| Eskom | **Specification** | **Peaking** |
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## 1. BACKGROUND

The Drakensberg Pumped Storage Scheme Turbine Refurbishment outages necessitate specialized welding and associated services 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 turbine plants. 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. The flow rate of the water is controlled with guide vanes in conjunction with a governor system. The governor system consists of various components to allow the guide vane servomotors, operating ring and guide vanes to move.

This Technical Specification outlines the detailed requirements for welding 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-, machining- and associated services contract with a suitably experienced *Contractor* to execute Drakensberg (DRP) turbine refurbishment outages in accordance with this Technical Specification. The outages, which are subject to possible date changes, are currently scheduled for August 2025 (DRP Unit 3), October 2025 (DRP Unit 4), March 2027 (DRP Unit 2) and April 2027 (DRP U1). Turbine plant refurbishment is limited to 60 days (double shifts).

### *2.2 Brief description of the works*

The *works* include provision of manpower, consumables, tools, equipment, quality control and associated services, such as general machining and heat treatment, by the *Contractor* during the planned turbine refurbishment 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 require welding, machining and potential heat treatment during the turbine refurbishment outages.

### 3.2.1.1 Guide Vane Bush Casing (Middle and Bottom) Repairs

The weld repairs of the pump-turbine guide vane bush casings are part of the *Employer*'s programme of overhauling the pump-turbines at Drakensberg Pumped Storage Scheme. The *works* of this activity is described as the in-situ guide vane bush casing repairs by means of corrosion resistant overlay welding and machining on 20 pump turbine guide vane middle bush casings and 20 guide vane bottom bush casings, as per the table below.

<table>
<tr><th colspan="2">a) Scope of Work</th></tr>
<tr><td>i.</td><td>The welding Contractor performs all necessary welding and associated welding services, excluding line-boring of the internal bore diameters, which will be done by the Employer's appointed line-boring service provider.<br><br>The guide vane bush casing repairs will consist of the following high-level activities:<ul><li>Machining, prior to welding of the butter layer, consisting of bore material excavation by means of line-boring performed by the Employer's line-boring service provider.</li><li>NDT, consisting of 100% surface crack inspections, performed by the Employer's NDT service provider.</li><li>Welding of the butter layer, performed by the welding Contractor.</li><li>Machining, if necessary, after welding of the butter layer and prior to welding of the stainless-steel overlay, consisting of bore material excavation by means of line-boring performed by the Employer's line-boring service provider.</li><li>NDT, consisting of 100% surface crack inspections, performed by the Employer's NDT service provider.</li><li>Welding of the stainless-steel overlay, performed by the welding Contractor.</li><li>Final machining, performed by the Employer's line-boring service provider.</li><li>NDT, consisting of 100% surface crack inspections and 15% volumetric inspections, performed by the Employer's NDT service provider.</li></ul>The welding Contractor provides oversight and quality control for the complete repair, including during line-boring, to ensure dimensional compliance in terms of the welding procedures as well as the final required dimensions, as per the following:<ul><li>The middle bush casing has an inner diameter specification of Ø380.000mm to Ø380.057mm.</li><li>The bottom bush casing has an inner diameter specification of Ø370.000mm to Ø370.057mm.</li></ul></td></tr>
<tr><td>ii.</td><td>The existing casings are made from JIS SM41A carbon steel and are integral parts of the turbine head cover and bottom stay ring.</td></tr>
<tr><td>iii.</td><td>Should the line-boring service provider require tack welds to temporary secure line-boring equipment and tools to the existing plant, the welding Contractor shall perform these welds according to a Welding Procedure Specification.</td></tr>
<tr><td>iv.</td><td>The Employer's line-boring service provider uses the healthy, non-corroded and un-worn parts of the middle- or bottom bush casing inner diameters as datums to align the boring bar radially.</td></tr>
<tr><td>v.</td><td>The Employer's line-boring service provider machines back the corroded areas by not more than 5mm to 7mm in radius (from the existing Ø380mm to no more than Ø394mm) to achieve a healthy part of the base metal. The final material to be machined away will be determined during the execution of the works.<ul><li>The height on the middle bush casing to be machined away is 57mm as illustrated in Figure 1.</li><li>The height on the bottom bush casing to be machined away is 60mm as illustrated in Figure 2.</li></ul></td></tr>
<tr><td>vi.</td><td>The welding Contractor uses a bore welder to deposit a butter layer of 309L stainless-steel and then a set of final layers of 316L stainless steel ensuring that the 316L layer is thick enough for final machining to the original bore size. The welding Contractor shall utilise a previously proven and qualified corrosion resistant overlay welding procedure specification, subject to the Employer's acceptance.</td></tr>
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| vii. | The *Employer*'s line-boring service provider line bores the welded area to the original bore sizes concentric. The acceptance criteria for any eccentricity is 0.050 mm or less. |
| viii. | After final machining, the inner diameters of the casings are within the tolerance specifications as listed below:<br>• Guide vane middle bush casing inner diameter specification = Ø380.000mm to Ø380.057mm.<br>• Guide vane bottom bush casing inner diameter specification = Ø370.000mm to Ø370.057mm. |
| ix. | The welding *Contractor* takes note that the maximum taper over the length of the bush casing is 0.050 mm. |
| x. | The welding *Contractor* takes note that the surface finish of the machined internal diameter is 0.8 μm $R_a$ or better. |
| xi. | The *Employer*'s line-boring service provider removes all burrs and sharp edges from the casings after final machining and polishes the edges to obtain a smooth profile. Refer to Figure 11.1.2, as per Addendum A. |
| xii. | The weld repairs on the casings are tested for cracks by Non-Destructive examination. The welding *Contractor* shall request, from the *Employer's* Outage Management, 100% Dye Penetrant Testing (PT) and 15% Ultrasonic Testing to be performed by the *Employer*'s NDT Service Provider. |
| xiii. | The work to be completed in less than ten calendar days. |

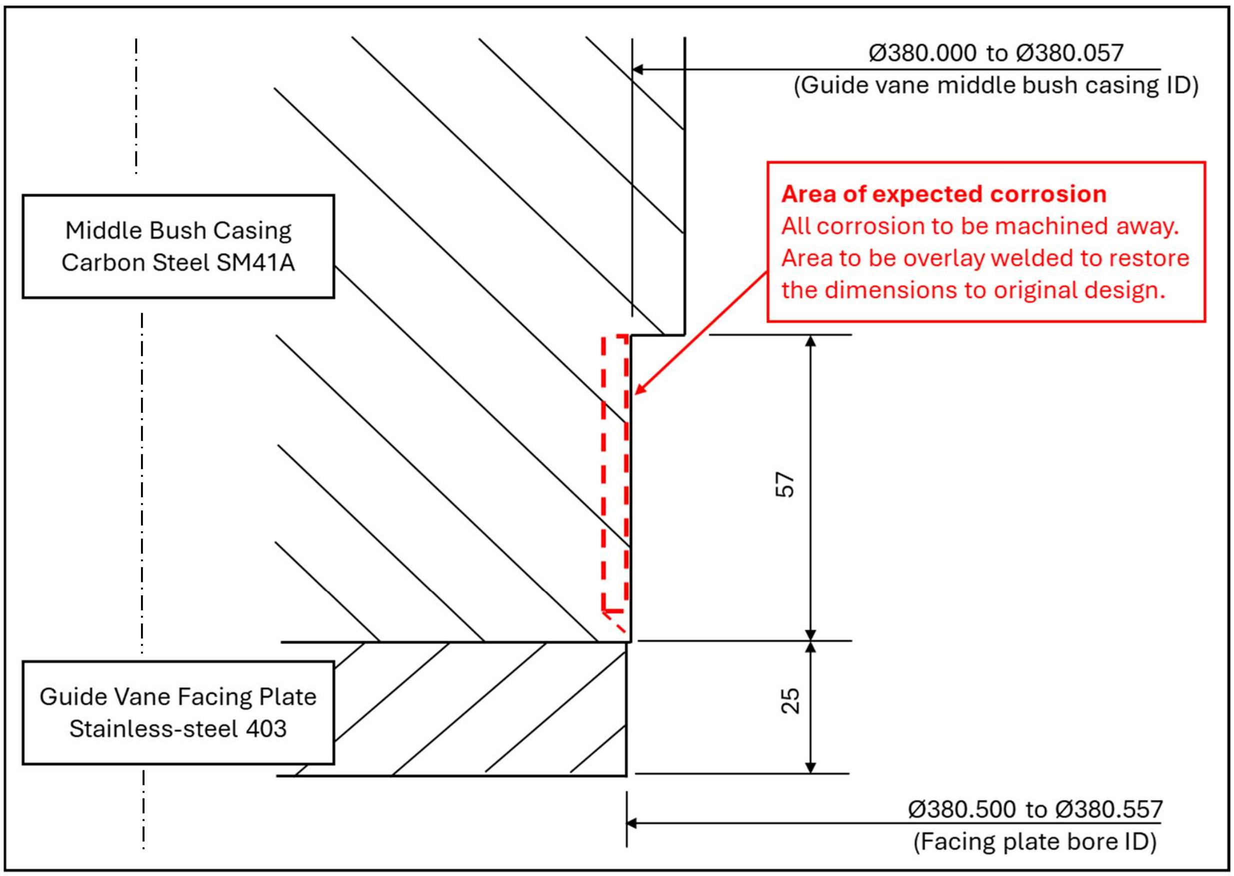


**Figure 1: Guide vane middle bush casing repair illustration**

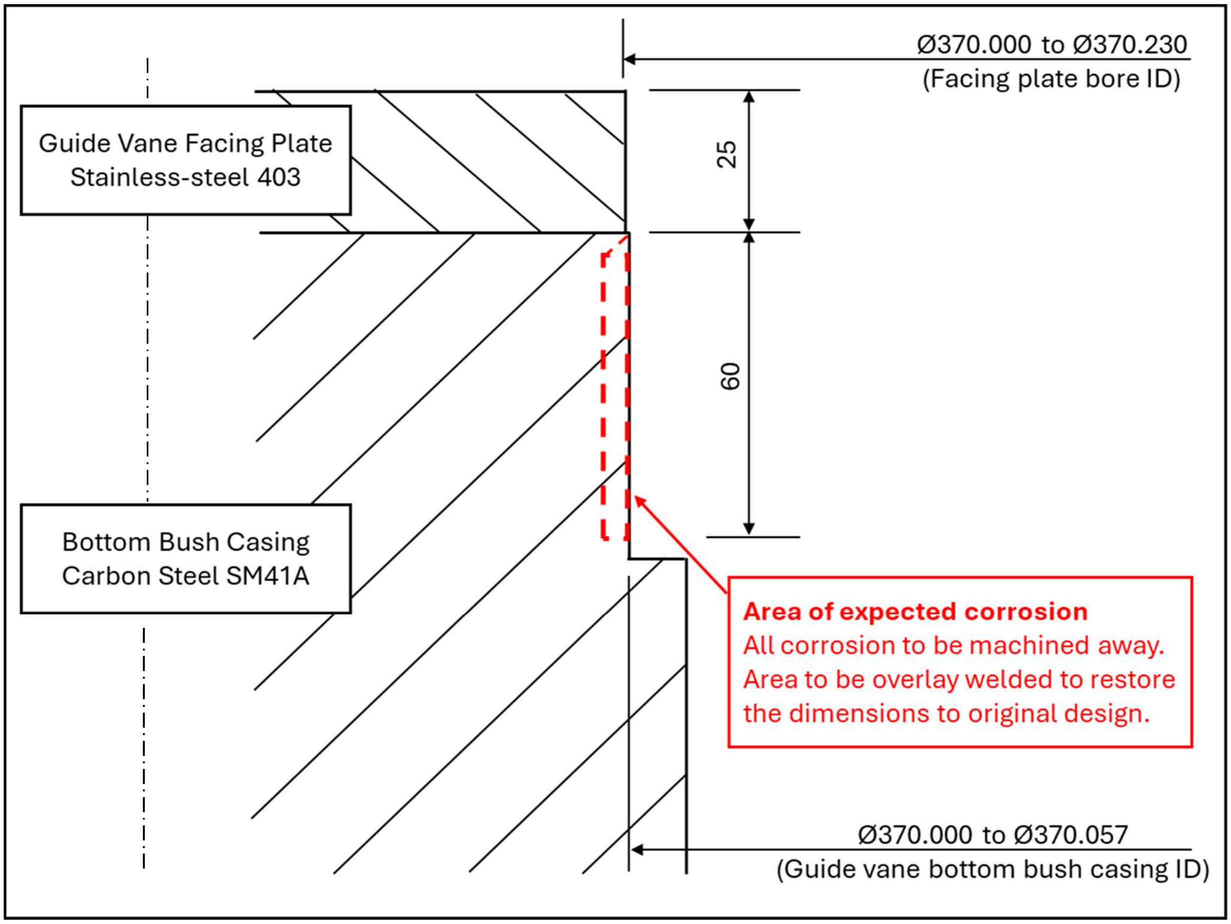


**Figure 2: Guide vane bottom bush casing repair illustration**

### 3.2.1.2 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>
<tr><th>Item</th><th>Code</th><th>Dimensions<br>[mm]</th><th>Material Specification</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td>[1]Spiral casing liner<br>(shell plates)</td><td rowspan="3">ASME Code Sec VIII Div 1 / ASME IX</td><td>Ø: 2250 to 1184<br>t: 35-65</td><td rowspan="3">SM50B (JIS)</td><td rowspan="2">0.48/526<br>REV 4</td><td>Temperature: Ambient<br>Pressure: 72 Bar<br>[4]Weld Position: Various<br>[4]In-situ welding<br>[4]Weld Type: Weld build-up<br>[4]Weld Process: SMAW<br>[4]Machining: Grinding; Blending; Polishing<br>[7]NDT Request: PT/MPI/UT</td></tr>
<tr><td>[2]Stay vanes</td><td>t (Avg.): 30</td><td>Temperature: Ambient<br>Pressure: 72 Bar<br>[5]Weld Position: Vertical<br>[5]In-situ welding<br>[5]Weld Type: Weld build-up<br>[5]Weld Process: SMAW<br>[5]Machining: Grinding; Blending; Polishing<br>[7]NDT Request: PT/MPI/UT</td></tr>
<tr><td>[3]Spiral casing mandoor sealing faces and O-ring groove</td><td>t: 120<br>Sealing face width: 275<br>Oval Door: Ø1120x1420L<br>O-ring: Ø6 (cross-sectional)</td><td>0.48/1753<br>0.48/1754</td><td>Temperature: Ambient<br>Pressure: 72 Bar<br>[6]Weld Position: Vertical<br>[6]In-situ welding<br>[6]Weld Type: Weld build-up<br>[6]Weld Process: SMAW<br>[6]Machining: Specialised machining of O-ring groove<br>[7]NDT Request: PT/MPI/UT</td></tr>
<tr><td>1</td><td colspan="5">The spiral casing is a reducing steel lined spiral passage, that is completely coated internally and embedded in concrete, and responsible for directing the water from a penstock onto the runner.</td></tr>
<tr><td>2</td><td colspan="5">Stay vanes are profiled, fixed and completely coated and its function is to guide the incoming water from the spiral casing through the guide vanes onto the turbine runner.</td></tr>
<tr><td>3</td><td colspan="5">Access to the spiral casing is obtained through a vertical orientated oval flanged access door that is coated internally. Sealing is ensured by a 6 mm O-ring installed into an O-ring groove between the two sealing faces (spiral casing flange face and door flange face).</td></tr>
<tr><td>4</td><td colspan="5">With regards to the spiral casing liner, defects can be averaged to 5 mm deep and can be localised or spread. The repairs will consist of wall thickness restoration by means of in-situ weld build-ups of all identified areas. The Contractor to take note that actual defect depths will only be known upon inspection. Welding positions will vary according to where the defects are identified and the preferred welding process to be implemented by the Contractor shall be manual SMAW. The weld build-ups shall be ground/polished to suit the surrounding areas.</td></tr>
<tr><td>5</td><td colspan="5">With regards to the stay vanes, defects typically consist of localised pit-like craters that can reach depths of up to 10 mm deep, refer to Figure 11.3.2 as per Addendum A. The welding required by the Contractor shall be in-situ weld build-ups by means of manual SMAW in the vertical position, due to the stay vanes being fixed and profiled. The weld build-ups shall be ground/polished to suit the surrounding areas.</td></tr>
</table>

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| 6 | The spiral casing mandoor defects, if any, typically includes localised damage of the general surface areas or deterioration of the 6 mm O-ring groove, situated on the spiral casing flange. The repairs will consist of weld build-ups in the vertical in-situ position. The preferred process to be utilised by the *Contractor* shall be manual SMAW. Specialised machining shall be required by the *Contractor* to machine the O-ring groove dimensions (groove radius, depth, width, corner radius, surface finish) according to the static axial application, if found to be necessary, refer to Figure 11.3.1 as per Appendix A. The O-ring groove dimensions shall be confirmed by the *Contractor*, once access is obtained, and agreed with the *Employer* prior to welding/machining. A surface finish of 0.8μm Ra or better for sealing surfaces and 1.6 μm Ra or better for vertical lead-ins shall be achieved. |
| 7 | The *Contractor* shall request NDT, from the *Employer's* Outage Management, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths. |

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

#### 3.2.1.3 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>
<tr><th>Item</th><th>Code</th><th colspan="2">Dimensions<br>[mm]</th><th>Material Specification</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td>[1]Draft tube liner</td><td rowspan="2">ASME Code Sec VIII Div 1 / ASME IX</td><td>t:<br>Ø:<br>r (oval):</td><td>22 to 28<br>2700 to 1988<br>994 to 2250</td><td rowspan="2">BS4360 Grade 43A</td><td>0.48/426 SHT 1/2</td><td>Temperature: Ambient<br>Pressure: 10 Bar<br>[3]Weld Position: Various<br>[3]In-situ welding<br>[3]Weld Type: Weld build-ups<br>[3]Weld Process: SMAW<br>[3]Machining: Grinding; Blending; Polishing<br>[5]NDT Request: PT/MPI/UT</td></tr>
<tr><td>[2]Draft tube mandoor sealing faces</td><td>t:<br>Seal face width:<br>Door:</td><td>50<br>115<br>870x1140</td><td>0.48/429</td><td>Temperature: Ambient<br>Pressure: 10 Bar<br>[4]Weld Position: Vertical<br>[4]In-situ welding<br>[4]Weld Type: Weld build-ups<br>[4]Weld Process: SMAW<br>[4]Machining: Grinding; Blending; Polishing<br>[5]NDT Request: PT/MPI/UT</td></tr>
<tr><td>1</td><td colspan="6">The draft tube is a steel lined, coated and 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 to an oval shape with a horizontal orientation which then alters to a slight upward angle as it approaches up to the lower dam.</td></tr>
<tr><td>2</td><td colspan="6">Access to the draft tube is obtained through a vertical orientated rectangular flanged access door. Sealing is ensured by a 6 mm gasket installed between the two sealing faces (draft tube flange face and door flange face). Refer to Figure 11.4.2 as per Addendum A.</td></tr>
<tr><td>3</td><td colspan="6">Typical draft tube liner defects can be either localised or spread over a wider area with an averaged depth of 5 mm, as per Figure 11.4.1 in Addendum A. General maintenance consists of cleaning these concerned areas and coating with corrosion protection epoxy. The 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 vary. The preferred welding process to be utilised by the Contractor shall be manual SMAW. The weld build-ups shall be ground/polished to suit the surrounding areas.</td></tr>
<tr><td>4</td><td colspan="6">The draft tube mandoor defects, if any, typically include localised damage of the general surface areas or deterioration of the sealing surface. Weld build-ups will be required, in-situ, for restoration. Welding positions will most likely be in the vertical orientation. The preferred welding process to be utilised by the Contractor shall be manual SMAW. The weld build-ups shall be ground/polished to suit the surrounding areas and all sealing surfaces shall have a surface finish of 0.8μm Ra or better.</td></tr>
<tr><td>5</td><td colspan="6">The Contractor shall request NDT, from the Employer's Outage Management, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths.</td></tr>
</table>

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

#### 3.2.1.4 Turbine Head Cover Surface Repairs and O-ring Groove, O-ring Lead-In and O-ring Sealing Surface Repairs

The turbine head cover is removed from the stay ring during the turbine refurbishment outage, exposing the interfacing and normally non-accessible areas. The *Employer* will conduct inspections to identify all defects within this area on the head cover as well as stay rings, including O-ring grooves and sealing surfaces between the two components, that shall be repair welded by the *Contractor,* if necessary. The table below summarizes necessary information that will serve as input to the repair procedure.

| Item | Code | Dimensions [mm] | | Material Spec | Drawing | Plant Parameters / Additional Information |
|---|---|---|---|---|---|---|
| [1]Turbine Head Cover | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | t: | Various > 20 | JIS SM50B<br>JIS SM41A<br>JIS SS41 | 0.48/526<br>0.48/561 SHT1&2<br>0.48/562 SHT 1&2 | [3]Weld position: Overhead and vertical<br>[3]On-site welding<br>[3]Weld Type: Weld build-ups<br>[3]Machining: Grinding; Polishing<br>[3]Weld process: SMAW<br>[5]NDT Request: PT/MPI/UT |
| [2]Stay Ring | | t: | 53 - 75 | JIS SM41A<br>JIS SS41<br>JIS SM50B | | [4]Weld position: Flat and vertical<br>[4]On-site welding<br>[4]Weld Type: Weld build-ups<br>[4]Machining: Grinding; Polishing<br>[4]Weld process: SMAW<br>[5]NDT Request: PT/MPI/UT |
| 1 | The head cover, top part that is lifted from normal sitting position and supported during the turbine refurbishment outages, comprises of different materials, typically plates, of similar material grouping and is situated around the main shaft. Overall outer diameter is approximately 6650 mm. | | | | | |
| 2 | The stay ring, bottom fixed component, consists of similar materials and has one important round O-ring groove, for a 12mm O-ring, with an approximate diameter of 5860 mm. The O-ring are replaced during this opportunity and the groove, lead-in surfaces as well as sealing surfaces shall be repaired by the *Contractor*, where and if necessary. | | | | | |
| 3 | With regards to the turbine head cover, the sealing surfaces, on top of the O-rings, typically corrode and based on findings shall be repair welded by the *Contractor* only at the areas where required. The corroded or damaged areas shall be excavated, and weld build-ups shall be performed by the *Contractor*. The weld build-ups shall be ground/polished to suit the surrounding areas to achieve a surface finish of 0.8µm Ra or better. The *Contractor* shall weld by means of manual SMAW. The top cover is lifted and supported in an elevated position; hence the sealing surfaces will be in the overhead position, while other areas to be repaired might be in the vertical position. Distortion shall be controlled as best as possible and monitored by the *Contractor*. | | | | | |
| 4 | With regards to the stay ring, any damage or corrosion identified, to be repaired by the *Contractor*, on the O-ring grooves, lead-in surfaces and sealing surfaces shall be repaired in-situ, most likely in the flat and possibly in the vertical positions. Damaged areas shall be excavated, and weld build-ups shall be performed by the *Contractor* to repair the identified areas. Should an O-ring groove be repaired, specialised machining for the round O-ring groove shall be required to achieve a surface finish of 0.8µm Ra or better for sealing surfaces and 1.6 µm Ra or better for vertical lead-ins. Refer to Figure 11.5.1 as per Addendum A as an example of previous damage. All other build-ups shall be ground/polished to suit the surrounding areas. Manual SMAW shall be utilised by the *Contractor.* Like for the top cover, distortion shall be controlled and monitored by the *Contractor*. | | | | | |
| 5 | The *Contractor* shall request NDT, from the *Employer's* Outage Management, consisting of 100% PT or MPI and 15% UT for weld build-ups depending on where the build-up is performed as well as the depth. | | | | | |

**Figure 3: Turbine head cover surface repairs and O-ring groove information**

### 3.2.1.5 Guide Vane Link Pin (Eccentric & Straight) and Governor Servomotor Link Pin Locking Plate Welding

The *Contractor* shall weld the locking plates for the guide vane (GV) link eccentric and straight pins as well as the governor servomotor link pins during the assembly phase of the turbine refurbishment outage. Input data for the relevant repair procedure is summarized in the table below.

<table>
<tr><th>Item</th><th>Code</th><th colspan="2">Dimensions<br>[mm]</th><th>Material Specificatio n</th><th>Drawing</th><th>Plant Parameters</th></tr>
<tr><td>[1]GV link eccentric pin locking plates<br><br>(20 in total)</td><td rowspan="3">Unknown: Refer to Section 3.2.2.2<br><br>BS EN 15614-1 Level 2<br><br>or<br><br>ASME IX</td><td rowspan="2">Locking plate t:<br><br>GV link arm t:</td><td rowspan="2">28<br><br>55</td><td rowspan="3">JIS G3101 SS41 plate</td><td rowspan="3">0.48/720</td><td rowspan="3">[3]Weld position: Flat<br><br>[3]In-situ welding<br><br>[3]Weld type: Fillet stitch weld<br><br>[3]Weld process: SMAW<br><br>[3]Machining: Fillet welds to be left as welded<br><br>[4]NDT Request: PT or MPI</td></tr>
<tr><td>[1]GV link straight pin locking plates<br><br>(20 in total)</td></tr>
<tr><td>[2]Governor servomotor link pin locking plates<br><br>(4 in total)</td><td>Locking plate t:<br><br>Servo link bar t:</td><td>50<br><br>111</td></tr>
<tr><td>1</td><td colspan="6">The linkage between the GV arm lever, link arm and operating ring is secured by eccentric and straight pins. The position of these pins is essential and therefore are secured by means of circular/disk plates that fits over the pins and are welded onto the top link arm plates. There are 20 guide vanes each with 1 eccentric pin and 1 straight pin, thus 20 eccentric pin locking plates and 20 straight pin locking plates in total.</td></tr>
<tr><td>2</td><td colspan="6">The linkage between the servomotor rod link arm, connecting link bars and operating ring, is ensured by eccentric pins. The eccentric pin positions are locked by means of fixed welded circular locking plates. There are 2 servomotors link bars each with 2 eccentric pins, thus a total of 4 locking plates.</td></tr>
<tr><td>3</td><td colspan="6">The Contractor shall weld in-situ during the assembly phase of the turbine refurbishment outage, with manual SMAW, a 10 mm (leg length) fillet stitch weld consisting of 80 mm lengths at a pitch/spacing of 200 mm around the circular locking plates in the flat position. There are 44 locking plates in total to be stitch welded. No machining or polishing will be required as the fillet welds shall be left as-welded condition. Refer to Figure 11.6.1 for a presentation of the circular locking plates.</td></tr>
<tr><td>4</td><td colspan="6">The Contractor shall request NDT, from the Employer's Outage Management, and shall consist of 100% PT or MPI for all fillet welds.</td></tr>
</table>

**Table 3: GV link (eccentric & straight) pin and governor servomotor link pin locking plates information**

### 3.2.1.6 Operating Ring Vertical and Horizontal Wearing Plate Journal Repair and Welding of Wear Plate Locking Plates

Operating ring journal repairs shall be implemented by the *Contractor*. Inspections will be carried out by the *Employer*, during the disassembly phase and upon gaining of access, to identify all defects and concerning areas, which will be handed over to the *Contractor*. The following table provides information to be used as input for determining the repair procedure.

| Item | Code | Dimensions [mm] | | Material Specification | Drawing | Plant Parameters |
|---|---|---|---|---|---|---|
| [1]Operating ring vertical and horizontal journals | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | t: | >50 | Operating ring:<br>JIS G3106 SM41A | 0.48/718 | [3]Weld position: Vertical; Flat<br>[3]On-site welding<br>[3]Weld type: Weld build-up<br>[3]Machining: Grinding; Blending; Polishing. JIG as per Addendum A<br>[3]Weld process: SMAW<br>[5]NDT Request: PT |
| [2]Wear plate locking plates | | t: | >15 | Similar material group as JIS G3106 SM41A | N/A | [4]Weld position: Vertical<br>[4]On-site welding<br>[4]Weld type: Fillet weld<br>[4]Machining: Fillet welds to be left as welded<br>[4]Weld process: SMAW<br>[5]NDT Request: PT |
| 1 | Wear plates, that are installed/bolted onto the vertical journals on the inner diameter of the operating ring, as well as the horizontal journals on the top cover ensure adequate movement and protection of all underlying surfaces of the operating ring whilst being driven by the governor servomotors to position the guide vanes. | | | | | |
| 2 | Locking plates are installed on either side of the wear plates to prevent unwanted looseness and possible damage that might be caused should a wear plate move. It must be noted that some units do not have locking plates and therefore each unit will be assessed during the disassembly phase to confirm if and what type of welding intervention will be required. Locking plates are simple rectangular steel plates/blocks. Refer to Figure 11.7.2 and 11.7.3 as per Addendum A. | | | | | |
| 3 | With regards to the operating ring vertical and horizontal journals, the *Contractor* shall perform weld build-up repairs, on site, of all defects by means of SMAW, in both the vertical and flat positions. Typical defects, as previously experienced, included indents, galling, localised damage and general wear that required weld build-ups. The *Contractor* to take note that actual defect depths will only be known upon inspection. The weld build-ups shall be ground/polished to suit the surrounding areas to a surface finish of 0.8µm Ra or better. A jig shall be manufactured by the *Contractor* to assist with grinding of the vertical journal back to its desired radius after weld buildup repairs, refer to Figure 11.7.1 as per Addendum A. | | | | | |
| 4 | With regards to the wear plate locking plates, the *Contractor* shall perform on-site vertical fillet welds, with a maximum leg length of 8 mm, on each locking plate, only if found to be necessary, on both ends of the wear plates by means of SMAW. Vertical up welding will not be allowed, except if separately qualified by a test piece. The vertical fillet welds will be left as-welded and not be blended or polished. | | | | | |
| 5 | The *Contractor* shall request NDT, from the *Employer's* Outage Management, and shall consist of 100% PT for all fillet welds and weld build-ups, for this particular case based on the application. | | | | | |

**Table 4: Operating ring journal and wear plates locking information**

### 3.2.1.7 Guide Vanes Blade Repairs

Guide Vane Blade inspections will be conducted by the *Employer,* after the removal of each Guide Vane during the disassembly phase, to identify all defects that can typically include cracks, erosion, cavitation, local impact damage due to particles, top and bottom facing area pick-up damage, etc. The defective areas will be handed over to the *Contractor* for repair welding. The table below summarises information required to determine the repair procedure.

<table>
<tr><th colspan="2">Item</th><th>Code</th><th colspan="2">Dimensions [mm]</th><th>Material Specification</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td colspan="2">[1]Guide vane blades</td><td>ASME Code Sec VIII Div 1 / ASME IX</td><td>t (min):<br>t (max):<br>H:</td><td>90<br>216<br>393</td><td>JIS G5121 SCS1</td><td>0.48/719</td><td>[2]Weld position: Mostly flat depending on moveability<br>[2]On-site welding<br>[3]Weld type: Weld build-ups<br>[3]Machining: Lathe; Grinding; Blending; Polishing<br>[4]Weld process: GTAW<br>[5]NDT Request: PT & UT</td></tr>
<tr><td>1</td><td colspan="7">Guide vanes are critical components, within the governor system, that direct and control the flow of water into the turbine runner. There are a total of 20 guide vanes. The guide vane blades are manufactured from corrosion resistant cast steels.</td></tr>
<tr><td>2</td><td colspan="7">The guide vanes are removed during the turbine refurbishment outages for machining purposes that will occur on-site, therefore it can be moved, orientated and positioned to a certain extent to accommodate the desired welding positions. Welding shall be done on-site.</td></tr>
<tr><td>3</td><td colspan="7">Guide vane blade face typical localised defects can be 5-10 mm deep, while spread cavitation are typically less than 3mm as illustrated per Figure 11.8.1 in Addendum A. Guide vane top and bottom interface weld repairs, as per Figure 11.8.4 per Addendum A, shall be performed by the Contractor, only if found to be necessary by the Employer. The Contractor shall confirm the correct blade height, subject to the Employer’s acceptance, prior to welding, to ensure accurate machining by the Employer’s lathe operating on-site service provider on the Employer’s lathe following the weld build-up. The Contractor to take note that actual defect depths and spread will only be known upon inspection. The weld build-ups shall be ground/polished to suit the adjacent areas. The guide vane journals as well as collars shall be repair welded, if found necessary, by the Contractor by means of circumferential weld runs or build ups that will require machining, which will be done by the Employer’s lathe operating service provider on the Employer’s lathe onsite. The Contractor shall provide oversight and ensure quality control and accurate final dimensions and surface finishes during all lathe machining, done by the Employer’s lathe operating service provider, required on-site on the guide vanes following weld repairs. Refer to Figures 11.8.2 and 11.8.3 as per Addendum A for a general overview of the guide vanes and Figure 11.8.5 for typical collar damage.</td></tr>
<tr><td>4</td><td colspan="7">Due to the function of the guide vanes the weld will be treated as a critical weld and the Contractor shall perform weld build-up repairs by means of GTAW.</td></tr>
<tr><td>5</td><td colspan="7">The Contractor shall request NDT, from the Employer’s Outage Management, consisting of 100% PT and 15% UT for weld build-ups, depending on the build-up depths.</td></tr>
</table>

**Table 5: Guide vane blades information**

### 3.2.1.8 Guide Vanes Facing Plate Repairs

The *Contractor* shall repair weld all defects identified by the *Employer* on the Guide Vane top and bottom Facing Plates. Information regarding the Facing Plates, to be utilised as input to determine the appropriate repair procedure, are summarized as per the following table below.

<table>
<tr><th colspan="2">Item</th><th>Code</th><th colspan="2">Dimensions<br>[mm]</th><th>Material Specification</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td colspan="2">[1]Guide vane top and bottom facing plates</td><td>ASME Code Sec VIII Div 1 / ASME IX</td><td>t:</td><td>25</td><td>SUS403</td><td>0.48/562 SHT 1&2</td><td>[2]Weld position: Flat and overhead<br>[2]In-situ & on-site welding<br>[3]Weld type: Weld build-ups<br>[3]Machining: Grinding; Blending; Polishing<br>[4]Weld process: GTAW (& PWHT)<br>[5]NDT Request: PT & UT</td></tr>
<tr><td>1</td><td colspan="7">Guide vanes are situated between a top and bottom facing plate. The clearance between the guide vanes and facing plates are crucial for operation purposes. The facing plates must be defect free, level and flush with adjacent healthy surfaces to ensure and maintain current clearances between the guide vane top and bottom interfaces, with no high spots that could result in material pick-up.</td></tr>
<tr><td>2</td><td colspan="7">The top facing plate will be lifted with the top cover therefore, welding shall be done by the Contractor in the overhead position, while the bottom facing plate will remain in-situ (flat).</td></tr>
<tr><td>3</td><td colspan="7">Repairs shall be done by the Contractor in the form of weld build-ups of all localised pick-up damage, surface craters as well as dispersed areas where material/pick-up was previously polished away, by means of a flapper disc. Typical defects depths can range between 0.3 to 5 mm deep. The Contractor to take note that actual defect depths will only be known upon inspection. Refer to Figure 11.9.1 as per Addendum A for an example of bottom facing plate damage. The weld build-ups shall be ground/polished to suit the surrounding areas and achieve a surface finish of 0.8µm or better. Straight edges to be used to ensure the repaired areas are flush with the surrounding areas.</td></tr>
<tr><td>4</td><td colspan="7">The facing plates are critical components in the sense that it can have adverse effects on the functioning of the guide vanes, should any high spots, weld or material failure or distortion occur. The welding process to be implemented by the Contractor shall be GTAW with the possibility of PWHT.</td></tr>
<tr><td>5</td><td colspan="7">The Contractor shall request NDT, from the Employer's Outage Management, consisting of 100% PT and 15% UT for weld build-ups, depending of the build-up depths.</td></tr>
</table>

**Table 6: Guide vane facing plates information**

### 3.2.1.9 Turbine Runner Blade Repairs

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

| 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: | 100-120 | Stainless Steel Casting: 13Cr-3.8Ni | 0.48/1132<br>0.48/407 | [2]Weld position: Various<br>[2]In-situ on-site welding<br>[3]Weld Type: Weld build-ups<br>[3]Machining: Grinding; Blending; Polishing<br>[4]Weld process: GTAW & PWHT<br>[5]NDT Request: PT & UT |

| | |
|---|---|
| 1 | The vertical turbine runner extracts energy from the water flow and causes the connecting shaft to rotate the Generator, which generates electricity. The runner consists of 6 blades in total. |
| 2 | Runner orientation is vertical, but blades are curved, thus depending on where the defects are noted the welding position will be determined. In-situ weld repairs, due to the runner being fixed to the shaft, shall be performed by the Contractor. |
| 3 | Typical localised 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 shall consist of weld build-ups and shall be ground/polished to suit the surrounding areas to ensure the profile of the runner blades are maintained. Refer to Figure 11.10.1 and 11.10.2 for reference of typical runner blade damage. Typically, there are 3 areas per blade where cavitation damage is noted, thus a total of 18 areas that will most likely require repairs. An assessment to be done by the *Contractor* whether distortion might affect turbine labyrinth clearances prior to welding. |
| 4 | The runner is a stainless-steel casting and PWHT will be required. GTAW will be performed for any runner repairs by the Contractor. |
| 5 | The Contractor shall request NDT, from the Employer's Outage Management, consisting of 100% PT and 15% UT for weld build-ups. |

**Table 7: Turbine runner information**

### 3.2.1.10 Guide Vane Head Repairs

Guide vane head repairs shall be implemented by the *Contractor*. Inspections will be carried out by the *Employer,* during the disassembly phase and upon gaining of access, to identify all defects and areas of concerns, especially on the bottom flange contact surface, that requires repair welding by the *Contractor*. Information, to determine the most appropriate repair procedure, is given as per the following table.

<table>
<tr><th colspan="2">Item</th><th>Code</th><th colspan="2">Dimensions [mm]</th><th>Material Specification</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td colspan="2">[1]Guide vane heads</td><td>Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX</td><td>t:</td><td>40</td><td>JIS G5101 SC46</td><td>0.48/720<br>0.48/6276</td><td>[2]Weld position: Flat<br>[3]Offsite Repair – Due to machining required.<br>[3]Weld type: Weld build-ups<br>[3]Machining: Grinding; Blending/Polishing; Lathe machining; Possibility of line-boring.<br>[4]Weld process: GTAW<br>[5]NDT Request: PT & UT</td></tr>
<tr><td>1</td><td colspan="7">Guide vane heads form a critical part of the guide vanes’ driving mechanism. The guide vane heads are fixed to the guide vanes and transfers the driving forces from the servomotors, operating ring and link arms to the guide vanes to ensure the required opening or closing movements during operation. There are a total of 20 guide vane heads.</td></tr>
<tr><td>2</td><td colspan="7">The guide vane heads will be removed during the turbine refurbishment outage and repairs shall take place off site at the Contractor’s facility; therefore, placement will allow for welding in the flat or desired position.</td></tr>
<tr><td>3</td><td colspan="7">Repairs shall be done by the Contractor in the form of weld build-ups and machining of the bottom flange interfacing faces. Typically, corrosion damage and wear to the bottom flanges are present as per Figure 11.11.3 within Addendum A, these areas shall be locally excavated and repaired by means of a weld build-up and ground/machined to the required finish and thickness. The Contractor to take note that these components are prone to distortion and previously a few bores had to be line bored to size. Refer to Figure 11.11.1 as per Addendum A for an example check sheet used during previous outages as well as a schematic illustration of the distortion that occurred as per Figure 11.11.2. The bores as well as the bottom flanges’ parallelism shall be measured and inspected as part of the final acceptance. Due to the machining requirements, the repairs shall be implemented offsite at the Contractor’s facilities. A surface finish of 0.8µm or better shall be achieved. The quantity, if any, of guide vane heads to be sent off site shall be confirmed upon completion of the Employer’s inspections during the turbine refurbishment outage upon gaining of access.<br>All other identified defects, by the Employer, on the guide vane head body, such as cracks, craters or unacceptable indications shall be build-up weld repaired and blended accordingly by the Contractor.</td></tr>
<tr><td>4</td><td colspan="7">The welding process to be implemented by the Contractor shall be GTAW.</td></tr>
<tr><td>5</td><td colspan="7">The Contractor shall request NDT, from the Employer’s Outage Management, consisting of 100% PT and 15% UT for weld build-ups. Offsite NDT interventions throughout the repair shall be clearly communicated to prevent delays and to ensure the availability of the Employer’s NDT service provider.</td></tr>
</table>

**Table 8: Guide vane head information**

### 3.2.1.11 Shaft Seal Sleeve Replacement

The unit 3 shaft seal sleeve is due for replacement during the turbine refurbishment outage. The *Contractor* shall remove the current shaft seal sleeve, without damaging of the shaft, and install a spare sleeve, by means of welding, that will be supplied by the *Employer*. Relevant information to determine the most appropriate repair procedure, is summarised within the table below.

| Item | Code | Dimensions [mm] | | Material Spec | Drawing | Plant Parameters / Additional Information |
|---|---|---|---|---|---|---|
| [1]Shaft seal sleeve | Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX | t:<br>Ø (ID):<br>Ø (OD):<br>L: | 15<br>1070(+0.165; -0)<br>1100(+0; -0.105)<br>375 - 385 | JIS G4304 SUS410 | 0.48/5904 | [2]Removal: Drilling & grinding<br>[3]Weld position: Vertical<br>[3]Weld type: Butt Weld<br>[3]In-situ on-site welding<br>[4]Weld process: GTAW & PWHT<br>[4]NDT Request: PT & UT<br>[5]Installation: Viton O-ring<br>[5]Machining: Grinding;<br>Polish |

| | |
|---|---|
| 1 | In a hydro power station shaft seals are critical components for preventing water leakage between the rotating turbine shaft and the stationary top cover. The shaft seal sleeve is a wearing part, consisting of two half segments, refer to Figure 11.12.1 as per Addendum A, and is replaced on a regular basis. |
| 2 | The removal procedure, to be implemented by the Contractor, of the old shaft seal sleeve halves, refer to Figure 11.12.2 as per Addendum A, consists of the following:<br>• Using a 4 mm drill bit, remove the stop pins from the sleeve flush bolts.<br>• Remove the flush bolts with a punch in the direction of rotation (anticlockwise) from the access/ bolt head side.<br>• Grind out the welds on the sleeve halves (under no circumstances grind deeper than 13 mm).<br>• Using a nub nose chisel, break the remaining weld and remove the sleeve halves.<br>• The Contractor to take note that each shaft sleeve half weighs approximately 75kg. |
| 3 | The Contractor shall perform in-situ welding of the two shaft seal segments around the main machine shaft. The two weld grooves, 180 degrees apart on either side of the shaft, require vertical welding. The weld type shall be a partial joint penetration butt weld, to ensure the sleeve is not welded onto the main shaft. Vertical down welding shall not be allowed, except if qualified by a specific test piece. Vertical up welding, as proven by the WPQR, shall be utilised by the Contractor. |
| 4 | The welding process to be implemented by the *Contractor* shall be GTAW. The parent material, vertical welding and critical function of the shaft seal sleeve deem the welding as critical. Proper pre-heating and PWHT are required due to the large heat dissipation of the shaft, causing the welded area not to retain heat long enough to form a proper weld without cracks. The *Contractor* shall request NDT, from the *Employer*'s Outage Management, consisting of 100% PT and 15% UT. |

| | |
|---|---|
| 5 | The installation & in-situ welding procedure, to be implemented by the *Contractor*, of the new shaft seal sleeve segment halves consists of the following:<br>• Thoroughly clean the shaft surface to remove all unwanted particles or build-up by means of manual abrasive scouring pads. No power tools will be used, and the *Contractor* ensures the scouring pad is compatible with the stainless-steel shaft to prevent contamination.<br>• Before positioning the sleeve for final fitment apply white paint on the shaft where the sleeve fits around the shaft, excluding the area near the weld joint.<br>• Fit the bottom Viton O-ring, supplied by the *Employer*, around the shaft and glue in place with Loctite O-ring adhesive (426).<br>• Clean the inner surface of the sleeve with acetone, set and clamp the sleeve halves onto the shaft using two pull lifts and slings.<br>• Ensure all contact surfaces between the sleeve and shaft are closed using a dead blow hammer to strike the sleeve halves at centre and work around to the joint surfaces. Make use of feeler gauges to ensure the gap is closed around the shaft.<br>• Check the root gap of the two weld joints as per requirement in the welding procedure. Measure the outside diameter of the sleeve at three equally spaced heights.<br>• Confirm if the diameters are within tolerance, (ø 1100 +0−0.105 mm) and the sleeve is fitted correctly, (i.e., concentric with the shaft).<br>• Fit the two middle bolts to hold the sleeve halves in place on each sleeve half.<br>• Perform welding of the joints.<br>• Using a template with the curvature of the designed sleeve diameter, grind the welds smooth and ensure profile conforms to the template. The template can be a simple cardboard cut-out with the outer radius of the shaft sleeve to confirm the curvature.<br>• Before final polishing, perform 100% PT and 15% UT per weld to ensure no unacceptable defects exist.<br>• In the event of defects, follow corrective action procedure, (grind, re-weld, test and polish).<br>• Drill and tap M16 holes under the bolt holes of the sleeve, see Eskom drawing 18.48/5904.<br>• Countersink holes using a centring guide bush.<br>• Set the flush bolts by applying thread locking adhesive to the thread.<br>• Tighten the flush bolts until the bolt head shears off.<br>• Drill and fit the 6 mm retaining pin, (do not drill through the sleeve into the shaft)<br>• Using the curvature template, grind the bolt heads and welds flush and smooth to a required surface finish of Ra 0.8 µm or better.<br>• Polish the complete surface of the sleeve with a fine grade (#500) oil stone.<br>• Perform a final PT inspection of the welds.<br>• In the event of defects, follow corrective action procedure, (grind re-weld test and polish)<br>• Measure and record the diameter of the shaft seal sleeve.<br>• Measurements are taken at three equally spaced heights and three diametric positions (120 degrees apart), including the welded areas.<br>• Fit the top Viton O-ring around the shaft and glue in place with Loctite 426 O-ring glue. |

**Table 9: Shaft seal sleeve information**

### 3.2.1.12 Shaft Seal Base Plate Repairs

The *Contractor* shall weld repair all identified defects, by the *Employer*, on the shaft seal base plates. The most appropriate procedure for the required repairs shall be implemented by the *Contractor* based on the following summarised information as per the table below.

<table>
<tr><th>Item</th><th>Code</th><th colspan="2">Dimensions<br>[mm]</th><th>Material Spec</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td rowspan="3">[1]Shaft seal base plate</td><td rowspan="3">Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX</td><td>t:</td><td>30</td><td rowspan="3">JIS G3101 SS41</td><td rowspan="3">18.48/4683</td><td rowspan="3">[2]Weld position: Flat<br>[2]Offsite weld repair – due to setup, but to be assessed by the Contractor<br>[3]Weld type: Fillet welds, butt welds and weld build-ups<br>[3] Machining: Grinding/Blending<br>[4]Weld process: GTAW<br>[5]NDT Request: PT & UT</td></tr>
<tr><td>Ø (ID):</td><td>1100</td></tr>
<tr><td>Ø (OD):</td><td>1500</td></tr>
<tr><td>1</td><td colspan="6">The shaft seal base plate consists of 4 flanged segments that are bolted onto each other around the main shaft. Air exhaust pipes are fixed onto 2 of the segments. The shaft seal contains water during GEN MODE and PUMP MODE, while during SCO MODE air is pumped in the area above the turbine to displace water to a level below the runner, which allows the turbine to operate in air. Any shaft seal base plate defects, cracks or damage can cause air leaks, resulting in short blowdown air requirement intervals.</td></tr>
<tr><td>2</td><td colspan="6">The shaft seal base plate shall be removed and disassembled by the Employer and repairs can take place off site at the Contractor’s facility if necessary. Therefore, the components can be positioned as required by the Contractor’s welding procedure during welding.</td></tr>
<tr><td>3</td><td colspan="6">Typical defects include cracks or damage on the connecting fillet and butt weld joints between the base plate, air release piping, fittings and flanges. The Contractor shall rip the defective welds and repair weld accordingly. Fillet and butt welds on piping, should repairs be required, shall be left as-welded and not be machined or polished. Other possible repairs will consist of weld build-ups for all general base plate defects as well as defects related to the flange faces between the base plate segments to ensure sufficient flange face contact. Weld build-ups shall be ground, blended and polished according to the surrounding areas. Refer to Figure 11.13.1 and 11.13.2 as per Addendum A.</td></tr>
<tr><td>4</td><td colspan="6">The welding process to be implemented by the Contractor shall be GTAW.</td></tr>
<tr><td>5</td><td colspan="6">NDT will be requested by the Contractor, from the Employer’s Outage Management, and shall consist of 100% PT for all fillet welds, while 100% PT as well as 15% UT will be required for weld build-ups and butt welds. Offsite NDT interventions throughout the repair shall be clearly communicated to prevent delays and to ensure the availability of the Employer’s NDT service provider.</td></tr>
</table>

**Table 10: Shaft seal base plate information**

### 3.2.1.13 Shaft Seal Upper-, Middle- & Lower-Case Housing O-ring Groove Refurbishment

The *Employer* will conduct inspections on the shaft seal upper case housings in general to identify all concerning defects and to verify whether the O-ring grooves require weld refurbishment. All identified defects, including the O-ring grooves, 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>
<tr><th>Item</th><th>Code</th><th colspan="2">Dimensions [mm]</th><th>Material Spec</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td>[1]Shaft seal upper-, middle- & lower-case housings</td><td>Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX</td><td>t:<br>Ø O-ring:<br>O-ring groove depth:</td><td>20 – 35<br>4<br>4</td><td>JIS G5121 SCS1</td><td>18.48/4683</td><td>[2]Weld position: Flat<br>[2]Offsite weld repair – due to machining and PWHT required<br>[3]Weld type: Weld build-up<br>[3]Machining: O-ring groove machining, blending and fettling<br>[4]Weld process: GTAW & PWHT<br>[5]NDT Request: PT & UT</td></tr>
<tr><td>1</td><td colspan="6">The shaft seal consists of a three-layer water cooled multi segmented carbon seal that runs on the shaft sleeve. The 3 upper case housings are installed on top of each other and the base plate, each with a 4 mm O-ring seal, static axial application, arrangement in between, thus 3 O-ring grooves in total.</td></tr>
<tr><td>2</td><td colspan="6">The shaft seal upper case housings shall be removed and disassembled by the Employer and repairs shall take place off site at the Contractor's facility, and therefore can be positioned as required by the Contractor's welding procedure during welding.</td></tr>
<tr><td>3</td><td colspan="6">Typical defects include damage to the O-ring grooves in the form of material breakage that effects the sealing of the O-rings. The Contractor shall excavate the identified areas on the O-ring grooves and perform the required weld build-ups. Other possible localised defects on the 3 upper case housings shall also be repair welded by the Contractor by means of weld build-up if necessary. The specialised machining required for the 4 mm O-ring groove shall be done, by the Contractor, after the weld build-up is performed. The O-ring groove dimensions (depth, width, corner radius and surface finish) according to the static axial application shall be confirmed and agreed upon once access is obtained. The O-ring groove shall have a surface finish of 0.8µm Ra or better for sealing surfaces and 1.6 µm Ra or better for vertical lead-ins. All other weld build-ups shall be blended according to the surrounding areas. Refer to Figures 11.14.1 to 11.14.3 as per Addendum A for an overview of previous damage.</td></tr>
<tr><td>4</td><td colspan="6">The welding process to be implemented by the Contractor shall be GTAW. The Contractor shall control possible distortion. The parent material will require heat treatment consisting of pre-heat, interpass temperature and PWHT.</td></tr>
<tr><td>5</td><td colspan="6">NDT shall be requested by the Contractor, from the Employer's Outage Management, and shall consist of 100% PT as well as 15% UT, depending on weld build-up depts. Offsite NDT interventions throughout the repair shall be clearly communicated to prevent delays and to ensure the availability of the Employer's NDT service provider.</td></tr>
</table>

**Table 11: Shaft seal upper case housings and O-ring groove information**

### 3.2.1.14 Turbine Embedded Pipework and Bottom Facing Plate Blanking

Turbine embedded pipework was previously found to be leaking, at an area that is impossible to repair due to the pipes being embedded in concrete, therefore these pipes were decommissioned and completely blanked off at the draining holes in the GV bottom facing plate. The supply and welding of new blanks shall be done by the *Contractor*. Furthermore, the draining holes in the bottom facing plates shall be drilled concentric so that blanks of the same material can be supplied, installed and welded, by the *Contractor*, to form a uniform surface and concealing the embedded pipework blanks. Refer to the table below for summarised information required to determine the repair procedure.

<table>
<tr><th>Item</th><th>Code</th><th colspan="2">Dimensions<br>[mm]</th><th>Material Spec</th><th>Drawing</th><th>Plant Parameters / Additional Information</th></tr>
<tr><td>[1]Embedded Pipework Blanks</td><td rowspan="2">Unknown: Refer to Section 3.2.2.2<br>BS EN 15614-1 Level 2<br>or<br>ASME IX</td><td>Ø<br>(pipe)</td><td>100</td><td>JIS STPG38 SCH80</td><td rowspan="2">0.48/562 SHT1&2<br>0.48/809</td><td>[3]Weld position: Flat<br>[3]In-situ welding<br>[3]Weld type: Seal/Butt weld<br>[3]Machining: Weld prep<br>[3]Weld process: SMAW<br>[3]Supply: JIS STPG38 Blanks<br>[5]NDT Request: PT</td></tr>
<tr><td>[2]Bottom Facing Plate Holes</td><td>t (face plate):</td><td>25</td><td>SUS403</td><td>[4]Weld position: Flat<br>[4]In-situ welding<br>[4]Weld type: Seal/Butt weld<br>[4]Machining: Drilling; Grinding; Polishing<br>[4]Weld process: GTAW (& PWHT)<br>[4]Supply: SUS403 Blanks/Plugs<br>[5]NDT Request: PT</td></tr>
<tr><td>1</td><td colspan="6">The existing embedded pipework blanks are in a poor condition and will therefore be removed by the Employer. New blanks of adequate sizes, to be measured and supplied by the Contractor. There are 10 vertical pipes of 100 NB each that will each require a blank.</td></tr>
<tr><td>2</td><td colspan="6">The guide vane bottom facing plates have 10 opening holes that are aligned with the top ends of the embedded pipework where the blanks are installed. The holes were originally 80 NB each.</td></tr>
<tr><td>3</td><td colspan="6">With regards to the embedded pipework, the pipes are vertically orientated, thus the Contractor shall perform in-situ welding of the blanks in the flat position. The access at the area where welding will occur is very limited and only allows for a seal/butt weld (Take note: The enlarging of the bottom facing plate openings as per number 4 below, also forms part of the Contractor's works, can be done prior to welding of the pipe blanks to aid with access). The Employer will remove the current blanks and upon completion, the Contractor shall assess, measure each pipe end and supply blanks of the correct sizes and same material. The Contractor can consider using the Employer's on-site lathes for machining of the blanks. The Contractor shall perform all weld preparations on the pipe ends and blanks. Upon completion of welding, no further machining will be required, and the seal/butt weld shall be left as-welded. The preferred welding process is manual SMAW, due to the access limitation. Refer to Figure 11.15.1 as per Addendum A for embedded pipework blanks and openings in the bottom facing plate.</td></tr>
<tr><td>4</td><td colspan="6">With regards to the guide vane bottom facing plate holes; The ridges/edges of these opening holes are in a poor condition that is not favourable for welding due to previous grinding. The openings are not concentric with diameter sizes ranging between 80 – 110 mm. The Contractor shall drill/machine the openings larger to concentric holes ranging between 100-130 mm, depending on the condition of each hole. The Contractor shall machine, supply and weld tight fit plugs from the same material and thickness as the bottom facing plate. All welding preparation work on holes and plugs shall be done by the Contractor. A partial penetrating butt weld shall be performed by the Contractor by means of GTAW with the possibility of PWHT. The butt weld shall be ground and blended smooth according to the surrounding areas to a surface finish of 0.8µm Ra or better. The Contractor shall control distortion.</td></tr>
<tr><td>5</td><td colspan="6">The Contractor shall request NDT, from the Employer's Outage Management, consisting of 100% PT for the embedded pipework blank welds, while the bottom facing plate plugs' butt welds will include 100% PT and 15% UT.</td></tr>
</table>

**Table 12: Embedded pipework and GV bottom facing plate plugging information**

### 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 perform off-site at the facilities of the *Contractor* or subcontractor.
- The *Contractor* must be able to qualify Welding Procedure Specifications as well as Welders, if necessary, to complete the welding requirements within the outage duration.
- 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.
- The *Contractor* can consider utilising the *Employer's* on-site lathe where applicable, to a certain extent, depending on availability.
- 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 specialised 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, as and when required, according to the parent material and qualified welding procedure shall be thoroughly implemented.
    - 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).

#### 3.2.2.2 Codes & Standards and Specifications Requirements

Welding Procedure Qualification as well as Welder (or welding operator) Qualification 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 Qualification shall be performed in accordance with BS EN 15614-1 Level 2, and Welder Qualification shall be conducted in accordance with ISO 9606-1. Alternatively, ASME IX is also acceptable. Overlay Welding Procedure Qualification shall be according to BS EN 15614-7 and will be specific to corrosion resistant overlay welding.

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 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 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 QCP's. 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

#### 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*, includes the following:

- 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.
- Resistance heating is allowed and must be done in accordance with an approved HT procedure 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*, includes 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*, includes the following:

- 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 insultation 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 service provider.
- 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 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 localized 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 stabilizing 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* 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* that 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.

#### 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, as per the Technical Evaluation Strategy (31A/11111-P3-C) 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 Material

The *Employer* provides certain material/spares required as specifically stated per Section 3.2.1 for each welding item. This excludes the supply of blanks for the embedded pipework and blanks/plugs for the bottom facing plate.

## 4.4 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 Drakensberg PSS.

## 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 Turbine Refurbishment outages.

# 6. DRAWINGS

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

| Drawing Number* | Title |
|---|---|
| 0.48/407 | Pump Turbine Runner Outline Details |
| 0.48/561 SHT 1 | Pump Turbine Top Cover Plan |
| 0.48/561 SHT 2 | Pump Turbine Top Cover Elevation |
| 18.48/U1/5894 | Pump Turbine Guide Vane Top Bush |
| 18.48/U1/5898 | Pump Turbine Guide Vane Middle Bush |
| 18.48/U1/5899 | Pump Turbine Guide Vane Bottom Bush |
| 0.48/526 | Pump Turbine Spiral Case and Stay Ring Details |
| 0.48/1753 | Pump Turbine Spiral Casing Penstock Section Manhole Cover Details |
| 0.48/1754 | Pump Turbine Spiral Casing Penstock Section Details |

| | |
|---|---|
| 0.48/426 SHT 1&2 | Pump Turbine Draft Tube Liner Details |
| 0.48/429 | Pump Turbine Draft Tube Liner Upper Mandoor Cover Details |
| 0.48/561 SHT 1&2 | Top Cover Elevation |
| 0.48/720 | Pump Turbine Guide Vane Operating Mechanism Sub Assembly |
| 0.48/718 | Pump Turbine Guide Operating Ring Details |
| 0.48/719 | Pump Turbine Guide Vane Details |
| 0.48/562 SHT 1&2 | Pump Turbine Bottom Ring Plan Details |
| 0.48/1132 | Main Shaft and Runner Sub-Assembly |
| 0.48/407 | Pump Turbine Outline of Runner |
| 0.48/U1/6276 SHT 2 | Guide Vane Head Shear Pin Cam Lever Details |
| 0.48/U2/6276 SHT 2 | Guide Vane Head Shear Pin Cam Lever Details |
| 0.48/U3/6276 SHT 2 | Guide Vane Head Shear Pin Cam Lever Details |
| 0.48/U4/6276 SHT 2 | Guide Vane Head Shear Pin Cam Lever Details |
| 18.48/U2/6357 | Shaft Sleeve Section & Details |
| 18.48/U1/4683 | Sealing Water System Shaft Sealing Box Sub-Assembly |
| 18.48/U2/4683 | Sealing Water System Shaft Sealing Box Sub-Assembly |
| 18.48/U3/4683 | Sealing Water System Shaft Sealing Box Sub-Assembly |
| 18.48/U4/4683 | Sealing Water System Shaft Sealing Box Sub-Assembly |
| 0.48/809 SHT 1, 2, 3 & 4 | Schematic Diagram of Water and Air Piping Unit 1, 2, 3 & 4 |

**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.*

## 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 | 2009 | ✓ |

| | | | |
|---|---|---|---|
| | Part 2: Arc welding of ferritic steels<br>Part 3: Arc welding of stainless steels | | |
| 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 his employees carry identification 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 that are sent offsite as part of the *works* such as welding-, machining- or heat treatment related 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 Turbine Refurbishment 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 back-dating 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.
- QCP's will make provision for referencing of the relevant documents.
- The following minimum intervention points must be included in each of the weld repair QCP's 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) (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 (Drakensberg Pumped Storage Scheme).
- 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 (Drakensberg Pumped Storage Scheme) is situated in an environmentally sensitive area.
- The *Contractor* acquaints 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.

### 8.7 Security

General access to the *Employer*'s Power Station (Drakensberg Pumped Storage Scheme) 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 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 by the *Contractor*.
  - Material Certificates
    - 3.1 Material Certificates, as stipulated per Section 3.2.2.6, will be provided by the *Contractor*. The *Contractor* only supplies material for Section 3.2.1.15 for the welding of embedded pipework blanks and bottom facing plate blanks.
  - Approved Concessions
    - All requested concessions, with the *Employe*r's response, as stipulated per Section 3.2.2.8, 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, 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

a) The *Contractor* submits a quality control plan for the *Employer's* acceptance.
b) The *Contractor* submits the finalized 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 offsite activities.
   - Final offsite and onsite 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.

e) The *Contractor* confirms that current test certificates apply to all Equipment identified in the programme.

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

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

### 10.1 Crane

A 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*.

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

# 11. ADDENDUM A

## 11.1 Guide Vane Bush Casing (Middle and Bottom) Repairs

Figure 11.1.1: Guide vane bush casing repairs

Figure 11.1.2: Bottom bush casing before and after repairs

## 11.2 Line-Boring Setup Examples

The welding *Contractor* to take note of the line-boring setup for information purposes only. The line-boring will be performed by the *Employer*'s line-boring service provider.

**Figure 11.2.1: 2007 Guide vane top bush machining setup**

**Figure 11.2.2: 2007 Guide vane top bush boring**

**Figure 11.2.3: 2007 Guide vane middle bush boring**

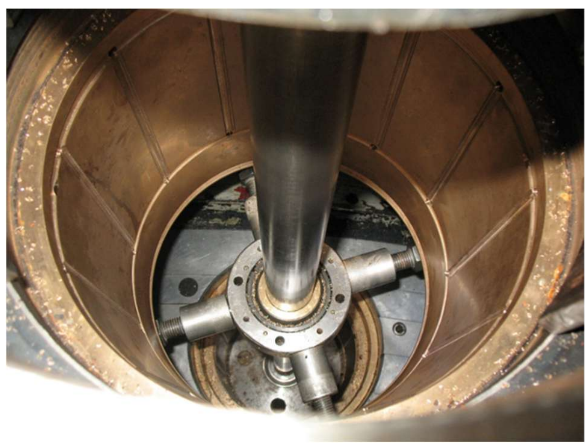
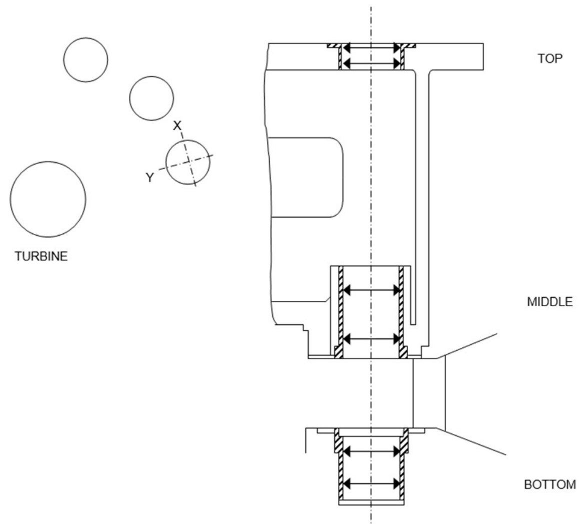


**Figure 11.2.4: 2007 Guide vane bottom bush line boring setup**




| LINE BORING QUALITY CONTROL PLAN | | | | | | |
|---|---|---|---|---|---|---|
| CONTRACTOR : | | UNIT | 4 | GUIDE VANE | 1 | |
| INSPECTION STATUS | H = HOLD POINT | W =WITNESS POINT | | I = INSPECTION POINT | | S = SURVEILLANCE |

| Activity no | Activity description Scope of work | Measurements after machining | | | | | Inspection status | Contractor | | Accepted by ESKOM | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Upper | | Lower | | | Date | Signature | Date | Signature |
| | | Acceptance criteria | X | Y | X | Y | | | | | |
| 1 | Set up satisfactory, datum=bottom bush, no damage to bushes | | | | | | W | | | | |
| 2 | Top bush boring bar run-out | <0.030 | | | | | W | | | | |
| 3 | Top bush ID measurement | TBD | | | | | I | | | | |
| 4 | Top bush surface roughness | 0.8 | | | | | W | | | | |
| 5 | Middle bush boring bar run-out | <0.030 | | | | | I | | | | |
| 6 | Middle bush ID measurement | TBD | | | | | I | | | | |
| 7 | Middle bush surface roughness | 0.8 | | | | | I | | | | |
| 8 | Bottom bush boring bar run-out | <0.030 | | | | | w | | | | |
| 9 | Bottom bush ID measurement | TBD | | | | | I | | | | |
| 10 | Bottom bush surface roughness | 0.8 | | | | | I | | | | |

APPROVED BY: ____________________ SIGNED: ____________________ DATE: ____________________

**Figure 11.2.5: Example of line boring check sheet**

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

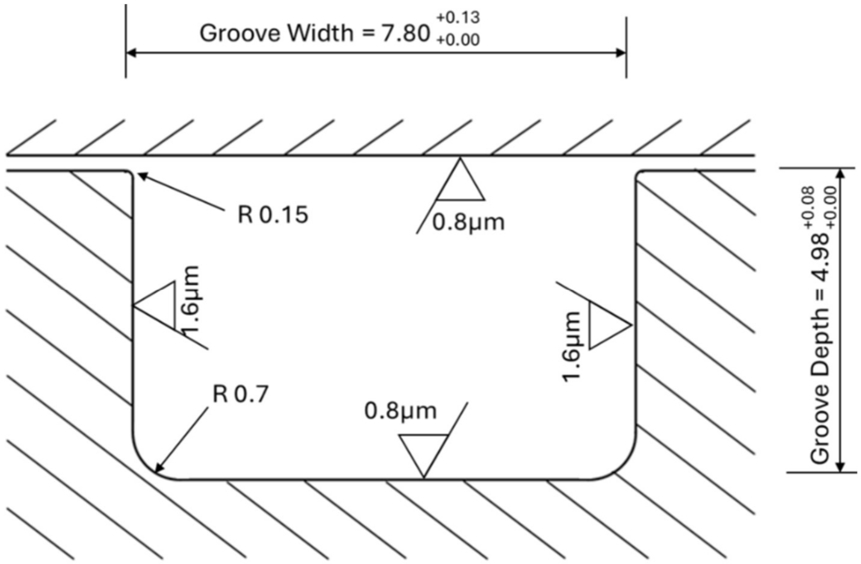



**Figure 11.3.1: Spiral casing mandoor 6mm O-ring groove**

**Figure 11.3.2: Example of damage on vertical stay vane**

### 11.4 Draft Tube Liner and Mandoor Repairs

**Figure 11.4.1: Draft tube liner damage (typical for spiral casing liner as well)**

**Figure 11.4.2: Draft tube mandoor with sealing surfaces on flange**

### 11.5 Turbine Head Cover Surface Repairs and Stay Ring O-ring Groove, O-ring Lead-In and O-ring Sealing Surface Repairs

**Figure 11.5.14: O-ring groove and surrounding surfaces' damage as per previous outages**

### 11.6 Guide Vane Link Pin (Eccentric & Straight) and Governor Servomotor Link Pin Locking Plate Welding

**Figure11.6.1: GV and Servomotor Pin Circular Locking Plates with stitch welding**

## 11.7 Operating Ring Vertical Wearing Plate Journal Repair and Welding of Wear Plate Locking Plates

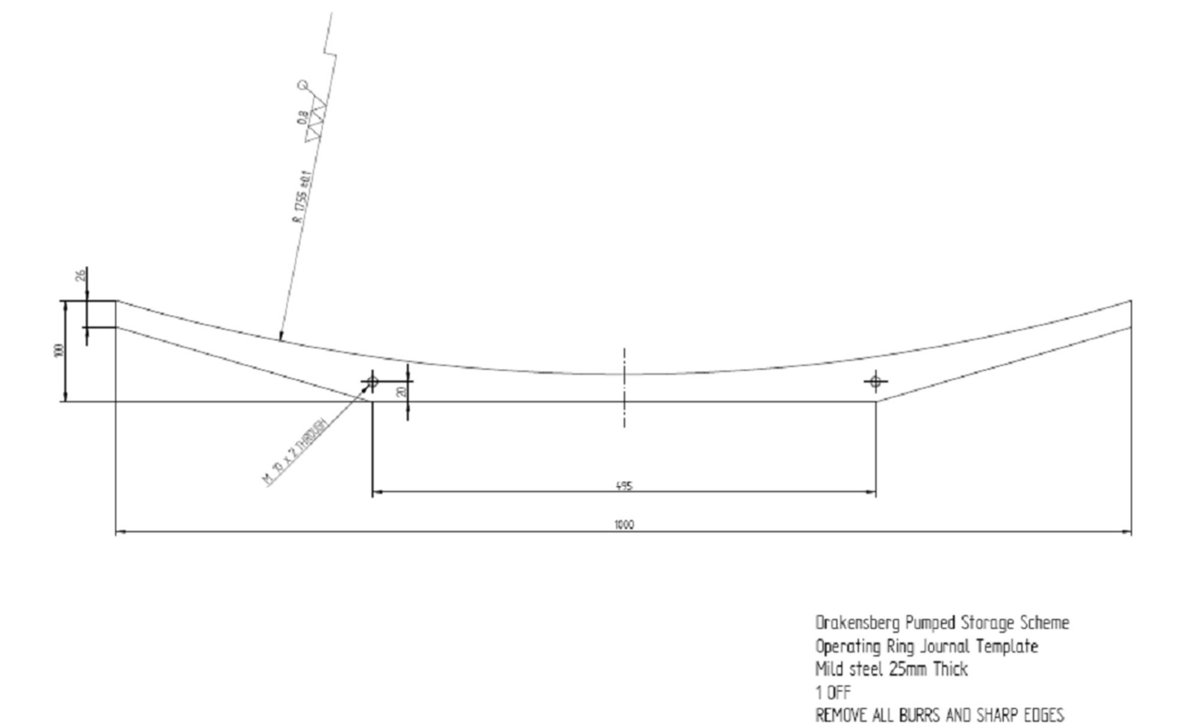



**Figure 11.7.1: Designed template to be used for grinding the journal back to its desired radius**

**Figure 11.7.2: Vertical wear plate with flat rectangular locking plate on each side**

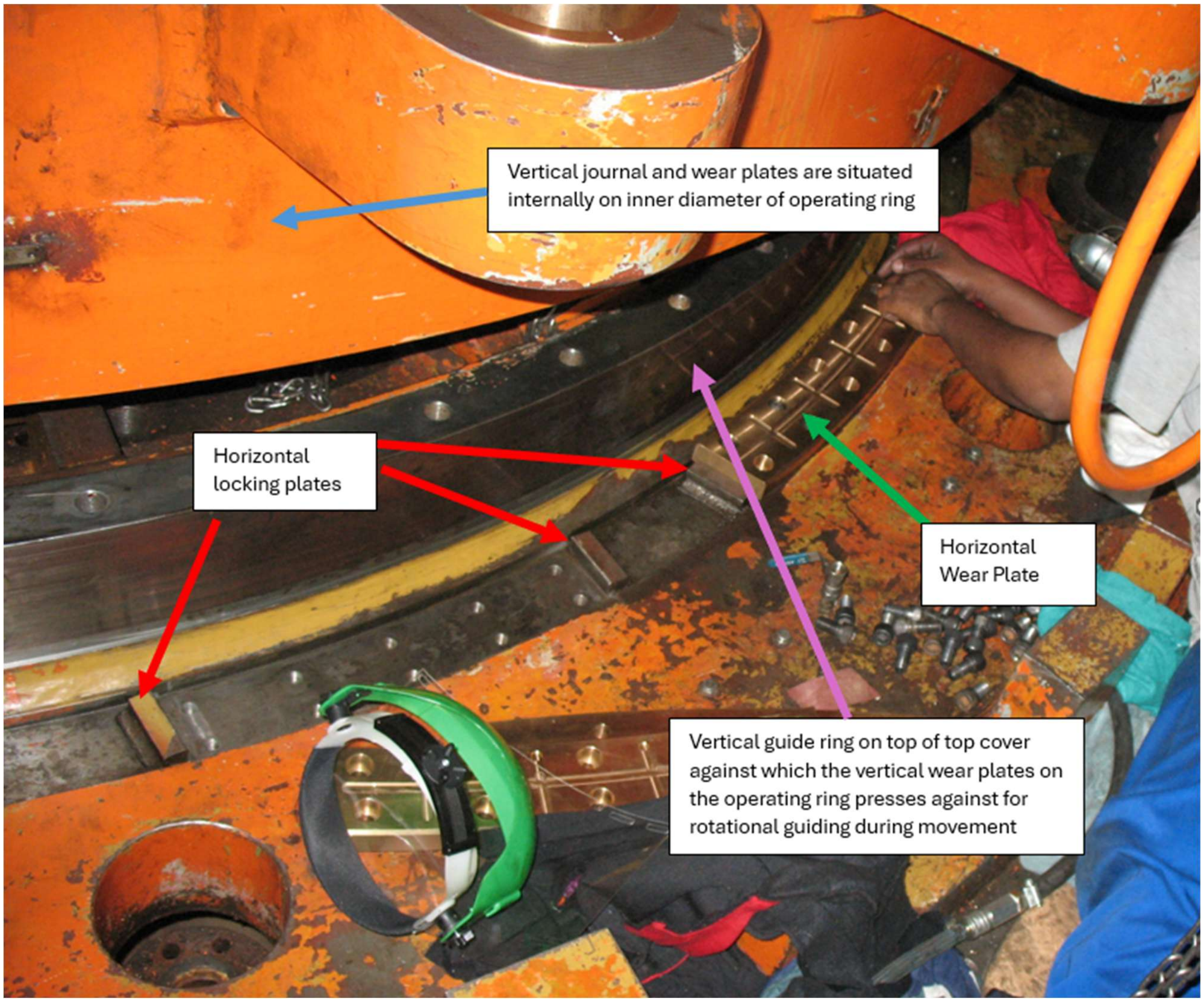



**Figure 11.7.3: Horizontal Wear Plates with locking plates**

## 11.8 Guide Vanes Blade Repairs

**Figure 11.8.1: Example of dispersed guide vane cavitation**

**Figure11.8.2: Guide vane and guide vane blade**


**Figure 11.8.3: Guide vanes removed and placed on machine hall floor**

**Figure 11.8.4: Guide vane upper and lower interfacing face repair welding prior to lathe machining**

Figure 11.8.5: Guide vane collar damage

## 11.9 Guide Vanes Facing Plate Repairs

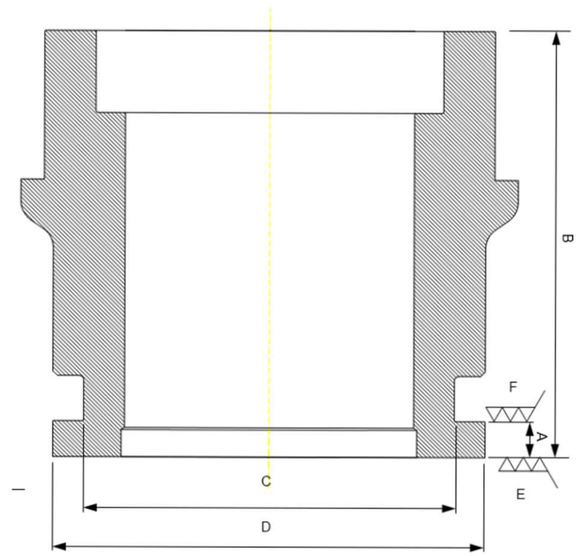
Figure 11.9.1: Guide vane facing plate previous pick-up removal by flapper disc

## 11.10 Turbine Runner Blade Repairs

**Figure11.10.1: Turbine runner blades cavitation and damage**

**Figure 11.10.2: Bottom view of runner blades with marked cavitation areas**

## 11.11 Guide Vane Head Repairs




| GUIDE VANE HEAD MACHINING QUALITY CONTROL PLAN | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CONTRACTOR : | | UNIT | 4 | GUIDE VANE HEAD | 1 | | | | |
| INSPECTION STATUS | H = HOLD POINT | W =WITNESS POINT | | I = INSPECTION POINT | | S = SURVEILLANCE | | | |
| Activity no. | Activity description Scope of work | MEASUREMENTS | | | Inspection status | Contractor | | Accepted by ESKOM | |
| | | | | | | Date | Signature | Date | Signature |
| | | Acceptance criteria | X | Y | | | | | |
| 1 | Set up run-out in bore | <0.03 | | | I | | | | |
| 2 | Collar thickness A | 40.000 - 39.975 | | | I | | | | |
| 3 | Overall length Bs | 473.20 - 472.80 | | | I | | | | |
| 4 | Collar ID C | 410.00 - 409.95 | | | I | | | | |
| 5 | Collar ID D | 478.00 - 477.95 | | | I | | | | |
| 6 | Surface roughness E | <0.8Ra | | | I | | | | |
| 7 | Surface roughness F | <0.8Ra | | | I | | | | |
| | | | | | I | | | | |
| | | | | | I | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

APPROVED BY: ____________________ SIGNED: ____________________ DATE: ____________________

**Figure 11.11.1: Example of check sheet used previously for guide vane head repair and distortion checks**

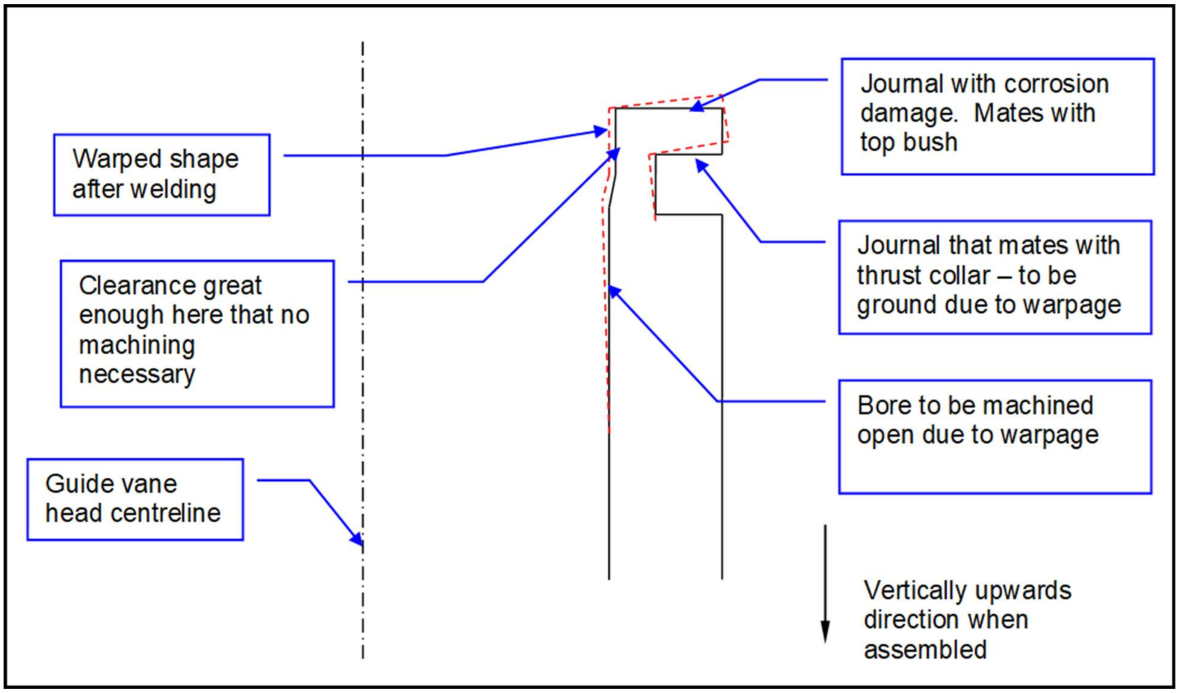



**Figure 11.11.2: Previous distortion that occurred on one of the guide vane heads**


**Figure11.11.3: Example of previous damage on guide vane head bottom flange surface**

## 11.12 Shaft Seal Sleeve Replacement

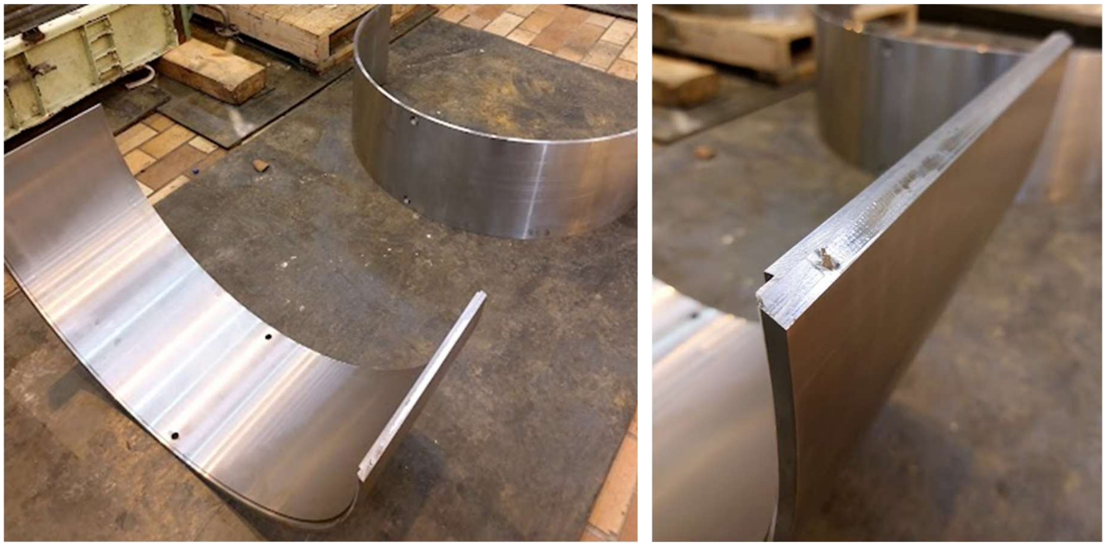


**Figure 11.12.1: New shaft sleeve segments prior to installation**

**Figure 11.12.2: Old sleeve after removal**

### 11.13 Shaft Seal Base Plate Repairs

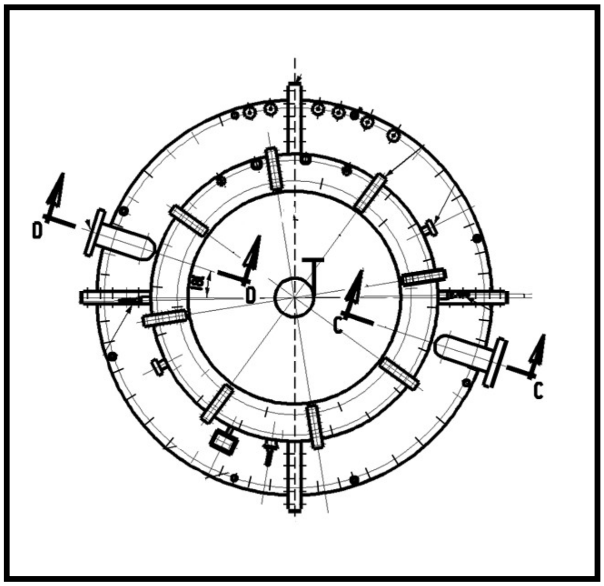



**Figure 11.13.1: Top view of shaft seal assembly**

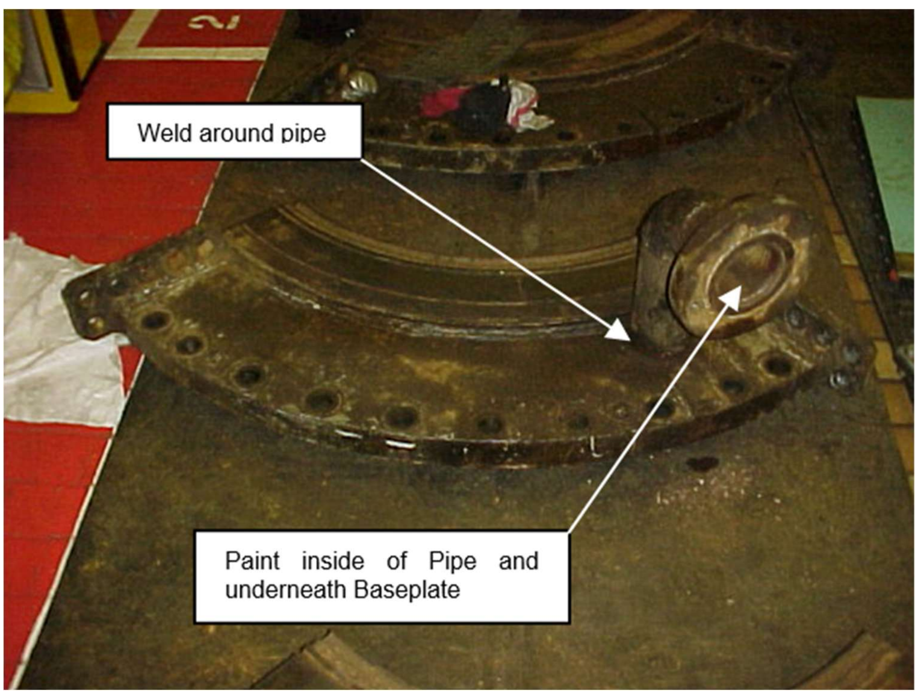



**Figure 11.13.2: One of the shaft seal base plate segments with piping**

## 11.14 Shaft Seal Upper Case Housing O-ring Groove Refurbishment

Figure 11.14.1: Shaft seal upper case housing O-ring groove damage_1

Figure 11.14.2: Shaft seal upper case housing O-ring groove damage_2

Figure 11.14.3: Shaft seal upper case housing O-ring groove damage_3

## 11.15 Turbine Embedded Pipework and Bottom Facing Plate Blanking

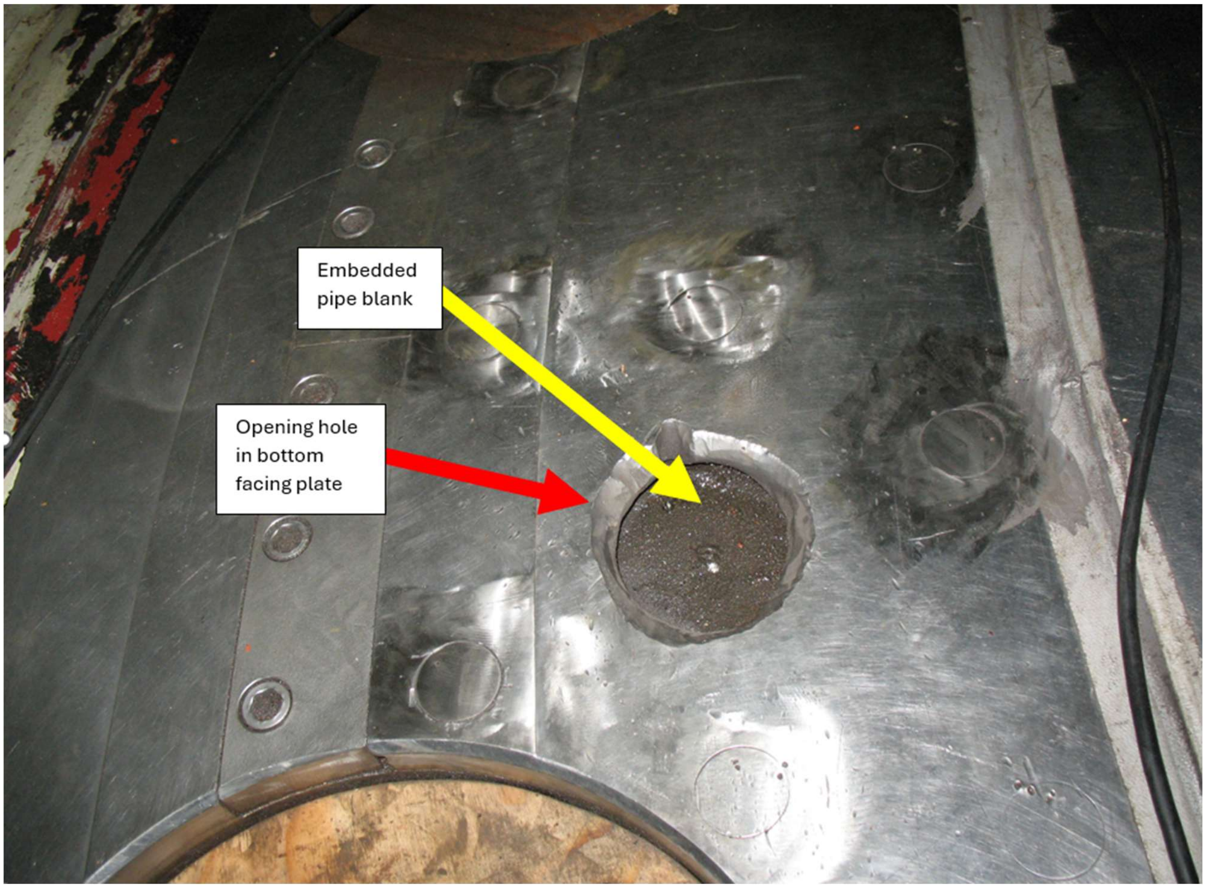



**Figure 11.15.1: Embedded pipework blank and opening hole in bottom facing plate**