools for establishing job roles, personnel recruiting, supervision, and appraisal, as well as TET standards. They're also helpful for benchmarking and harmonizing qualifications on a national and international level. Standards, in general, provide a solid framework for high-quality TET that is labour market-relevant, current, and consistent in delivery across all public and private institutions.

However, it must be noted that, Occupational Standards and Training standards/qualifications standards are different. Occupational standards are defined in terms of activities performed by a person in a selected occupation (e.g., an electrical engineer designs electrical wiring circuits, performs troubleshooting in electrical wiring, etc.) and they are usually defined by employers following procedures agreed upon by all stakeholders. Education and training standards are developed from the activities defined in occupational standards, and they include learning objectives to ensure that the necessary skills and knowledge are developed by a person to enable him or her to function at an agreed level in an occupation. Education and Training standards are used to define curricula in training institutions. It is however critical that there must be a direct link between the occupational standards and the training standards to respond to demands of the labour market.

In TET delivery, Tanzania adopted the Competence Based Education and Training (CBET) approach. The CBET approach focuses on providing learners with the skills and knowledge required to meet the occupational standards. Occupational standards are thus the starting point for developing competency-based training (CBET) programmes. TET institutions will be required to benchmark their curricula with relevant occupational standards.

Occupational Standards are developed based on a given occupation's current and future demands. As a result, they serve as a means of bridging the gap between the worlds of employment and technical

education and training (TET).

The Welding Engineer Occupation has its own set of occupational standards. The document explains how the occupational standards were developed, as well as the scope, the occupational profile in the form of DACUM charts, and the Occupational Standards.

## 2.0.OCCUPATIONAL STANDARD DEVELOPMENT PROCESS

The Occupational standards development process began with an examination of major documents that guide Tanzanian skill development. The *10-year National Skills Development Strategy (2016-2026)* was one of the documents reviewed, and it outlined six (6) economic sectors that should be prioritized when developing skills development programmes.

These sectors include: Transport and logistics, Tourism and Hospitality, Agribusiness, Construction, Energy and ICT. NACTE labour market reports were also used in the literature review to determine the skills demand in the Tanzanian labour market as a whole.

After the literature review, a workshop comprised of expert workers and educators with substantial knowledge and experience in the occupation conducted an occupational analysis utilizing the DACUM approach to produce the occupational profile. The analysis resulted in DACUM Charts, which are attached as **Appendix 1** to this document.

The occupational standards were then developed. Experts in Occupational Analysis and the Development of Occupational Standards facilitated the workshop. Interviews, online surveys, and a stakeholder forum were used to validate the Occupational Standards. Engineers, supervisory technicians on the job, and experienced Welding Engineers were key informants in the survey to discover occupational trends. This information was used to gain insight from the workplaces regarding trends and changes in the profession, including how well graduates are prepared for working in the occupation. A total of …….. online surveys were completed by experts from the labour market across the country. Apart from the survey aiding in defining the scope for the occupational analysis, they also served to engage a wide cross-section of experts in the occupation. Apart from this, the stakeholders' forum was attended by …….. participants from different parts of the country representing various companies.

## 3.0. THE SCOPE AND OVERVIEW OF THE OCCUPATION STANDARDS FOR WELDING ENGINEERS

The standards cover a broad range of duties and tasks that can be performed by an Welding Engineer. However, the occupational standards are not meant to replace individual job descriptions. Instead, they are to be used for guidance in defining skill levels and knowledge for the technician in specific

settings or positions. The Welding Engineer may perform tasks in a number of key areas of the occupational standards, but not necessarily in all areas. For example, in large operations, other individuals may be employed or designated to perform specific tasks.

The welding engineers shall have a good level of welding technology and skills, be able to manage welding production workshops and construction sites, prepare, guide, and implement welding technical documents, inspect, analyze, and control welding quality, predict welding production risks, solve general technical problems, analyze major technical problems and propose solutions, conduct welding production safety management, and provide professional training and guidance to welding personnel. Generally, the Welding Engineer performs the following responsibilities:

a) Compile, revise, review, and continuously improve welding process technical documents and welding quality control documents
b) Guide, manage, and supervise the welding construction site
c) Develop welding production plan
d) Estimate the welding project cost
e) Conduct human resource management for welding production
f) Control the quality of welding projects
g) Generate relevant work management documents and technical analysis reports
h) Conduct safety management for welding production
i) Solve major technical problems in welding production
j) Design and improve welding fixtures
k) Maintain and manage welding equipment and supporting facilities
l) Assess and predict the risks of welded structures
m) Provide professional training, technical guidance, and technical supervision
n) Conduct welding technology and quality analysis
o) Perform difficult skill operations such as overhead welding, oblique welding, and obstacle welding using common welding methods

The Occupational standards have been clustered into NTA qualification levels i.e. NTA level 7 and 8.

## 4.0.VALIDITY PERIOD

Due to the rapid development of technology, the validity period of occupational standards is 3-5 years. The review will proceed in the same manner as the one before it, with new occupational standards being developed based on current trends of the labour market.

## 5.0. OCCUPATIONAL STANDARDS

## 5.1. OCCUPATIONAL STANDARDS FOR WELDING ENGINEER – NTA 8

| **OCCUPATION** | **WELDING ENGINEER** | **OCCUPATION CODE** | |
|---|---|---|---|
| **DUTY TITLE** | SMAW APW | **DUTY NO.** | 801 |
| **TASK TITLE** | BUTT 45° FIXED SMAW OF LOW-CARBON STEEL OR LOW-ALLOY STEEL PIPE | **TASK NO.** | 8011 |
| **PERFORMANCE CRITERIA** | The person performing this task must be able to complete the operation process of butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe according to the specific welding technology. | | |
| **RANGE STATEMENT** | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Power supply of SMAW;<br>2. Ground wire clamp;<br>3. Electrode holder;<br>4. Adjustable welding (bench) stand;<br>5. Slag hammer;<br>6. Electric angle grinder;<br>7. Straight grinder;<br>8. File;<br>9. File bench;<br>10. Electrode dry oven;<br>11. Electrode insulation barrel;<br>12. Pipe clamp;<br>13. Welding mask;<br>14. Wire brush;<br>15. Hand hammer;<br>16. Chisel;<br>17. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>18. Weld testing tools and gauges. | | |

| **EVIDENCE REQUIREMENTS** | |
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| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Select appropriate tools, equipment, and protective equipment;<br>2. Read drawings or technical process documents;<br>3. Prepare base metal groove, clean, assemble and position welding;<br>4. Select the electrode that matches the base metal; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Maintain and manage the equipment and tools for SMAW;<br>1.2 Make preparations before welding;<br>1.3 Control the appearance of the weld seam;<br>1.4 Select weld testing tools. |

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| 5. Select welding process parameters;<br>6. Determine the number of welding layers and passes and the change of electrode angle at different positions;<br>7. Weld the backing layer of butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe;<br>8. Weld the fill layer of butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe;<br>9. Weld the cover layer of butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe;<br>10. Clean the joint surface of the butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe;<br>11. Clean tools, equipment and workplace;<br>12. Store tools and equipment;<br>13. Check the welding quality. | **2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Specifications for health and safety precautions in welding operations;<br>2.2 Welding material selection standards;<br>2.3 Selection and preparation principles of grooves;<br>2.4 Principles for determining the number of welding layers and passes;<br>2.5 Selection criteria of welding process parameters.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Welding performance of metal materials;<br>3.2 Classification, characteristics, and application of welding equipment;<br>3.3 Process parameters of SMAW APW;<br>3.4 Relationship between weld shape and quality;<br>3.5 Classification, causes, and preventive measures of welding defects;<br>3.6 Forming process for butt 45° fixed SMAW of low-carbon steel or low-alloy steel pipe.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Equipment and tool use skills;<br>4.5 Parameter selection skills;<br>4.6 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:** |

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| | 1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | GMAW APW | DUTY NO. | 802 |
| TASK TITLE | BUTT 45° FIXED GMAW OF LOW-CARBON STEEL OR LOW-ALLOY STEEL PIPE | TASK NO. | 8021 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the operation process of butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe according to the specific welding technology. | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Power supply and wire feeder of GMAW;<br>2. Ground wire clamp;<br>3. GMAW gun;<br>4. Gas supply system (carbon dioxide cylinder, flow meter, heater, etc.);<br>5. Adjustable welding (bench) stand;<br>6. Electric angle grinder;<br>7. Straight grinder;<br>8. File;<br>9. File bench;<br>10. Welding mask;<br>11. Adjustable spanner;<br>12. Wire pliers;<br>13. Pipe clamp;<br>14. Welding mask;<br>15. Wire brush;<br>16. Hand hammer;<br>17. Chisel;<br>18. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>19. Weld testing tools and gauges. | | |

| EVIDENCE REQUIREMENTS | |
|---|---|
| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Select appropriate tools, equipment, and protective equipment;<br>2. Read drawings or technical process documents;<br>3. Prepare base metal groove, clean, assemble and position welding;<br>4. Select welding wires and shielding gas that match the base metal;<br>5. Select welding process parameters; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Maintain and manage the equipment and tools for GMAW;<br>1.2 Make preparations before welding;<br>1.3 Control the appearance of the weld seam;<br>1.4 Select weld testing tools.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles: |

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| 6. Determine the number of welding layers and passes and the change of welding gun angle at different positions;<br>7. Weld the backing layer of butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe8. Weld the fill layer of butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe;<br>8. Weld the cover layer of butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe;<br>9. Clean the joint surface of butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe;<br>10. Clean tools, equipment and workplace;<br>11. Store tools and equipment;<br>12. Check the welding quality. | 2.1 Specifications for health and safety precautions in welding operations;<br>2.2 Welding material selection standards;<br>2.3 Selection and preparation principles of grooves;<br>2.4 Principles for determining the number of welding layers and passes;<br>2.5 Selection criteria of welding process parameters.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Welding performance of metal materials;<br>3.2 Classification, characteristics, and application of welding equipment;<br>3.3 Process parameters for GMAW APW;<br>3.4 Relationship between weld shape and quality;<br>3.5 Classification, causes, and preventive measures of welding defects;<br>3.6 Forming process of butt 45° fixed GMAW weld of low-carbon steel or low-alloy steel pipe.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Equipment and tool use skills;<br>4.5 Parameter selection skills;<br>4.6 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | According to the welding technical standards and WPS, select reasonable process parameters to complete the welding of the butt 45° fixed GMAW weld of low-carbon steel or low alloy steel pipes, which shall be checked to meet the welding quality standards. |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools; |

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| | 2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | TIG APW | DUTY NO. | 803 |
| TASK TITLE | 45° FIXED OBSTRUCTED TIG | TASK NO. | 8031 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the 45° fixed obstructed TIG according to the specific welding technology. | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Power supply of TIG;<br>2. Ground wire clamp;<br>3. TIG gun;<br>4. Gas supply system (argon cylinder, flow meter, etc.);<br>5. Adjustable welding (bench) stand;<br>6. Electric angle grinder;<br>7. Straight grinder;<br>8. File;<br>9. File bench;<br>10. Obstacle;<br>11. Welding mask;<br>12. Adjustable spanner;<br>13. Tungsten grinder;<br>14. Pipe clamp;<br>15. Welding mask;<br>16. Wire brush;<br>17. Hand hammer;<br>18. Chisel;<br>19. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>20. Weld testing tools and gauges. | | |

| EVIDENCE REQUIREMENTS | |
|---|---|
| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Select appropriate tools, equipment, and protective equipment;<br>2. Read drawings or technical process documents;<br>3. Prepare base metal groove, clean, assemble, and position 45 ° fixed obstacled TIG;<br>4. Select the nozzle, electrode and wire of TIG;<br>5. Select welding process parameters; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Maintain and manage the equipment and tools for TIG;<br>1.2 Make preparations before welding;<br>1.3 Control the appearance of the weld seam;<br>1.4 Select weld gauge.<br><br>**2.0 Principle** |

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| 6. Determine the number of welding layers and passes and the change of welding gun angle and feeding mode at different positions;<br>7. Weld the backing layer of butt 45° fixed obstructed TIG of low carbon steel or low alloy steel pipe;<br>8. Weld the fill layer of butt 45° fixed obstructed TIG of low carbon steel or low alloy steel pipe;<br>9. Weld the cover layer of butt 45° fixed obstructed TIG of low carbon steel or low alloy steel pipe;<br>10. Clean the joint surface of the butt 45° fixed TIG of low-carbon steel or low-alloy steel pipe;<br>11. Clean tools, equipment and workplace;<br>12. Store tools and equipment;<br>13. Check the welding quality. | The person performing this task must be able to explain the following principles:<br>2.1 Specifications for health and safety precautions in welding operations;<br>2.2 Welding material selection standards;<br>2.3 Selection and preparation principles of grooves;<br>2.4 Principles for determining the number of welding layers and passes;<br>2.5 Selection criteria of welding process parameters.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Welding performance of metal materials;<br>3.2 Classification, characteristics, and application of welding equipment;<br>3.3 Process parameters of TIG APW;<br>3.4 Relationship between weld shape and quality;<br>3.5 Classification, causes, and preventive measures of welding defects;<br>3.6 Forming process of 45° fixed obstructed TIG weld.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Equipment and tool use skills;<br>4.5 Parameter selection skills;<br>4.6 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety; |

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| | 4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | FLOW OF DISSIMILAR MATERIALS | DUTY NO. | 804 |
| TASK TITLE | TS OF DISSIMILAR METALS | TASK NO. | 8041 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the TS of dissimilar metals according to the specific welding technology. | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Combustible gases (acetylene gas, propane, natural gas, liquefied petroleum gas, etc.);<br>2. Combustion gas (oxygen);<br>3. Cylinder;<br>4. Gas relief valve;<br>5. Rubber hose;<br>6. Welding torch;<br>7. Flux;<br>8. Welding materials;<br>9. Adjustable spanner;<br>10. Wire pliers;<br>11. Electric angle grinder;<br>12. Straight grinder;<br>13. File;<br>14. File bench;<br>15. Goggles;<br>16. Wire brush;<br>17. Hand hammer;<br>18. Chisel;<br>19. Nozzle cleaner;<br>20. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>21. Weld testing tools and gauges. | | |

| EVIDENCE REQUIREMENTS | |
|---|---|
| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Select appropriate tools, equipment, and protective equipment;<br>2. Read drawings or technical process documents;<br>3. Select materials for dissimilar metal TS;<br>4. Prepare dissimilar metal grooves and clean the surrounding; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Maintain and manage the equipment and tools for TS;<br>1.2 Make preparations before welding;<br>1.3 Control the appearance of the weld seam;<br>1.4 Select weld gauge. |

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| 5. Adjust the assembly gap for TS of dissimilar metals;<br>6. Adjust the heating method for TS of dissimilar metals;<br>7. Adjust the TS parameters of dissimilar metals for welding operations;<br>8. Inspect the appearance quality of dissimilar metal TS joints;<br>9. Repair defects in dissimilar metal TS joints;<br>10. Clean tools, equipment and workplace;<br>11. Store tools and equipment. | **2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Specifications for health and safety precautions in welding operations;<br>2.2 Welding material selection standards;<br>2.3 Principles for cleaning dissimilar metal surfaces;<br>2.4 Selection criteria of welding process parameters;<br>2.5 Principles for repair defects in dissimilar metal TS joints.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Welding performance of metal materials;<br>3.2 Characteristics, and application of TS equipment;<br>3.3 Process parameters for TS of dissimilar metals;<br>3.4 Heating method for TS;<br>3.5 Classification, causes, and preventive measures of welding defects.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Equipment and tool use skills;<br>4.5 Parameter selection skills;<br>4.6 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | According to the welding technical standards and WPS, select reasonable process parameters to complete the welding of the TS weld of dissimilar metals, which shall be checked to meet the welding quality standards. |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:** |

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| | 1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | FLOW OF DISSIMILAR MATERIALS | DUTY NO. | 804 |
| TASK TITLE | FS OF DISSIMILAR MATERIALS | TASK NO. | 8042 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the FS of dissimilar metals according to the specific welding technology. | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Brazing furnace;<br>2. Electric control cabinet;<br>3. Fixtures;<br>4. Adjustable spanner;<br>5. Wire pliers;<br>6. Electric angle grinder;<br>7. File;<br>8. File bench;<br>9. Wire brush;<br>10. Hand hammer;<br>11. Chisel;<br>12. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>13. Weld testing tools and gauges. | | |

| EVIDENCE REQUIREMENTS | |
|---|---|
| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Select appropriate tools, equipment, and protective equipment;<br>2. Read drawings or technical process documents;<br>3. Assemble the workpieces and adjust the gap of FS dissimilar material with fixtures;<br>4. Select materials for dissimilar metal TS;<br>5. Adjust the parameters of dissimilar metal TS;<br>6. Preset the materials for dissimilar metal TS;<br>7. Inspect the appearance quality of dissimilar metal TS joints;<br>8. Repair defects in dissimilar metal TS joints;<br>9. Clean tools, equipment and workplace;<br>10. Store tools and equipment. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Maintain and manage the equipment and tools for FS;<br>1.2 Make preparations before welding;<br>1.3 Control the appearance of the weld seam;<br>1.4 Select weld testing tools.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Specifications for health and safety precautions in welding operations;<br>2.2 Welding material selection standards;<br>2.3 Principles for cleaning dissimilar metal surfaces; |

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| | 2.4 Selection criteria of welding process parameters.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Welding performance of metal materials;<br>3.2 Characteristics, and application of TS equipment;<br>3.3 Process requirements for dissimilar metal FS;<br>3.4 Quality control method for dissimilar material FS joints;<br>3.5 Classification, causes, and preventive measures of welding defects;<br>3.6 Requirements for repair of defects in dissimilar metal FS joints.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Equipment and tool use skills;<br>4.5 Parameter selection skills;<br>4.6 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | According to the welding technical standards and WPS, select reasonable process parameters to complete the welding of the FS weld of dissimilar metals, which shall be checked to meet the welding quality standards. |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | WELDING OF STRUCTURES WITH POOR ACCESSIBILITY | DUTY NO. | 805 |
| TASK TITLE | DEVELOPMENT OF WELDING PROCESS PLAN | TASK NO. | 8051 |
| PERFORMANCE CRITERIA | The person performing this task must be able to develop a reasonable welding process plan based on specific requirements | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Computer;<br>2. Printer;<br>3. Regular office supplies. | | |

**EVIDENCE REQUIREMENTS**

| PRACTICAL PERFORMANCE | UNDERPINNING KNOWLEDGE |
|---|---|
| The person performing this task must be able to do the following:<br>1. Comply with health and safety precautions for welding of structures with poor accessibility;<br>2. Select appropriate tools, equipment, and protective equipment;<br>3. Develop a welding process plan that meets the working conditions;<br>4. Develop assurance measures for welding quality. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Weld the structures with poor accessibility by selecting appropriate welding methods;<br>1.2 Inspect the welding of structures with poor accessibility by selecting appropriate weld quality inspection methods.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Principles of welding sequence for structure assembly;<br>2.2 Principle of inspection of weld quality by layers and passes.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Theoretical basis for formulating welding processes for structures with poor accessibility;<br>3.2 Basic requirements for welding quality control.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills; |

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| | 4.2 Management skills;<br>4.3 Customer service skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills;<br>4.6 Computer application skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Develop a reasonable welding process plan based on the specific form of the welding structure |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | WELDING OF STRUCTURES WITH POOR ACCESSIBILITY | DUTY NO. | 805 |
| TASK TITLE | WELDING OPERATION AND INSPECTION | TASK NO. | 8052 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the welding operation and inspection of structures with poor accessibility based on the specific welding process | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Power supply of SMAW;<br>2. Ground wire clamp;<br>3. Electrode holder (gun);<br>4. Welding (bench) stand;<br>5. Gas supply system;<br>6. Slag hammer;<br>7. Electric angle grinder;<br>8. File;<br>9. Electrode dry oven;<br>10. Electrode insulation barrel;<br>11. Welding mask;<br>12. Wire brush;<br>13. Hammer;<br>14. Chisel;<br>15. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>16. Weld testing tools and gauges. | | |

| EVIDENCE REQUIREMENTS | |
|---|---|
| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Comply with health and safety precautions for operation and inspection of welding of structures with poor accessibility;<br>2. Select appropriate tools, equipment, and protective equipment for task;<br>3. Use and maintain protective equipment;<br>4. Select the welding materials that match the base metal;<br>5. Prepare base metal bevel, clean, assemble and position welding according to specifications and drawing requirements; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Select the welding operation and inspection methods;<br>1.2 Conduct welding operation and inspection of structures with poor accessibility;<br>1.3 Inspect team welding by steps.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles: |

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| 6. Use auxiliary tools to complete structural welding with poor accessibility such as complex environmental obstacle positions and narrow space;<br>7. Weld the parts that cannot be inspected after welding or key parts that cannot be repaired;<br>8. Handle welding defects and technical problems after welding;<br>9. Clean tools, equipment and workplace;<br>10. Store tools and equipment. | 2.1 Standards for welding and inspection of welds;<br>2.2 Importance of ensuring that welders can operate freely around the weld seam;<br>2.3 Principles for ensuring the normal operation of welding equipment.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Key points for welding inspection of structures with poor accessibility;<br>3.2 High difficulty welding methods and techniques;<br>3.3 Welding defect knowledge and related solutions.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Customer service skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills;<br>4.6 Computer application skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Complete welding and inspection of structures with poor accessibility according to technical requirements and welding quality requirements |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | ROBOT WELDING | DUTY NO. | 806 |
| TASK TITLE | ROBOT WELDING PROCESS OPTIMIZATION | TASK NO. | 8061 |
| PERFORMANCE CRITERIA | The person performing this task must be able to optimize the robot welding process based on specific requirements | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Welding robot;<br>2. Power supply for robot welding;<br>3. Gun/electrode holder;<br>4. Teaching pendant;<br>5. Control cabinet;<br>6. Gun cleaner;<br>7. Safety system (fence, grating, automatic door, door lock, etc.);<br>8. Welding bench, fixture, and positioner;<br>9. Smoke exhaust system;<br>10. Slag hammer;<br>11. Electric angle grinder;<br>12. Welding mask;<br>13. Weld gauge;<br>14. Wire brush;<br>15. Hammer;<br>16. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>17. Computer. | | |

| EVIDENCE REQUIREMENTS | |
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| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Review and formulate welding process implementation plan;<br>2. Complete the welding scheme design;<br>3. Establish a simulation model for the robot welding system;<br>4. Complete the offline programming of the welding system;<br>5. Program the welding of irregular workpieces;<br>6. Improve the fixture;<br>7. Take technological measures to control welding deformation;<br>8. Operate the welding robot; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Develop a reasonable welding sequence;<br>1.2 Demonstrate reasonable point positions;<br>1.3 Set reasonable welding parameters.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 The importance of complex assembly welding sequence on welding deformation;<br>2.2 Principle of robot welding process; |

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| 9. Inspect the quality of welding workpieces;<br>10. Analyze the cause of welding defects;<br>11. Propose solutions to prevent and solve welding defects;<br>12. Propose welding inspection method;<br>13. Evaluate the welding equipment;<br>14. Analyze common faults in others peripheral equipment. | 2.3 Teaching specifications for the posture of welding guns at common weld positions;<br>2.4 Welding quality acceptance standards;<br>2.5 Welding process operation specifications;<br>2.6 Acceptance standards for peripheral equipment.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Key points of robot welding process operation;<br>3.2 Use method of offline programming software of robot welding;<br>3.3 Programming knowledge of irregular welding;<br>3.4 Basic knowledge of fixtures;<br>3.5 Knowledge of welding deformation formation mechanism and deformation correction;<br>3.6 Composition and application characteristics of welding robots;<br>3.7 Formation mechanism of welding defects;<br>3.8 Welding process specifications;<br>3.9 Knowledge related to welding inspection.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Customer service skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills.<br><br>**5. Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Reasonably optimize the process based on the characteristics of welding products |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | ROBOT WELDING | DUTY NO. | 806 |
| TASK TITLE | ROBOT ARC WELDING | TASK NO. | 8062 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the robot arc welding and determine the quality of the weldment | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Arc welding robot;<br>2. Power supply for robot arc welding;<br>3. Welding gun;<br>4. Teaching pendant;<br>5. Control cabinet;<br>6. Gun cleaner;<br>7. Safety system (fence, grating, automatic door, door lock, etc.);<br>8. Welding bench, fixture, and positioner;<br>9. Smoke exhaust system;<br>10. Slag hammer;<br>11. Electric angle grinder;<br>12. Welding mask;<br>13. Weld gauge;<br>14. Wire brush;<br>15. Hammer;<br>16. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>17. Computer. | | |

| EVIDENCE REQUIREMENTS | |
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| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Backup the robot arc welding system;<br>2. Program the arc welding trajectory with robot offline programming software;<br>3. Import, export, modify, and run the offline program of the robot arc welding system;<br>4. Modify, run, and calibrate the offline program of the robot arc welding system;<br>5. Test the robot arc welding process;<br>6. Review and develop robot arc welding process;<br>7. Develop and optimize the production takt of robot arc welding;<br>8. Improve the fixture of robot arc welding; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Backup of robot arc welding system, offline programming, offline program import and export methods, as well as offline program modification, operation, and calibration;<br>1.2 Use offline programming software for arc welding robots;<br>1.3 Model the offline programming for arc welding robots.<br><br>**2.0 Principle** |

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| 9. Perform offline programming;<br>10. Establish a simulation model for the arc welding robot system;<br>11. Check the quality of the robot arc welding structure;<br>12. Determine the quality of robot arc welding weldments based on the results of metallographic structure and mechanical performance tests;<br>13. Evaluate the arc welding robot and peripheral equipment;<br>14. Analyze common faults in arc welding robots and peripheral equipment;<br>15. Handle common fault information displayed in teaching pendant. | The person performing this task must be able to explain the following principles:<br>2.1 Operation specification for robot welding process control;<br>2.2 Acceptance standards for robot arc welding structures;<br>2.3 Acceptance standards for arc welding robot and peripheral equipment.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Test method for robot arc welding process<br>3.2 Key points and operational essentials of robot arc welding process;<br>3.3 Method for managing the production takt of robot arc welding;<br>3.4 Basic knowledge of fixture assembly for arc welding robot;<br>3.5 Effect of metallographic structure of robot arc welding on weld performance;<br>3.6 Analysis method for common faults of arc welding robot equipment;<br>3.7 Reasons and solutions for the occurrence of common robot fault numbers or codes.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Customer service skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | According to the production requirements of the product, develop the welding process, program and execute robot welding to achieve a reliable weld |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools; |

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| | 3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | ROBOT WELDING | DUTY NO. | 806 |
| TASK TITLE | ROBOT SPOT WELDING | TASK NO. | 8063 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete the robot spot welding and determine the quality of the weldment | | |
| RANGE STATEMENT | The task can be performed in the welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Spot welding robot;<br>2. Power supply for robot spot welding;<br>3. Electrode holder;<br>4. Teaching pendant;<br>5. Control cabinet;<br>6. Safety system (fence, grating, automatic door, door lock, etc.);<br>7. Welding bench, fixture, and positioner;<br>8. Smoke exhaust system;<br>9. Electric angle grinder;<br>10. Welding mask;<br>11. Weld gauge;<br>12. Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.);<br>13. Computer. | | |

| EVIDENCE REQUIREMENTS | |
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| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
| The person performing this task must be able to do the following:<br>1. Backup the robot spot welding system;<br>2. Program the spot welding points with robot offline programming software;<br>3. Import, export, modify, and run the offline program of the robot spot welding system;<br>4. Modify, run, and calibrate the offline program of the robot spot welding system;<br>5. Review and develop robot spot welding process;<br>6. Test the robot arc welding process;<br>7. Develop and optimize the production takt of robot spot welding;<br>8. Improve the fixture of robot spot welding;<br>9. Program the robot interference range;<br>10. Conduct offline programming of spot welding robots;<br>11. Establish a simulation model for the spot welding robot system; | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Backup of robot spot welding system, offline programming, offline program import and export methods, as well as offline program modification, operation, and calibration;<br>1.2 Use offline programming software for spot welding robots;<br>1.3 Model the offline programming for spot welding robots.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Principles to be followed for robot welding process control;<br>2.2 Acceptance standards for robot spot welding structures; |

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| 12. Guide the design of a spot welding robot workstation plan;<br>13. Check the quality of the robot spot welding structure;<br>14. Determine the quality of robot spot welding weldments based on the results of metallographic structure and mechanical performance tests;<br>15. Evaluate the spot welding robot and peripheral equipment;<br>16. Analyze common faults in spot welding robots and peripheral equipment. | 2.3 Acceptance standards for spot welding robot and peripheral equipment;<br>2.4 Programming operation specifications for robot interference range;<br>2.5 Modeling specification for spot welding robot system.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Evaluation method for robot spot welding process;<br>3.2 Test method for robot spot welding process;<br>3.3 Method for analyzing the production takt of robot spot welding;<br>3.4 Basic knowledge of fixture assembly for spot welding robot;<br>3.5 Use method of offline programming software of spot welding robot;<br>3.6 Selection method of spot welding robot welding workstation;<br>3.7 Effect of metallographic structure of robot spot welding on weld performance.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Customer service skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | According to the production requirements of the product, develop the welding process, program and execute robot welding to achieve a reliable weld |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

<table>
<tr><td>OCCUPATION</td><td colspan="2">WELDING ENGINEER</td><td>OCCUPATION CODE</td><td></td></tr>
<tr><td>DUTY TITLE</td><td colspan="2">WELDING MANAGEMENT</td><td>DUTY NO.</td><td>807</td></tr>
<tr><td>TASK TITLE</td><td colspan="2">WELDING PRODUCTION MANAGEMENT</td><td>TASK NO.</td><td>8071</td></tr>
<tr><td>PERFORMANCE CRITERIA</td><td colspan="4">The person performing this task must be able to conduct welding cost accounting, welding quota management, and organization and implementation of welding production</td></tr>
<tr><td>RANGE STATEMENT</td><td colspan="4">The task can be performed in the office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Computer;<br>2. Drawing software;<br>3. Printer;<br>4. Calculators, etc.</td></tr>
<tr><td colspan="5">EVIDENCE REQUIREMENTS</td></tr>
<tr><td colspan="2">PRACTICAL PERFORMANCE</td><td colspan="3">UNDERPINNING KNOWLEDGE</td></tr>
<tr><td colspan="2">The person performing this task must be able to do the following:<br>1. Prepare bidding documents;<br>2. Estimate the production costs;<br>3. Calculate the energy consumption quota of welding materials;<br>4. Calculate the labor hour quota;<br>5. Develop cost control methods and conduct cost analysis;<br>6. Organize and implement welding production;<br>7. Develop reasonable technical measures for welding production safety.</td><td colspan="3">Detailed knowledge about:<br>1.0 Methods<br>The person performing this task must be able to explain how to:<br>1.1 Select budget method;<br>1.2 Calculate production quota;<br>1.3 Select methods to control costs.<br><br>2.0 Principle<br>The person performing this task must be able to explain the following principles:<br>2.1 Cost control principles;<br>2.2 Principles for setting project organizational structure;<br>2.3 Basic principles of production safety.<br><br>3.0 Theories<br>The person performing this task must be able to explain the following:<br>3.1 Basic knowledge of bidding and tendering;<br>3.2 Calculation of welding production quota;<br>3.3 Cost control techniques and cost analysis methods;<br>3.4 Knowledge related to the organization and implementation of welding production.</td></tr>
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| | **4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Teamwork skills;<br>4.5 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Organize the implementation of welding production; develop reasonable technical measures for welding production safety |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

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| **OCCUPATION** | **WELDING ENGINEER** | **OCCUPATION CODE** | |
| **DUTY TITLE** | WELDING MANAGEMENT | **DUTY NO.** | 807 |
| **TASK TITLE** | WELDING CONSTRUCTION MANAGEMENT | **TASK NO.** | 8072 |
| **PERFORMANCE CRITERIA** | The person performing this task must be able to prepare a construction organization design plan; provide technical guidance and supervision during construction; and carry out relevant work in accordance with engineering management procedures | | |
| **RANGE STATEMENT** | The task can be performed in the office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Computer;<br>2. Drawing software;<br>3. Printer;<br>4. Calculators, etc. | | |

**EVIDENCE REQUIREMENTS**

| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
|---|---|
| The person performing this task must be able to do the following:<br>1. Review construction drawings;<br>2. Prepare construction organization design plan;<br>3. Make technical preparation for welding projects;<br>4. Prepare the necessary materials for the welding project;<br>5. Prepare the labor organization for welding projects;<br>6. Prepare the construction site for the welding project;<br>7. Establish construction organization structure;<br>8. Develop technical measures for quality and safety;<br>9. Control the technical quality of the construction site;<br>10. Accept the welding project;<br>11. Dispose welding wastes. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Determine production preparation for construction projects;<br>1.2 Prepare a construction design plan;<br>1.3 Guide and supervise the construction;<br>1.4 Check the welding quality.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 The principle of purpose, management span, systematization and simplification of construction organization structure setting;<br>2.2 Compilation principles of construction organization design.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Production preparation for construction projects;<br>3.2 Quality management of construction;<br>3.3 Management of completion acceptance of construction projects; |

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| | 3.4 Housekeeping and environmental protection during construction.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Team work skills;<br>4.5 Report writing skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Prepare for construction project production, manage construction quality, organize the completion acceptance of construction projects, and control the disposal of welding waste. |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | WELDING MANAGEMENT | DUTY NO. | 807 |
| TASK TITLE | PREPARATION OF TECHNICAL DOCUMENTS | TASK NO. | 8073 |
| PERFORMANCE CRITERIA | The person performing this task must be able to prepare technical documents based on specific product requirements, welding requirements, and related standards | | |
| RANGE STATEMENT | The task can be performed in the office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Computer;<br>2. Drawing software;<br>3. Related reference books. | | |

**EVIDENCE REQUIREMENTS**

| PRACTICAL PERFORMANCE | UNDERPINNING KNOWLEDGE |
|---|---|
| The person performing this task must be able to do the following:<br>1. Make welding assembly drawings;<br>2. Complete the assembly process card;<br>3. Review the welding structure processability;<br>4. Develop welding procedure specification;<br>5. Develop process guidelines;<br>6. Prepare welding process card;<br>7. Prepare processing process cards;<br>8. Analyze the welding structure process. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Design and prepare technical documents based on product performance and material characteristics;<br>1.2 Guide the welding construction.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Preparation specifications for welding technical documents;<br>2.2 The importance of ensuring product quality;<br>2.3 Selection criteria of welding process parameters;<br>2.4 Evaluation criteria of welding process.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Selection of welding methods, welding materials, and welding equipment;<br>3.2 Knowledge related to welding structure process review;<br>3.3 Knowledge related to preparation of welding procedure specification; |

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| | 3.4 Filling out and analyzing relevant forms such as assembly process cards, welding process cards, and assembly process cards.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Drawing reading and drawing skills;<br>4.4 Teamwork skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Prepare technical documents based on specific product requirements, welding requirements, and related standards |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

| OCCUPATION | WELDING ENGINEER | OCCUPATION CODE | |
|---|---|---|---|
| DUTY TITLE | WELDING MANAGEMENT | DUTY NO. | 807 |
| TASK TITLE | QUALITY INSPECTION AND MANAGEMENT | TASK NO. | 8074 |
| PERFORMANCE CRITERIA | The person performing this task must be able to complete quality inspection and management according to specific welding production processes and procedures, in order to achieve control over product quality | | |
| RANGE STATEMENT | The task can be performed in the office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Computers and auxiliary equipment;<br>2. Related reference books. | | |

**EVIDENCE REQUIREMENTS**

| PRACTICAL PERFORMANCE | UNDERPINNING KNOWLEDGE |
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| The person performing this task must be able to do the following:<br>1. Evaluate the welder's qualification and skills;<br>2. Develop welding procedure specification;<br>3. Establish a scientific and effective equipment management system and strictly implement it;<br>4. Ensure the assembly quality of weldment;<br>5. Control weld repair;<br>6. Check the quality of welding structure. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Establish a welding quality system;<br>1.2 Control welding production quality in terms of materials, processes, and welding quality inspection.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Standards for welding production quality inspection;<br>2.2 Welding production quality management specification.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Construction and operation mode of welding quality system;<br>3.2 Factors affecting the quality of welding processes;<br>3.3 Quality control of welding production.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Professional skills; |

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| | 4.4 Teamwork skills;<br>4.5 Computer application skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Guide welding production according to the quality management system, conduct quality inspections of welding structures, and propose solutions for quality issues |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

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| **OCCUPATION** | WELDING ENGINEER | **OCCUPATION CODE** | |
| **DUTY TITLE** | TRAINING AND GUIDANCE | **DUTY NO.** | 808 |
| **TASK TITLE** | THEORETICAL TRAINING | **TASK NO.** | 8081 |
| **PERFORMANCE CRITERIA** | The person performing this task must be able to conduct theoretical training on the welders according to the requirements | | |
| **RANGE STATEMENT** | The task can be performed in the welding office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Classroom;<br>2. Computer;<br>3. Teaching apparatus;<br>4. Welding equipment. | | |

**EVIDENCE REQUIREMENTS**

| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
|---|---|
| The person performing this task must be able to do the following:<br>1. Comply with health and safety precautions for welding operations;<br>2. Develop theoretical training needs;<br>3. Write theoretical training handouts;<br>4. Apply basic theoretical knowledge;<br>5. Explain the key points of skill operation. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Write handouts for welding theory training;<br>1.2 Conduct theoretical training.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 The importance of theoretical training content;<br>2.2 Guidelines for writing theoretical training handouts.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Theoretical knowledge of welding training;<br>3.2 Contents of welding theory training handouts.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Presentation skills;<br>4.4 Writing skills;<br>4.5 Teamwork skills;<br>4.6 Computer application skills.<br><br>**5.0 Math Skills** |

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| | 5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Conduct theoretical training on the welders according to the requirements |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

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| **OCCUPATION** | WELDING ENGINEER | **OCCUPATION CODE** | |
| **DUTY TITLE** | TRAINING AND GUIDANCE | **DUTY NO.** | 808 |
| **TASK TITLE** | SKILL GUIDANCE | **TASK NO.** | 8082 |
| **PERFORMANCE CRITERIA** | The person performing this task must be able to conduct skill training on the welders according to the requirements | | |
| **RANGE STATEMENT** | The task can be performed in the welding office and welding workshop under the supervision of senior welding engineers or mechanical engineers.<br>The equipment and tools to be used include:<br>1. Classroom;<br>2. Computer;<br>3. Teaching apparatus;<br>4. Welding equipment. | | |

**EVIDENCE REQUIREMENTS**

| **PRACTICAL PERFORMANCE** | **UNDERPINNING KNOWLEDGE** |
|---|---|
| The person performing this task must be able to do the following:<br>1. Comply with health and safety precautions for welding operations;<br>2. Develop skill training needs;<br>3. Develop skill training plans;<br>4. Write skill training handouts;<br>5. Demonstrate the welding operation;<br>6. Explain the key points of operation;<br>7. Guide welding operations;<br>8. Clean tools, equipment and workplace;<br>9. Store tools and equipment. | **Detailed knowledge about:**<br>**1.0 Methods**<br>The person performing this task must be able to explain how to:<br>1.1 Write handouts for guidance;<br>1.2 Provide skill guidance.<br><br>**2.0 Principle**<br>The person performing this task must be able to explain the following principles:<br>2.1 Principles of common welding methods;<br>2.2 Preparation specifications for welding operation instructions;<br>2.3 Principles for developing welding skill training plans.<br><br>**3.0 Theories**<br>The person performing this task must be able to explain the following:<br>3.1 Operating techniques for different welding methods;<br>3.2 Key points for operation at different welding positions.<br><br>**4.0 Essential Skills**<br>4.1 Communication skills;<br>4.2 Management skills;<br>4.3 Presentation skills;<br>4.4 Writing skills; |

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| | 4.5 Teamwork skills;<br>4.6 Computer application skills.<br><br>**5.0 Math Skills**<br>5.1 Data analysis skills;<br>5.2 Engineering mathematics skills. |
| **DESCRIPTION ON THE END PRODUCTS / SERVICE** | Conduct skill training on the welders according to the requirements |
| **CIRCUMSTANTIAL KNOWLEDGE** | **Detailed knowledge about:**<br>1. Safe operation and use of equipment and tools;<br>2. Safe operation and use of testing tools;<br>3. Occupational health and safety;<br>4. Waste and waste disposal methods. |

**TABLE 1: DACUM CHARTS FOR WELDING ENGINEER - NTA 8**

| DUTIES | TASKS | ENABLERS |
|---|---|---|
| 1.0 SMAW APW | 1.1 Butt 45 ° fixed SMAW of low-carbon steel or low-alloy steel pipe. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Use welding technology standards<br>· Reading of welding drawings<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Knowledge and practice of SMAW<br>· Use of welding equipment<br>· Blanking and cutting<br>· Welding inspection skills and knowledge<br>· Occupational health and safety<br><br>· **Tools and equipment**<br>· Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.)<br>· Groove preparation equipment<br>· Power supply of SMAW<br>· Grinding tools, cleaning tools, and measuring tools<br>· Fixtures<br>· Electrode drying and insulation equipment<br><br>**Materials**<br>· Low carbon or low alloy steel pipe<br>· Electrodes<br><br>**Requirements for employees**<br>· Teamwork spirit<br>· Honesty<br>· Time management<br>· Quality awareness |
| 2.0 GMAW APW | 2.1 Butt 45° fixed GMAW of low-carbon steel or low-alloy steel pipe. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Use welding technology standards<br>· Reading of welding drawings<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Knowledge and practice of GMAW<br>· Use of welding equipment |

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| | | · Blanking and cutting<br>· Welding inspection skills and knowledge<br>· Occupational health and safety<br><br>**Tools and equipment**<br>· Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.)<br>· Groove preparation equipment<br>· Power supply, wire feeder and accessory equipment of GMAW<br>· Grinding tools, cleaning tools, and measuring tools<br>· Fixtures<br><br>**Materials**<br>· Low carbon or low alloy steel pipe<br>· Wires<br>· shielding gas<br><br>**Requirements for employees**<br>· Teamwork spirit<br>· Honesty<br>· Time management<br>· Quality awareness |
| 3.0 TIG APW | 3.1 45 ° fixed obstructed TIG. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Use welding technology standards<br>· Reading of welding drawings<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Knowledge and practice of TIG and other non-GMAW<br>· Use of welding equipment<br>· Blanking and cutting<br>· Welding inspection skills and knowledge<br>· Occupational health and safety<br><br>**Tools and equipment**<br>· Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.)<br>· Groove preparation equipment<br>· Power supply of TIG |

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| | | · Grinding tools, cleaning tools, and measuring tools<br>· Fixtures<br>· Tungsten grinder<br><br>**Materials**<br>· Low carbon or low alloy steel pipe<br>· Wires<br>· Tungsten electrode<br>· shielding gas<br><br>· **Requirements for employees**<br>· Teamwork spirit<br>· Honesty<br>· Time management<br>· Quality awareness |
| 4.0 FLOW of dissimilar materials | 4.1 TS of dissimilar metals.<br>4.2 FS of dissimilar materials. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Use welding technology standards<br>· Reading of welding drawings<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Knowledge and practice of TS and FS<br>· Use of welding equipment<br>· Blanking and cutting<br>· Welding inspection skills and knowledge<br>· Occupational health and safety<br><br>**Tools and equipment**<br>· Personal protective equipment (safety shoes, protective clothing, welding gloves, etc.)<br>· TS equipment and accessories<br>· Brazing furnace<br>· Grinding and cleaning tools<br>· Fixtures<br><br>**Materials**<br>· Dissimilar metals<br>· Fluxes<br>· Filler metals<br><br>**Requirements for employees**<br>· Teamwork spirit |

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| | | · Honesty<br>· Time management<br>· Quality awareness |
| 5.0 Welding of structures with poor accessibility | 5.1 Development of welding process plan.<br>5.2 Welding operation and inspection. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Welding methods and equipment usage<br>· Welding inspection<br>· Welding quality control<br>· Welding precautions<br><br>**Tools and equipment**<br>· Complete set of tools for welding<br>· Printer<br>· Regular office supplies<br><br>**Materials**<br>· Welding materials<br>· Computer<br>· Regular office supplies<br><br>**Requirements for employees**<br>· Teamwork spirit<br>· Honesty<br>· Time management<br>· Quality awareness |
| 6.0 Robot welding | 6.1 Robot welding process optimization.<br>6.2 Robot arc welding.<br>6.3 Robot spot welding. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Use the manufacturer's manual<br>· Use welding technology standards<br>· Reading of welding drawings<br>· Welding principle and defect control<br>· Welding of metal materials<br>· Welding structure manufacturing<br>· Programming and practice of robot welding<br>· Skills and knowledge in industrial robots and welding systems<br>· Knowledge of arc welding and spot welding<br>· Use of welding equipment<br>· Blanking and cutting |

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| | | · Welding inspection skills and knowledge<br>· Occupational health and safety<br><br>**Tools and equipment**<br>· Workstation of welding robots<br>· Personal protective equipment such as safety shoes, goggles, gloves, hearing protector, safety helmets, etc<br>· Angle grinder, hammer and other auxiliary tools<br><br>**Materials**<br>· Gas<br>· Wires<br>· Welding materials such as steel plates<br>· Computer<br>· Programming software<br><br>**Requirements for employees**<br>· Teamwork spirit<br>· Strict operation<br>· Time management<br>· Keeping promises |
| 7.0 Welding management | 7.1 Welding production management.<br>7.2 Welding construction management.<br>7.3 Preparation of technical documents.<br>7.4 Quality inspection and management. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Production or construction cost budget<br>· Technical measures for welding production safety<br>· Control over the technical quality of the construction site<br>· Control and disposal of welding waste and noise pollution<br>· Make welding assembly drawings<br>· Review the welding structure processability<br>· Develop technical documents such as Welding Procedure Specification and procedure specification<br>· Analyze the welding structure process<br>· Qualification of welders, review of skills and welding processes |

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| | | · Implement welding process discipline<br><br>**Tools and equipment**<br>· Drawing software<br>· Calculators, etc.<br><br>**Materials**<br>· Computer<br>· Print cartridge<br>· Printer<br>· Printing paper<br><br>**Requirements for employees**<br>Teamwork spirit, honesty and trustworthiness, time management, and keeping promises. |
| 8.0 Training and guidance | 8.1 Theoretical training.<br>8.2 Skill guidance. | **General skills and knowledge**<br>· Cooperate with others using communication skills and report to the superiors<br>· Select appropriate tools and protective equipment<br>· Use and maintenance of protective equipment<br>· Theoretical knowledge of welding training<br>· Knowledge related to welding skill training<br>· Preparation method for welding theory training handouts<br>· Preparation principles for welding operation instructions<br><br>**Tools and equipment**<br>· Personal protective equipment such as helmets, safety shoes, goggles, gloves, etc<br>· Teaching apparatus<br>· Welding equipment<br><br>**Materials**<br>· Computer<br>· Welding materials such as electrodes, wires, shielding gas, etc.<br><br>**Requirements for employees** |

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| | | Teamwork spirit, honesty, time management, and keeping promises |