| Eskom | Specification | Peaking |
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Title: Technical Specification for Gariep Hydroelectric Power Station **Welding, Machining and Associated Services**

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# 1. BACKGROUND

The Gariep (GRP) Hydroelectric Power Station turbine plants necessitate specialised welding and associated services during the Mini Overhaul (MO) outages to support the refurbishment and maintenance of turbine components to ensure plant availability, reliability as well as production performance.

The Power Station consists of four units each with separate vertical shaft turbine plants capable of generating 90 MW individually, operating at 136.4 rpm with a maximum net head of 62.5m. The turbine plant generally consists of a main shaft rotating by means of water flowing through a runner of the turbine, which turns the rotor of the generator and generate electricity to the national grid of South Africa.

This Technical Specification outlines the detailed requirements for welding, general machining and associated services including, but not limited to equipment, setups, consumables, material supply, machining, heat treatment, personnel qualifications, applicable design codes, quality control measures, documentation, testing and inspection and acceptance criteria.

# 2. DESCRIPTION OF THE *WORKS*

## 2.1 *Employer*'s objectives

The *Employer*'s objective is to establish a welding and associated services contract with a suitably experienced *Contractor* to execute welding repairs during the Gariep (GRP) MO outages in accordance with this Technical Specification. The outages, which are subject to possible date and duration changes, are currently scheduled for March 2027 (GRP Unit 2), April 2027 (GRP Unit 3), June 2027 (GRP Unit 4) and July 2028 (GRP U1). The MO outages are currently limited to 25 days for GRP U2 and GRP U1, while GRP U3 and GRP U4 are currently scheduled for 31 days.

## *2.2* Brief description of the *works*

The *works* include provision of manpower, consumables, tools, equipment, quality control and associated services, such as welding, general machining and heat treatment, by the *Contractor* during the planned MO outages, to perform the specified welding according to the applicable codes, standards and *Employer*'s requirements.

# 3. WORK TO BE PERFORMED BY THE *CONTRACTOR*

## 3.1 Specifications

The *Contractor* adheres to the following in providing the *works*:

a) The *Employer*'s safety rules
b) The *Employer*'s codes of practice
c) All the documents stated in this document.

## 3.2 Scope of work

The *works* to be performed by the *Contractor* include the following:

### 3.2.1 Turbine Components' Welding and Machining Works

Various components within the turbine plant, for each unit, require welding, associated general machining and potential heat treatment during the MO outages.

### 3.2.1.1 Spiral Casing Liner, Stay Vanes and Mandoor Repairs

Spiral casing and stay vane inspections will be conducted by the *Employer,* and all identified areas of concern will be handed over to the *Contractor* for repair welding. General information to be utilised as input for the repair procedure is given as per the table below.

**Table 1: Spiral casing, stay vanes and mandoor information**

| Item | Code | Dimensions [mm] | Material Specification | Drawing | Plant Parameters / Additional Information |
|---|---|---|---|---|---|
| [1]Spiral casing liner<br>(shell plates) | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | Ø: 5460 - 2360<br>t: 18 - 72 | JIS G3106<br>SM50B (modified) | 0.38/131<br>0.38/2231 | Temperature: Ambient<br>Design Pressure: 10.13 Bar<br>[4]Weld Position: Various<br>[4]In-situ welding<br>[4]Weld Type: Weld build-up<br>[4]Weld Process: SMAW/TIG<br>[4]Machining/Excavation: Grinding; Blending; Polishing<br>[7]NDT Request: PT/MPI/UT |
| [2]Stay vanes | | t: 100<br>length (l): ±500<br>height (h): 1385 | BS 968 High Tensile Weldable Structural Steel | 0.38/151<br>0.38/193 | Temperature: Ambient<br>Design Pressure: 10.13 Bar<br>[5]Weld Position: Vertical<br>[5]In-situ welding<br>[5]Weld Type: Weld build-up<br>[5]Weld Process: SMAW/TIG<br>[5] Machining/Excavation: Grinding; Blending; Polishing<br>[7]NDT Request: PT/MPI/UT |
| [3]Spiral casing mandoor, flange and reinforcement pad | | t: 18 - 35 | JIS G3106<br>SM50B (modified) | N/A | Temperature: Ambient<br>Design Pressure: 10.13 Bar<br>[6]Weld Position: Various<br>[6]Weld Type: Weld build-up<br>[6]Weld Process: SMAW/TIG<br>[6]Machining: Excavation, Grinding, Polishing<br>[7]NDT Request: PT/MPI/UT |

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| 1 | The spiral casing is a steel-lined, gradually narrowing spiral passage that is fully concrete-embedded and internally coated. Its function is to evenly guide and regulate the water flow from the penstock to the turbine runner. |
| 2 | The stay vanes are fixed, profiled components that are fully coated, and their function is to guide the incoming water from the spiral casing through the guide vanes and onward to the turbine runner. |
| 3 | Access to the spiral casing is provided through a flanged access door that is internally coated. A gasket installed between the sealing faces of the spiral-casing flange and the mandoor flange ensures proper sealing at the access interface. |
| 4 | For the spiral casing liner, defects may average to 5 mm in depth and may occur either locally or over broader areas. Repairs consist of restoring the original wall thickness by performing in-situ weld build-ups on all identified defect locations. The *Contractor* is advised that the actual defect depths will only be confirmed during inspection. Welding positions will vary depending on defect location, and the preferred welding processes are manual SMAW or GTAW. All weld build-ups are to be ground or polished to match the surrounding surfaces. |

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| 5 | For the stay vanes, typical defects consist of localised pit-type craters that may reach average depths of 10 mm. Repairs are to be carried out by the *Contractor* through in-situ weld build-ups using manual SMAW or GTAW in the vertical welding position, due to the fixed and profiled nature of the stay vanes. All weld build-ups are to be ground or polished to blend with the surrounding surfaces. |
| 6 | For the spiral casing mandoor, any defects, typically localised corrosion or erosion damage, are to be repaired by weld build-up to restore the original design dimensions. The sealing faces on both the mandoor flange and the spiral-casing access-manhole flange will be thoroughly inspected, and all identified defects or surface indications will be formally handed over to the welding *Contractor* for repair. The preferred welding processes are manual SMAW or GTAW. Following welding and the subsequent machining or blending operations, all sealing surfaces will be free of localised high or low areas and will achieve a surface finish of 0.8 µm Ra or better to ensure proper sealing. |
| 7 | The *Contractor* will request NDT, from the *Employer*'s Outage Management department, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths, orientations and application. |
| Refer to Addendum A Section 13.1 Spiral Casing Liner, Stay Vanes and Mandoor Repairs for additional figures and information pertaining to the spiral casing repairs:<br>• Figure 1: Spiral casing typical liner damage<br>• Figure 2: Example of typical damage on vertical stay vane<br>• Figure 3: Spiral casing mandoor | |

### 3.2.1.2 Draft Tube Liner and Mandoor Repairs

The *Employer* will conduct draft tube inspections, and all identified defects will be handed over to the *Contractor* for repair welding. Refer to the table below for summarised information required to determine the repair procedure.

**Table 2: Draft tube and mandoor information**

| Item | Code | Dimensions [mm] | Material Specification | Drawing | Plant Parameters / Additional Information |
|---|---|---|---|---|---|
| [1]Draft tube liner (upper and lower) | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | $T_{upper}$: 22<br>$Ø_{upper}$: 4900 - 5600<br>T_lower: 9 - 16<br>$Ø_{lower}$: Various, refer to drawings | BS 15 Mild Steel Plate for Structural Purposes | 0.38/1000<br>0.38/2225 | Temperature: Ambient<br>Pressure: 1.5 Bar<br>[3]Weld Position: Vertical<br>[3]In-situ welding<br>[3]Weld Type: Weld build-ups<br>[3]Weld Process: SMAW/TIG<br>[3] Machining/Excavation: Grinding; Blending; Polishing<br>[5]NDT Request: PT/MPI/UT |
| [2]Draft tube mandoor and sealing faces | | t: 16-40<br>Seal face flange width: 120<br>Door: 1085 x 1100 | | 0.38/105 | Temperature: Ambient<br>Pressure: 1.5Bar<br>[4]Weld Position: Various<br>[4]In-situ welding<br>[4]Weld Type: Weld build-ups<br>[4]Weld Process: SMAW/TIG<br>[4]Machining: Excavation; Grinding; Blending; Polishing<br>[5]NDT Request: PT/MPI/UT |

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| 1 | The draft tube is a steel lined, coated and shape altering tube at the discharge of the turbine runner that is embedded in concrete. The draft tube varies from circular in shape with a vertical orientation (upper draft tube at turbine discharge) to an oval shape with a horizontal orientation (lower draft tube at turning point) to a rectangular shape with an upwards sloping orientation (lower draft tube to lower dam discharge) as it approaches the lower dam. |
| 2 | Access to the draft tube is obtained through a vertical orientated rectangular flanged access door. Sealing is ensured by a gasket installed between the two sealing faces (draft tube flange face and door flange face). |
| 3 | Typical draft tube liner defects can be either localised or spread over a wider area with an averaged depth of 5 mm. General maintenance previously consisted of cleaning these concerned areas and coating with corrosion protection epoxy. The weld repairs will consist of in-situ wall thickness restoration by means of weld build-ups of all identified areas. The *Contractor* to take note that actual defect depths will only be known upon inspection and depending on where the defects are found, the welding positions will most likely be vertical for the upper draft tube, while various welding positions will be required for the lower draft tube due to orientation. The preferred welding processes to be utilised by the *Contractor* are manual SMAW or GTAW. The weld build-ups are to be ground/polished to suit the surrounding areas. |
| 4 | For the draft tube mandoor, any defects, typically localised corrosion or erosion damage, will be repaired by weld build-up to restore the original design dimensions. The sealing faces on both the mandoor flange and the draft tube access-manhole flange will be thoroughly inspected, and all identified defects or surface indications will be formally handed over to the welding *Contractor* for repair. The preferred welding processes are manual SMAW or GTAW. Following welding and the subsequent machining or blending operations, all sealing surfaces will be free of localised high or low areas and will achieve a surface finish of 0.8 µm Ra or better to ensure proper sealing |
| 5 | The *Contractor* will request NDT, from the *Employer*'s Outage Management department, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths and application. |
| Refer to Addendum A Section 13.2: Draft Tube Liner and Mandoor Repairs for additional figures and information pertaining to the draft tube repairs:<br>• Figure 4: Draft tube liner damage<br>• Figure 5: Draft tube access mandoor | |

### 3.2.1.3 Turbine Runner Blade Repairs

Turbine runner defects, identified by the *Employer*, are to be repair welded by the *Contractor*. The table below summarises necessary information that will serve as input to the repair procedure.

**Table 3: Turbine runner information**

| Item | Code | Dimensions [mm] | | Material Specification | Drawing | Plant Parameters / Additional Information |
|---|---|---|---|---|---|---|
| [1]Turbine runner | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | t: | 22-750 | Runner/Blades: JIS G5121 SCS1<br>Cone: JIS G3101 SS41P | 0.38/151<br>0.38/505 | [2]Weld position: Various<br>[2]In-situ on-site welding<br>[3]Weld Type: Weld build-ups<br>[3]Machining: Excavating; Grinding; Blending; Polishing<br>[4]Weld process: GTAW & PWHT<br>[5]NDT Request: PT; UT; HT |

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| 1 | The vertical turbine runner captures energy from the water flow and transmits it through the connecting shaft to drive the generator, producing electricity. The runner comprises of 15 blades manufactured from martensitic stainless cast steel (JIS G5121 SCS1) and a runner cone fabricated from carbon structural steel plate (JIS G3101 SS41P). The *Contractor* will perform a positive material identification (PMI) test to verify the material specifications of both the blades and the cone. |
| 2 | Runner orientation is vertical, but blades are curved, thus depending on where the defects are located the welding position will be determined. Possible weld repairs on the cone may be required in various welding positions, most likely including overhead and vertical. In-situ weld repairs, due to the runner being fixed to the shaft, are to be performed by the *Contractor*. |
| 3 | Typical localised blade defects can be up to 10 mm deep in extreme cases, while dispersed defects such as cavitation can be over a slightly larger area but generally do not reach depths of more than 5mm. The repairs will consist of weld build-ups and will be ground/polished to suit the surrounding areas to ensure the profile of the runner blades are maintained. Typical cavitation damages noticed on each of the Gariep runner blades include trailing edge cavitation and runner blade low-pressure area cavitation. The trailing edge cavitation generally consists of an approximate area of 30mm x 500mm with a depth of 5mm, while the low-pressure cavitation area repair covers an area of approximately 200mm in diameter with a depth of 5mm. An assessment to be done by the *Contractor* whether distortion, due to welding and PWHT, might affect turbine blade profile and turbine labyrinth clearances prior to welding. |
| 4 | The runner is a martensitic stainless-steel casting, as indicated above, and PWHT will be required in general, except if defects are very shallow and a welding procedure without PWHT have been qualified by the *Contractor* for the applicable dimensional range. The welding *Contractor* will comply with the general welding requirements as per section 3.2.2. GTAW will be performed for any runner repairs by the *Contractor*. |
| 5 | The *Contractor* will request NDT, from the *Employer*'s Outage Management department, consisting of 100% PT and 25% UT for weld build-ups. Additionally, 25% Hardness Testing (HT) is required. |
| Refer to Addendum A Section 13.3: Turbine Runner Blade Repairs for additional information and figures pertaining to typical runner blade damage:<br>• Figure 6: Turbine blade trailing edge cavitation<br>• Figure 7: Turbine blade low pressure area cavitation | |

### 3.2.2 Welding Requirements

#### 3.2.2.1 General Welding Requirements

The following requirements are applicable for all welding:

- The *Contractor* responsible for the welding shall be ISO 3834-2 certified (current) and approved, in terms of the relevant Product/Construction Standards, Welding Processes and required Parent Material Groups, by the *Employer* to perform Level 1 plant welding related work (maintenance, refurbishment and fabrication).
- All welding shall be performed in accordance with 240-106628253 Standard for Welding Requirements on Eskom Plant, including all referenced standards therein.
- The *Contractor* can subcontract other companies to carry out certain services, such as Heat Treatment (HT) and machining, given that these companies are adequately qualified. The *Contractor* will remain responsible for the final product.
- The *Contractor* shall provide all necessary tools, equipment, resources, consumables and relevant services to complete the *works*.
- The *Contractor* shall carry out site-based and off-site work as required. The *Contractor* shall clearly indicate which components and sections of the works will be performed off-site at the facilities of the *Contractor* or sub-*Contractor*.
- The *Contractor* must be able to qualify Welding Procedure Specifications (WPS/WPQR) as well as welders, if necessary and in accordance with the Standard for Welding Requirements

on Eskom Plant (240-106628253), to complete the welding requirements within the outage duration. The WPS/WPQR and welder qualifications shall be authorised by the *Contractor*'s IWE/IWT and independent AIA.

- All welding documentation will be subject to acceptance by the *Employer*.
- The *Contractor* shall perform Positive Material Identification (PMI) of all base materials prior to welding as well as verify the relevant thicknesses to ensure the correct welding procedure is implemented.
- For each refurbishment item, as per Section 3.2.1, the following shall be implemented and required by the *Contractor*:
    - All repairs shall be assessed to determine whether the *Employer*'s stipulated welding process, consisting either of GTAW or SMAW, is appropriate.
    - All repairs or welds shall be assessed in terms of application, dimensions, weld position, parent material and the requirement for heat treatment to determine the most appropriate repair procedure.
    - The *Contractor* shall ensure that the correct cutting, profiling and brushing tools, in terms of material, are utilised for the various parent materials to prevent unwanted weld contamination and adverse effects.
    - Proper cleaning and degreasing of the identified areas shall be implemented prior to welding.
    - The necessary weld preparations and machining of the parent materials shall be implemented, including excavation of defects, removal of weld metal as well as heat affected zones (HAZ) of previous welds.
    - All welding shall be done according to a qualified Welding Procedure Specification (WPS) and by a qualified welder, subject to the *Employer*'s acceptance.
    - The *Contractor* shall perform machining, profiling, blending and polishing of the weld repair to match the surrounding area to achieve a surface finish of 0.8µm Ra or better for all sealing surfaces only.
    - The *Contractor* shall control and monitor for distortion during welding.
    - The necessary heat treatment (pre-heat, interpass, PWHT and bake-outs), as and when required, according to the parent material and qualified welding procedure shall be thoroughly implemented. Tempilstiks (or other proven methods), where possible, to be utilised for quality control purposes.
    - General cleaning, including removal of slag where necessary, upon completion of welding shall be implemented.
    - The *Contractor* shall perform and document the necessary inspections, consisting of visual and dimensional inspections, throughout the welding process.
    - The *Contractor* shall request the necessary Non-Destructive Testing (NDT) throughout the welding, repair and machining process, as and when required, from the *Employer*'s Outage Management department.
    - The implementation of proper stainless-steel pickling and passivation, where necessary.
- The *Contractor* takes note that all drawings will be made available upon request and after signing of a non-disclosure agreement (NDA). All drawings shall be discarded off after tender award, should the tenderers not be successful, or after the contract period, should the tenderer be successful.

#### 3.2.2.2 Codes & Standards and Specifications Requirements

Welding Procedure Qualifications as well as Welder (or welding operator) Qualifications shall be in accordance with the appropriate welding standard incorporated into the design and construction code. The relevant design and construction code for each item to be repair welded are indicated for each item as per Section 3.2.1.

Numerous components, as specified per Section 3.2.1, to be repair welded have unconfirmed design and construction codes, for which the *Employer* requires a conservative approach. Therefore, the *Employer* prefers that Welding Procedure Qualifications shall be performed in accordance with BS EN 15614-1 Level 2, and Welder Qualifications shall be conducted in accordance with ISO 9606-1. Alternatively, ASME IX is also acceptable. Overlay Welding Procedure Qualifications shall be according to BS EN 15614-7 and will be specific to corrosion resistant overlay welding, alternatively ASME IX is also acceptable.

Any possible exceptions to this must be motivated, by the *Contractor*, for approval by the *Employer* through a concession. Combining and mixing of different family code specifications on a single weld are not allowed.

The latest revision of all relevant codes, standards and specifications shall be implemented to ensure compliance.

#### 3.2.2.3 Non-Destructive Testing (NDT) & Acceptance Criteria

All welding NDT is performed according to the requirements of the *Employer* as detailed in the Standard for Non-Destructive Testing (NDT) on Eskom Plant, 240-8353994. The *Employer*'s NDT service provider is responsible for this function; therefore, the requirement of NDT services will not be part of this *works*.

The *Contractor,* for the *works* as per this welding technical specification, is responsible for the inspection of welding set-ups, welding preparations and NDT inspection requests, to the *Employer*'s Outage Management department, for completed weldments. The *Contractor* will only liaise with the *Employer*'s NDT service provider to ensure the correct areas are inspected and that the correct information is captured on the NDT reports. Furthermore, the *Contractor* must notify the *Employer*'s Outage Management department 1 day in advance for NDT requests. The *Contractor* is allowed to perform in-house NDT, however it shall be subject to the *Employer*'s approval, depending on the criticality and application, and the in-house NDT shall be clearly indicated on the QCPs. All critical and final NDT inspections shall be done by the *Employer*'s service provider.

The *Contractor* takes note of the following information:

- NDT will be done, by the *Employer*'s NDT service provider, on all welds performed by the *Contractor*.
- The relevant design/construction code, application, weld type, material, process, position and geometry will determine the type of NDT that will be done. Fillet Welds will be limited to Surface Inspection only, consisting of 100% Liquid Penetrant Testing (PT) or Magnetic Particle Inspection (MPI), depending on the material. Butt Welds, Weld Build-Ups and Corrosion Resistant Overlay Welding will consist of 100% Surface Inspection (either PT or MPI) as well as Volumetric Inspection, to a certain percentage, consisting of Ultrasonic Testing (UT). For welds where PWHT (Post Weld Heat Treatment) was implemented, Hardness Testing will be required.
- NDT will still be indicated in the *Contractor*'s Quality Control Plan (QCP).
- NDT acceptance criteria will be as per the following:
    - BS EN ISO 5817 Welding Quality Levels for Imperfections – Quality Level B, alternatively the acceptance criteria of the WPS qualification/construction code will also be acceptable.

#### 3.2.2.4 Heat Treatment Requirements

Heat Treatment (HT) includes Pre-Heat, Interpass, Post Weld Heat Treatment (PWHT) and Post Welding Bake-Out, where applicable, and shall be clearly indicated in the Quality Control Plan (QCP).

The *Contractor* shall implement HT in accordance with an applicable qualified WPS, subject to the *Employer*'s review and acceptance, prior to commencement of the *works*.

The *Contractor* provides valid calibration certificates, subject to the *Employer*'s acceptance, for all relevant HT, especially PWHT, equipment and must be included in the final databook.

Pre-Heating requirements, to be adhered to by the *Contractor*, include the following:

- Resistance heating or induction heating is allowed, and preferred depending on the application and practicality, and must be done in accordance with an approved HT procedure subject to the *Employer*'s acceptance.
- Gas preheating is allowed provided there is a low risk for spot heating and resistance heating pad set ups are not practical, subject to the *Employer*'s acceptance.
- Whatever method of preheating is used, care must be taken to ensure that the temperatures recorded are representatives of those at the inner surface before welding commences, especially for thick-walled components.
- Constant monitoring of the process is required to ensure that the correct temperatures as set out in the WPS are being achieved by means of using a calibrated contact thermometer (e.g. thermo crayons such as Tempilstick, digital thermometer) prior to welding.

Interpass Temperature requirements, to be complied with by the *Contractor*, include the following:

- Interpass temperature, as per the qualified WPS, is monitored between welding passes and is the temperature immediately before each weld pass is performed.
- Welding will only continue once the correct temperature is obtained.

PWHT requirements, to be adhered to by the *Contractor*, include the following:

- Resistance heating or induction heating is allowed, and preferred depending on the application and practicality, and must be done in accordance with an approved HT procedure subject to the *Employer*'s acceptance.
- The temperature ranges, for the applicable material, must be according to the applicable design/construction code, material specification, or according to the agreed code for cases where the design/construction code is unknown.
- The welds and areas to be heat treated must be free from any products such as grease, lubricants and coatings that can adversely affect the HT process.
- The areas to be heat treated and surroundings must be protected against oxidation and mechanical damage.
- Where applicable open ends are closed off to prevent the cooling associated with draughts.
- The *Contractor* ensures that insulation is securely fastened using the appropriate strapping technique suitable for the intended temperature range and that no gaps from insulation to component and insulation to heating pads are present.
- The type of thermocouples and the relevant attachment method must be provided by the *Contractor* and must be in accordance with the requirements of the thermocouples, heating band and insulation. Additional thermocouples must be fitted at each controlling point as back up for use in the event of primary thermocouple failing. A detailed sketch must be provided by the *Contractor*.
- The heating pads must be securely strapped to the component for the duration of the heating cycle.
- Time at soaking temperature is measured from the time when the last thermocouple reading reaches the min temperature of the specified range.

- The *Contractor* must ensure constant supervision, and that HT equipment is attended to by suitably qualified technicians and operators, provided by the Heat Treatment sub-*Contractor*, should this service be subcontracted, if not, by the *Contractor* themselves.
- The equipment must be of a proper make suitable for HT and it shall bear proper electrical power input/output.
- Upon completion of the PWHT cycle, the *Contractor* shall:
  - Examine the component for distortion, discolouring, damage and arching.
  - Clean/polish the thermocouple attachment areas and conduct surface crack inspections (PT).
  - Ensure review and signature of the PWHT chart by the *Contractor*'s IWE/IWT.
- Repair welding after PWHT shall not be permitted.
- The *Contractor* shall provide a PWHT method statement, specific to each relevant weld and subject to the *Employer*'s acceptance prior to commencement of the work, as per the following minimum requirements:
  - Compiled strictly in accordance with the applicable qualified WPS and signed by the *Contractor*'s IWE/IWT.
  - Include the number and position of thermocouples and their relation to the heater, the component and the PWHT recorder as well as the function of each i.e. controlling, monitoring or half-peak, with the actual reference points for the thermocouples recorded in terms of distance (mm from 0 reference point).
  - Include the method of heat treatment e.g. furnace, inductive or resistance.
  - Include the position and dimensions of the heating, soaking and insulation band.
  - Include the method of heating control to obtain uniform heating without creating localised hotspots.
  - Include the minimum and maximum heating and cooling rates in ˚C per hour, as per the qualified WPS.
  - Include the minimum and maximum soak temperature in ˚C per hour, as per the qualified WPS.
  - Include the method for stabilising all temperature measurements before reaching soaking temperature.
  - Include the insulation type and characteristics.
  - Include cooling conditions, i.e. still air, forced cooling, etc., and the prevention of harmful thermal gradients that must be avoided at all times in all situations.

#### 3.2.2.5 Welding Filler Materials

Filler materials shall be supplied by the *Contractor* and selected based on the parent materials as well as the application and shall comply to the relevant standards as required per Section 7 of the *works*.

The *Contractor* shall ensure proper identifying, drying, storing and handling of electrodes and filler wires related to the manufacturer's recommendations as well as relevant standards.

The *Contractor* shall provide type 3.1 Material Certificates for quality assurance and traceability purposes, in accordance with EN 10204, for all filler materials (electrodes, wires & rods) that will be utilised during weld repairs as specified within each of the Qualified Welding Procedures, subject to the *Employer*'s review and acceptance prior to any welding.

#### 3.2.2.6 Supply of Materials

All materials supplied by the *Contractor*, where applicable, shall be accompanied by a 3.1 Material Certificate for quality assurance and traceability purposes, in accordance with EN 10204. Material verification, for supplied materials, shall be part of the QCP. The heat number, referenced by the material certificate, shall be visible on the material during witnessing by the *Employer*.

### 3.2.2.7 Welders, Welding Operators and Labour

In addition to the personnel and qualification requirements, as per 240-106628253 Standard for Welding Requirements on Eskom Plant, the following skilled resources are required to perform welding related work to complete and fulfil the requirements of the *works*:

- Qualified Quality Controller – Level 2 SAIW Inspector Qualification
- Qualified Boilermakers – Boilermaker Trade Test
- Semi-Skilled Labourers – Matric or N3 Mechanical Engineering Certificate

The *Employer* reserves the right to conduct periodic audits of the *Contractor* to ensure compliance with these requirements. The *Contractor* is required to provide proof of qualifications to the *Employer* for all the required personnel working on the *Employer*'s plant.

### 3.2.2.8 Pickling and Passivation of Stainless Steel

The *Contractor* shall perform pickling and passivation of all stainless-steel surfaces that were exposed to heat due to welding, grinding or heat treatment. Typical formulations based on hydrofluoric (HF), and nitric ($HNO_3$) acids remove scale, contaminants as well as the underlying chromium depleted layer and restore the corrosion resistance. The formulation is to be accepted by the *Employer* and can typically range, but is not limited to, between 15-20% $HNO_3$ and 1-1.5% HF based on volume. It is recommended that the *Contractor* make use of either gel or pastes, and the necessary safety precautions are followed during handling and application.

### 3.2.2.9 Equipment Requirements

The *Contractor* supplies all equipment, tools and gear required to complete the *works* with the desired surface finishes, sizes and tolerances. The *Contractor*'s equipment must be in a reliable, maintained and calibrated condition to deliver the *works* and quality requirements, including, but not limited to, hot boxes, temperature measuring equipment, recording equipment, welding machines, power sources, power tools, PMI equipment, measuring equipment and machining equipment as well as safety equipment and protective clothing.

The *Contractor* takes note of an equipment voltage regulation relevant to all equipment and machinery utilised within the unitised cylindrical steel liner enclosing the turbine, turbine pit and generator throughout all the floor levels. The regulation prohibits usage of equipment more than 24 Vac / 60 V DC within confined conductive areas. Therefore, the following must be complied with:

- Lighting and power tools: Maximum 24Vdc and is recommended to be battery operated
- Handheld Lamps: Maximum 12Vdc
- Power Source: 230 Vac inverted to 24 Vdc and located outside of the confined space area
- 230 Vac / 400 Vac portable equipment must not enter the confined space
- Voltage while welding: To be confirmed by the welding *Contractor* and should preferably be less than 60Vdc (open circuit voltage and welding/idle voltage). Voltage reduction device functionability is required, within the welding machines, for compliance due to open circuit voltage that might be more than 60 Vdc.
- KVA machine (PWHT): Equipment to be located outside of confined space with only leads entering and installed onto components. Entry to confined space and components to be prohibited while in progress. The machine capabilities and specifications to be issued to the *Employer*, such as output voltage and whether AC or DC. The output must be earthed and protected via residual current device (RCD). The heating pad cables to be double insulated. The above will serve as input to determining the risk, PWHT method and the safe working proximity.

All equipment and machinery used must meet the requirements of the Electrical Machinery Regulations in terms of their design, construction and earthing. The power supply details for each of the *Contractor*'s equipment and machinery and setup, including voltage and current distribution within each cable, is subject to the *Employer*'s review and approval.

#### 3.2.2.10 Welding Concessions

The *Contractor* shall motivate, by means of an official concession request, for any allowable exceptions or deviations to this technical specification document that might arise during the outage. Concessions due to poor planning or undeclared technical deviations will not be considered.

## 4. WORK TO BE PERFORMED BY THE *EMPLOYER* FOR THE *WORKS*

### 4.1 Inspection

The *Employer* has the right to perform various inspection, witness and hold points of the *works* at any time during the execution of the *works*, including dimensional inspections.

### 4.2 Documentation Review and Acceptance

The *Employer* reviews all required documentation, submitted by the *Contractor*, for acceptance to ensure compliance prior to implementation of the *works*.

### 4.3 NDT

The *Employer*'s appointed NDT service provider will be responsible for all NDT inspections.

## 5. *EMPLOYER*'S PHILOSOPHY

### 5.1 Engineering philosophy

Fully operational capability of the Pump/Turbine unit, improved reliability and maintainability of the Turbine system at Gariep Hydroelectric Power Station.

### 5.2 Maintenance philosophy

Welding repairs of critical components executed by an experienced and certified *Contractor* that provides the required quality and quality control will ensure that proper maintenance can be executed during the MO outages.

## 6. DRAWINGS

The following drawings are supplied, upon request, to the *Contractor* as part of the *works*.

| Drawing Number* | Title |
|---|---|
| 0.38/131 | Layout Drawing Unit 1-4 Hydro Turbine-Spiral Casing |
| 0.38/2231 | Spiral Casing |
| 0.38/151 | Gariep Power Station Hydro Turbine (MEA) Water Turbine |
| 0.38/193 SHT 5 | Stay Ring |
| 0.38/1000 | Outline of Upper Draft Tube Liner |
| 0.38/2225 | Lower Draft Tube Liner |
| 0.38/105 | Man-Door for Upper Draft Tube Liner |

| | |
|---|---|
| 0.38/505 | Gariep Power Station Hydro Turbine-Runner (MEA) |

**Refer to the latest revision of these drawings. Drawings will be made available to the Supplier by the Employer, subject to the signing of an NDA and it will be purely for the purpose of this Technical Specification.*

## 7. SPECIFICATIONS

The *Contractor* adheres to the following in providing the required welding and associated services:

| Reference Number | Title | Date or revision | Tick if *Contractor* to obtain |
|---|---|---|---|
| ISO 3834-1 | Quality requirements for fusion welding of metallic materials - Criteria for the selection of the appropriate level of quality requirements | 2021 | ✓ |
| ISO 3834-2 | Quality requirements for fusion welding of metallic materials - Comprehensive quality requirements | 2021 | ✓ |
| 240-106628253 | Standard for Welding Requirements on Eskom Plant. | 2 | * |
| BS EN 1011 | Welding - Recommendations for welding of metallic materials.<br>Part 1: General guidance for arc welding<br>Part 2: Arc welding of ferritic steels<br>Part 3: Arc welding of stainless steels | 2009 | ✓ |
| BS EN ISO 15609 | Specification and qualification of welding procedures for metallic materials - Welding procedure specification | 2019 | ✓ |
| BS EN 15614-1 | Specification and qualifications of welding procedure for metallic materials - Welding procedure test - Arc and gas welding of steels and arc welding of nickel and nickel alloys | 2017 | ✓ |
| BS EN 15614-7 | Specification and qualifications of welding procedure for metallic materials - Welding procedure test - Overlay welding | 2016 | ✓ |
| ISO 9606-1 | Qualification testing of welders - Fusion welding - Steels | 2012 | ✓ |
| BS EN 13480 | Metallic industrial piping | 2024 | ✓ |
| ASME VIII Div 1 | BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1 | 2025 | ✓ |
| ASME IX | BPVC Section IX - Welding, Brazing, and Fusing Qualifications | 2025 | ✓ |
| 240-83539994 | Standard for Non-Destructive Testing (NDT) on Eskom Plant | 3 | * |
| BS EN ISO 5817 | Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality Levels for Imperfections | 2023 | ✓ |

| | | | |
|---|---|---|---|
| EN 10204 | Metallic products - Types of inspections | 2004 | ✓ |
| SABS 10238 | Welding and Thermal Cutting Processes - Health and Safety | 2011 | ✓ |
| OHSA No. 85 of 1993 | Occupational Health and Safety Act. () | 1993 | ✓ |
| NEMA Act. 107 of 1998 | National Environmental Management Act | 1988 | ✓ |

*Available on request as these standards or procedures are *Employer* specific documents.

✓ Standards and codes, and the latest revisions thereof, to be obtained by the *Contractor* from the relevant standard organisation.

## 8. CONSTRAINTS ON HOW THE *CONTRACTOR* PROVIDES THE *WORKS*

### 8.1 Identification

The *Contractor* and their employees carry identification at all times while on site.

### 8.2 Visual and Dimensional Inspections

The *Contractor* is responsible to perform visual and dimensional inspections prior to, during and upon completion (final inspection) of the *works*, for each of the items as per Section 3.2.1, and submit a detailed report, subject to the *Employer*'s approval, for record purposes.

### 8.3 Loading and Offloading

The *Contractor* is responsible for loading and offloading of tools, equipment as well as all the *Employer*'s components being sent off-site, if any, as part of the *works* and associated services.

### 8.4 Quality management

The *Contractor* is responsible for Quality Control to ensure the performed welding and associated services meet the requirements of the *Employer*. Quality, inspection, testing and documentation requirements include the following:

- No work will be done without a quality control plan (QCP) that is accepted by the *Employer.* A QCP will therefore be submitted to the *Employer* for each item as per Section 3.2.1, no later than 2 weeks prior to each of the MO outage start dates.
- Each QCP shall contain a space, separate from the individual intervention points, where the names of the nominated quality representative from each party will print their names and sign next to it; this is to aid signature identification.
- Intervention points will be signed as work progresses and no backdating will be allowed.
- The *Contractor* will notify the *Employer* of interventions at least 24 hours in advance for on-site interventions and 72 hours for off-site interventions.
- QCPs will make provision for referencing of the relevant documents.
- The following minimum intervention points must be included in each of the weld repair QCPs for the *Employer*'s quality control representative:
    - Approval of QCP (H)
    - As-Found Inspection (W)
    - PMI (Positive Material Identification) (H)
    - NDT Procedures and Operators (H)
    - Weld Maps (R)
    - WPS/WPQR (H)

- Welder Qualifications (H)
- Welding Consumable Material Certificate (H)
- Material Verification (H) (for supplied material where applicable)
- Machining (W) (including general machining, only if applicable to repair)
- Weld as per WPS (S)
- PWHT (H) (only if applicable to repair)
- Final Machining (W) (only if applicable to repair)
- NDT (H)
- Final Inspection (H)
- Final Databook Acceptance (H)

### 8.5 Safety management

- The *Contractor* must understand and implement the basics in terms of Health and Safety according to SABS 10238 Welding and Thermal Cutting Processes.
- The *Contractor* complies with the Occupational Health and Safety Act. (OHSA No. 85 of 1993)
- The *Contractor* takes every precaution to ensure safety and to protect the *works*.
- The *Contractor* is responsible for the safety and security of his personnel, materials and equipment.
- The *Contractor* adheres to the safety regulations pertaining to the *Employer*'s Power Station (Gariep Hydroelectric Power Station).
- The *Contractor* provides all the required safety and personal protective equipment to his staff for the duration of the contract.

### 8.6 Environmental management

- The *Employer*'s Power Station (Gariep Hydroelectric Power Station) is situated in an environmentally sensitive area.
- The *Contractor* familiarises himself with all statutory and local environment regulations and adheres to these without exception.
- The *Contractor* complies with the Hazardous Chemical Regulations when using any hazardous chemicals, as well as complying with the requirements of the National Environmental Management Act of 1988. This includes all relevant scope of work, including, but not limited to, general cleaning of welding joints as well as pickling and passivation.

### 8.7 Security

General access to the *Employer*'s Power Station (Gariep Hydroelectric Power Station) is controlled and it is mandatory that the *Contractor* adhere to all security regulations in force during the period of the contract.

### 8.8 Other construction activities

The *Contractor* notes that there may be other work taking place during the period when he/she is providing the *works* at the *Employer*'s site and liaises with the other *Contractors* and site personnel in this regard.

### 8.9 Title to site materials

The *Contractor* has no title to plant and/or materials resulting from him/her supplying the *works*.

### 8.10 Documentation

- All documents supplied by the *Contractor* shall be of good quality and subject to the *Employer*'s acceptance.

- The *Contractor* notes that metric sizes, as specified by the International Standards Organization and agreed to by the South African Metrication Boards, are used. International System of Units (SI units) are used on drawings, pamphlets, calculations and documents.
- The *Contractor* shall provide a consolidated databook that will consist of all the documents, as required for each of the items as per Section 3.2.1, including, as a minimum and not limited to, the following:
  - QCP
    - Requirements stipulated as per Section 8.4.
  - Visual and Dimensional Inspection Reports
    - The *Contractor* shall perform as-found inspections prior to commencement of the *works*, that will be utilised to validate the correct WPS, as well as inspections upon completion for final acceptance purposes. These inspections will be indicated on the QCP and will consist of visual and dimensional inspections with findings documented, by the *Contractor*, in the form of an inspection report.
  - NDT Procedures and Operator Qualifications
    - The *Employer* will provide the relevant information, as received from the *Employer*'s NDT service provider to the *Contractor* for databook consolidation purposes as well as references within the QCP and relevant reports.
  - Method Statements
    - A method statement must be provided by the *Contractor*, only if specifically requested by the *Employer* for a given weld, otherwise a thorough and detailed QCP, subject to the *Employer*'s review, is acceptable.
  - Welding Procedure Specification (WPS) & Welding Procedure Qualification Record (WPQR/PQR)
    - The *Contractor* will provide, as per Section 3.2.2.2, a qualified WPS supported by a valid WPQR/PQR approved (signed) by the *Contractor*'s registered IWE or IWT as well as the independent AIA or notified body (examiner) who witnessed the welding and testing of the test pieces, for each of the listed items as per Section 3.2.1.
  - Welder Qualifications
    - The *Contractor* will provide, as per Section 3.2.2.2, valid Welder Qualifications (Welder Approval Certificates) approved by the *Contractor*'s IWE/IWT as well as the Authorized Inspection Authority who witnessed the welding and testing of the test pieces, for each of the listed items as per Section 3.2.1.
  - PMI Report
    - The *Contractor* will provide PMI reports, obtained from a calibrated X-Ray Fluorescence (XRF) meter, to verify the material grade of each weld repair, prior to welding.
  - Weld Map
    - A weld map will be provided by the *Contractor*, clearly indicating welded areas with allocated weld numbers for traceability purposes.
  - NDT Reports
    - NDT reports as received from the *Employer*'s NDT service provider will be reviewed by the *Contractor* to ensure accuracy and traceability. The weld numbers, as per the weld maps, must be referenced on NDT reports.
  - Welding Consumable Certificates
    - 3.1 Material Certificates, as stipulated per Section 3.2.2.5, will be provided for the welding consumables by the *Contractor*.
  - Material Certificates

- 3.1 Material Certificates, as stipulated per Section 3.2.2.6, will be provided by the *Contractor*, only if necessary, should materials be supplied by the *Contractor*.

- Approved Concessions
  - All requested concessions, with the *Employer*'s response, as stipulated per Section 3.2.2.10, will be included to the databook for reference, by the *Contractor*.
- Non-conformance Reports
  - Non-conformance Reports raised during execution of the *works* will be included to the final databook for reference.
- Heat Treatment
  - Heat Treatment Procedures, Record Graphs and Calibration Certificates - Requirements stipulated as per Section 3.2.2.4.

### 8.11 Rectification of Defects

Unacceptable indications and defects, as per the acceptance criteria of BS EN ISO 5817 or the applicable construction code, identified on the *Contractor*'s welding, by means of the required NDT that will be performed by the *Employer*'s service provider, must be repaired by the *Contractor* by means of a process subject to the *Employer*'s approval.

### 8.12 Completion

Completion is when the following has been done by completion date:

- The *Contractor* has done everything required to provide the *works,* and the *works* is accepted by the *Employer*.
- The *Contractor* submitted all signed documentation as required to the *Employer* for acceptance.
- The *Contractor*'s data book is accepted by the *Employer*.

## 9. REQUIREMENTS FOR THE PROGRAM

### 9.1 Welding Requirements for the Program

a) The *Contractor* submits a quality control plan for the *Employer*'s acceptance.
b) The *Contractor* submits the finalised program within one week after contract award.
c) The program indicates the start date, completion date and duration of each activity.
d) With regards to welding, the *Contractor* indicates the following on his program submitted to the *Employer* for acceptance, as a minimum, and is not limited to:
   - The time required for each weld repair as per section 3.2.1, including NDT, machining and PWHT (where applicable).
   - The time required for the various inspections such as PMI, visual and dimensional inspections and issuing of the relevant reports.
   - The program must include transport durations for off-site activities.
   - Final off-site, if necessary, and on-site inspection dates for each weld repair as per section 3.2.1.
   - Final submission date for the databook.
   - Statutory and other non-working days included in the contract period and occurring just after the contract period.

## 10. SERVICES AND OTHER THINGS PROVIDED BY THE *EMPLOYER*

The *Employer* provides the following to the *Contractor*:

### 10.1 Overhead Crane

An overhead crane is available in the *Employer*'s power station machine hall. The *Contractor* ensures that all necessary arrangements and preparations are made for the use of this crane.

### 10.2 Area for site establishment and storage

The *Employer* indicates a storage yard to the *Contractor*.

### 10.3 Power Supply

The *Employer* provides 380 V, and 220 V electrical power supply the *Contractor*. The *Contractor* will be responsible for suitable plugs for their equipment.

### 10.4 Grid Blasting

The *Employer*'s corrosion protection technical specification will include grid blasting, especially on the turbine runners, if necessary, thus grid blasting will be the responsibility of the *Employer*. All other welding preparation, coating removal, corrosion removal and parent material preparation where welding repairs are necessary will be the responsibility of the welding *Contractor*.

**All other services, parts, equipment, tools, etc. needed to provide the *works*, is supplied by the *Contractor.***

# 13. ADDENDUM A

## 13.1 Spiral Casing Liner, Stay Vanes and Mandoor Repairs

**Figure 1: Spiral casing typical liner damage**

**Figure 2: Example of typical damage on vertical stay vane**

**Figure 3: Spiral casing mandoor**

## 13.2 Draft Tube Liner and Mandoor Repairs

**Figure 4: Draft tube liner damage**


**Figure 5: Draft tube access mandoor**

### 13.3 Turbine Runner Blade Repairs

**Figure 6: Turbine blade trailing edge cavitation**

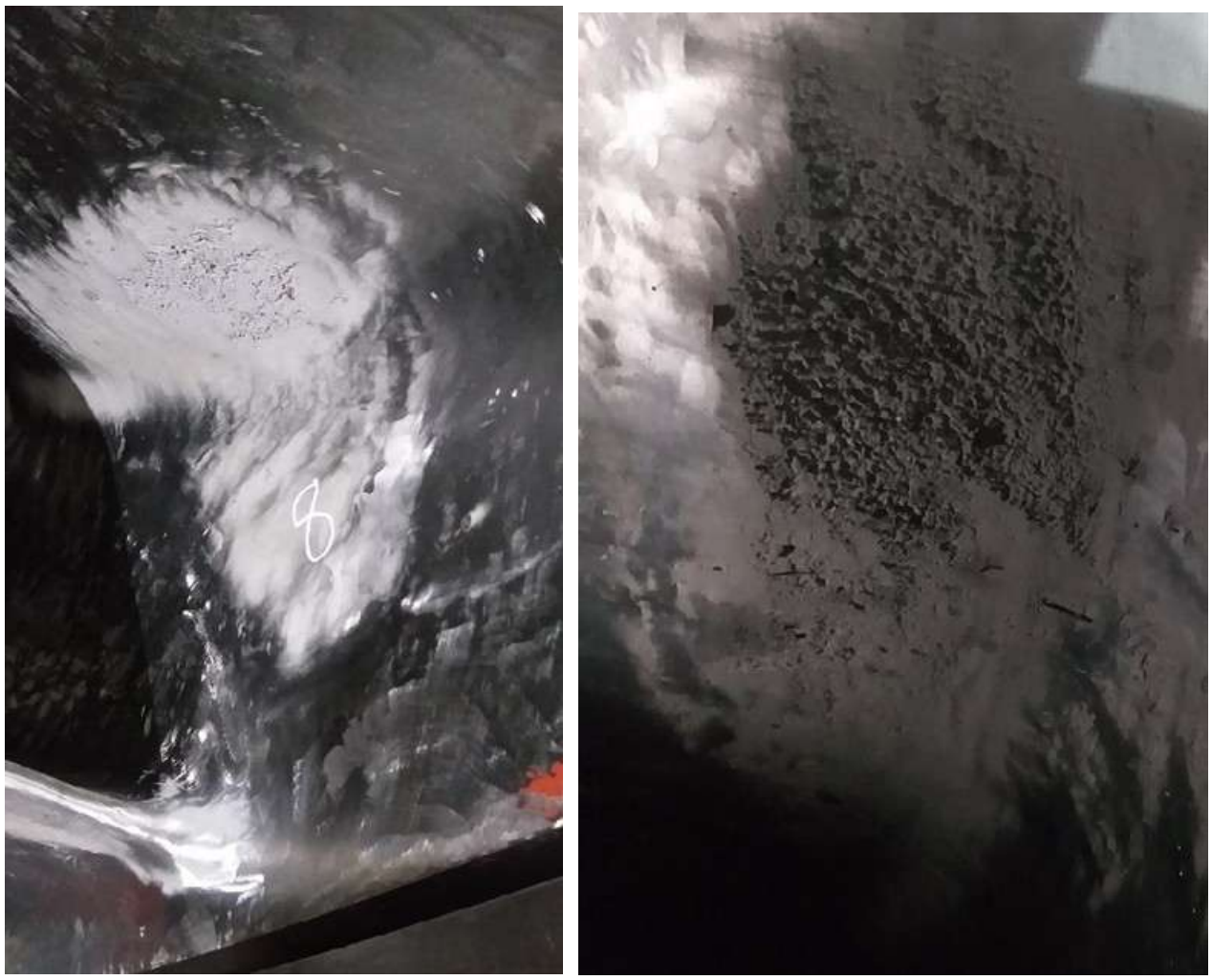

**Figure 7: Turbine blade low pressure area cavitation**