

1. BACKGROUND

The Vanderkloof Hydroelectric Power Station turbine refurbishment outages necessitate specialised 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 two units each with separate vertical shaft turbine plants capable of generating 120MW individually, operating at 125rpm with a maximum net head of 74.5m. The turbine plant generally consists of a main shaft rotating by means of water flowing through a runner of the turbine, which turns the rotor of the generator and generate electricity to the national grid of South Africa. 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, specialised machining, line-boring, general machining and associated services including, but not limited to equipment, setups, consumables, material supply, machining, heat treatment, personnel qualifications, applicable design codes, quality control measures, documentation, testing and inspection and acceptance criteria.

2. DESCRIPTION OF THE WORKS

2.1 *Employer's objectives*

The *Employer's* objective is to establish a welding-, machining- and associated services contract with a suitably experienced *Contractor* to execute Vanderkloof (VDK) turbine refurbishment outages in accordance with this Technical Specification. The outages, which are subject to possible date changes, are currently scheduled for October 2026 (VDK Unit 2) and February 2027 (VDK Unit 1). Turbine plant refurbishment is limited to a total of 122 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 welding, general machining, line-boring and heat treatment, by the *Contractor* during the planned turbine refurbishment outages, to perform the specified welding and line-boring according to the applicable codes, standards and *Employer's* requirements.

3. WORK TO BE PERFORMED BY THE CONTRACTOR

3.1 Specifications

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

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

3.2 Scope of work

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

3.2.1 Turbine Components' Welding and Machining Works

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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* program of overhauling the pump-turbines at Vanderkloof Hydroelectric Power Station. 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 turbine guide vane middle bush casings and 20 guide vane bottom bush casings, as per the table below.

Table 1: Guide vane bush casing repairs

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters / Additional Information
Guide vane middle bush casing	Unknown: Refer to Section 3.2.2.2	ØID_1:	350	JIS G3106 SM41A	0.39/725 0.39/390 0.39/719 0.39/718	Weld Position: Vertical In-situ welding Weld Type: Inner diameter weld build-ups / Corrosion protection overlay Weld Process: SMAW (or GTAW) Machining: Line-boring; Grinding NDT Request: PT/MPI/UT
Guide vane bottom bush casing	BS EN 15614-1 Level 2 or ASME IX	ØID_2:	307			
		Height:	60-65			
		ØID_1:	350			
		ØID_2:	220			
		Height:	65-70			
a) Scope of Work						
1	The welding <i>Contractor</i> performs all necessary welding, general machining and associated welding services on the 20 middle bush casings and 20 bottom bush casings, including line-boring, which can be sub-Contracted to a competent and capable sub-<i>Contractor</i>, of the internal bore diameters. NDT will be done by the <i>Employer's</i> appointed NDT service provider. The guide vane bush casing repairs, consisting of 20 middle bush casings and 20 bottom bush casings thus 40 in total, will consist of the following high-level activities: • Machining, prior to welding of the butter layer, consisting of bore material removal by means of line-boring, if necessary, performed by the welding <i>Contractor's</i> line-boring sub-<i>Contractor</i>, if the material removal is not performed by the <i>Contractor</i> themselves. • NDT, consisting of 100% surface crack inspections, performed by the <i>Employer's</i> NDT service provider. • Welding of the butter layer, performed by the welding <i>Contractor</i>. • 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 welding <i>Contractor's</i> line-boring sub-<i>Contractor</i>. • NDT, consisting of 100% surface crack inspections, performed by the <i>Employer's</i> NDT service provider. • Welding of the stainless-steel overlay on all 40 bush casings, performed by the welding <i>Contractor</i>. • Final machining, performed by the welding <i>Contractor's</i> line-boring sub-<i>Contractor</i>. • NDT, consisting of 100% surface crack inspections and 15% volumetric inspections, performed by the <i>Employer's</i> NDT service provider. The welding <i>Contractor</i> 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:					

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

	- The 20 middle bush casings have an inner diameter specification of Ø307mm and inner flange/shoulder diameter of Ø350mm. The middle bush casing inner flange/shoulder diameter is relevant to the corrosion protection overlay welding. - The 20 bottom bush casings have an inner diameter specification of Ø277mm and inner flange/shoulder diameter of Ø350mm. The bottom bush casing inner flange/shoulder diameter is relevant to the corrosion protection overlay welding.
2	The existing casings are made from JIS SM41A carbon steel and are integral parts of the turbine head cover and bottom stay ring.
3	Should the line-boring sub- <i>Contractor</i> require tack welds to temporary secure line-boring equipment and tools to the existing plant, the welding <i>Contractor</i> shall perform these welds according to a Welding Procedure Specification.
4	The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> 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.
5	The welding <i>Contractor's</i> line-boring sub-<i>Contractor</i> machines back the corroded areas by not more than 5mm to 7mm in radius to achieve a healthy part of the base metal. The final material to be machined away will be determined during the execution of the <i>works</i>. - The height on the middle bush casing to be machined away and overlay welded is approximately 60mm to 65mm as illustrated in Figure 1: Guide vane middle bush casing repairs illustration. Final height to be confirmed during inspection on-site once access is granted. - The height on the bottom bush casing to be machined away and overlay welded is approximately 65mm to 70mm as illustrated in Figure 2: Guide vane bottom bush casing repair illustration. Final height to be confirmed during inspection on-site once access is granted.
6	The welding <i>Contractor</i> 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 <i>Contractor</i> shall utilise a previously proven and qualified corrosion resistant overlay welding procedure specification, subject to the <i>Employer's</i> acceptance.
7	The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> bores the welded areas to the original bore sizes concentric. The acceptance criteria for any eccentricity is 0.050 mm or less.
8	After final machining, the inner diameters of the casings are within the tolerance specifications as listed below: - Guide vane middle bush casing inner flange/shoulder diameter specification = Ø350.000mm to Ø350.057mm. - Guide vane bottom bush casing inner flange/shoulder diameter specification = Ø350.000mm to Ø350.057mm.
9	The welding <i>Contractor</i> , as well as the line-boring sub- <i>Contractor</i> , takes note that the maximum taper over the length of the bush casing is 0.050 mm.
10	The welding <i>Contractor</i> , as well as the line-boring sub- <i>Contractor</i> , takes note that the surface finish of the final machined internal diameter is 0.8 µm Ra or better.
11	The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> removes all burrs and sharp edges from the casings after final machining and polishes the edges to obtain a smooth profile.
12	The weld repairs on the casings are tested for cracks by Non-Destructive examination. The welding <i>Contractor</i> shall request, from the <i>Employer's</i> Outage Management, 100% Dye Penetrant Testing (PT) and 15% Ultrasonic Testing to be performed by the <i>Employer's</i> NDT Service Provider.
13	The work to be completed in less than ten calendar days on all 40 bush casings.
b) Line-Boring Design The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> designs the following parts of the <i>works</i> :	
1	The line-boring sub- <i>Contractor</i> designs and provides all equipment and jigs necessary to align the boring bar and to keep it steady during machining. The jigs can be bolted down using the following bolt holes (all measurements in mm):

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

	- There are twenty guide vanes equally spaced on PCD 6000mm. - At the middle housing, jigs can be tack welded to the turbine top cover. All tack welds are required to be ground clean and repaired with corrosion protection to a standard accepted by the <i>Employer</i>. The guide vane middle bush gland packing follower bolt holes can also be used to locate the jig of the line-boring sub-<i>Contractor</i>. There are a total of 6 equally spaced holes, 24mm diameter for M20 bolts, on a PCD of Ø355mm, as per drawings 0.39/725 and 0.39/718. Alternatively, a jig can also be tack welded to the top guide vane facing plate, subject to the usage of the correct Welding Procedure Specification and grinding off the tack welds to ensure a flush surface after removal. The facing plates have an inner diameter of Ø5474mm and an outer diameter of Ø6595mm. - At the bottom bush, there are 40 x M20 bolts (designed for lifting purposes) equally spaced on PCD 6440mm, which can be utilised. Another option is to utilise the bolt holes for the guide vane seals, which will be removed, that are spaced in between the bottom bush holes on the bottom facing plate as per drawing 0.39/725. There are a total of 120 holes for M16 bolts. Refer to drawings 0.39/725 and 0.39/718. Alternatively, a jig can also be tack welded to the bottom guide vane facing plate, subject to the usage of the correct Welding Procedure Specification and grinding off the tack welds to ensure a flush surface after removal. The facing plates have an inner diameter of Ø5474mm and an outer diameter of Ø6595mm.
2	Only new, close tolerance bearings for line boring equipment are to be used.
3	The following are particulars of the design which are to be submitted as a Technical Returnable for acceptance. - Layout of jigs and assemblies. - Installation details of the sub-<i>Contractor</i>'s line-boring equipment and tools consisting of the fastening methods (bolting and/or tack welding) to the <i>Employer</i>'s plant infrastructure and equipment.
4	Refer to Addendum A <u>Section 13.1: Guide Vane Bush Casing (Middle and Bottom) Repairs</u> for additional figures and information pertaining to the guide vane bush casings repairs: <u>Figure 5: Vanderkloof middle bush casing</u> <u>Figure 6: Vanderkloof bottom bush casing</u> <u>Figure 7: Example of similar guide vane middle bush casing repairs</u>
c) Tests and Inspections The welding <i>Contractor</i> subcontracts the quality control to a third-party company who records the following dimensions:	
1	The welding <i>Contractor</i> subcontracts the quality control to a third-party company who records all findings and dimensions in a data pack subject to the <i>Employer</i> 's approval.
2	The line-bored casings are tested for cracks by Non-Destructive examination. The welding <i>Contractor</i> shall request, from the <i>Employer</i> 's Outage Management, 100% Dye Penetrant Testing (PT) and 15% Ultrasonic Testing.
3	Inner diameter measurements with a calibrated micrometre. Two readings perpendicular to each other are taken at the upper and lower parts of each bush casing repaired area on each of the 20-guide vane bottom bush casings and middle bush casings.
4	Concentricity checks by means of run-out.
5	The surface finish of the bush casings, after final machining, are tested with a calibrated instrument.
6	All measurements are recorded and can be witnessed by the <i>Employer</i> .
7	All recorded measurements are submitted to the <i>Employer</i> within 1 (one) day of being recorded for review and acceptance.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

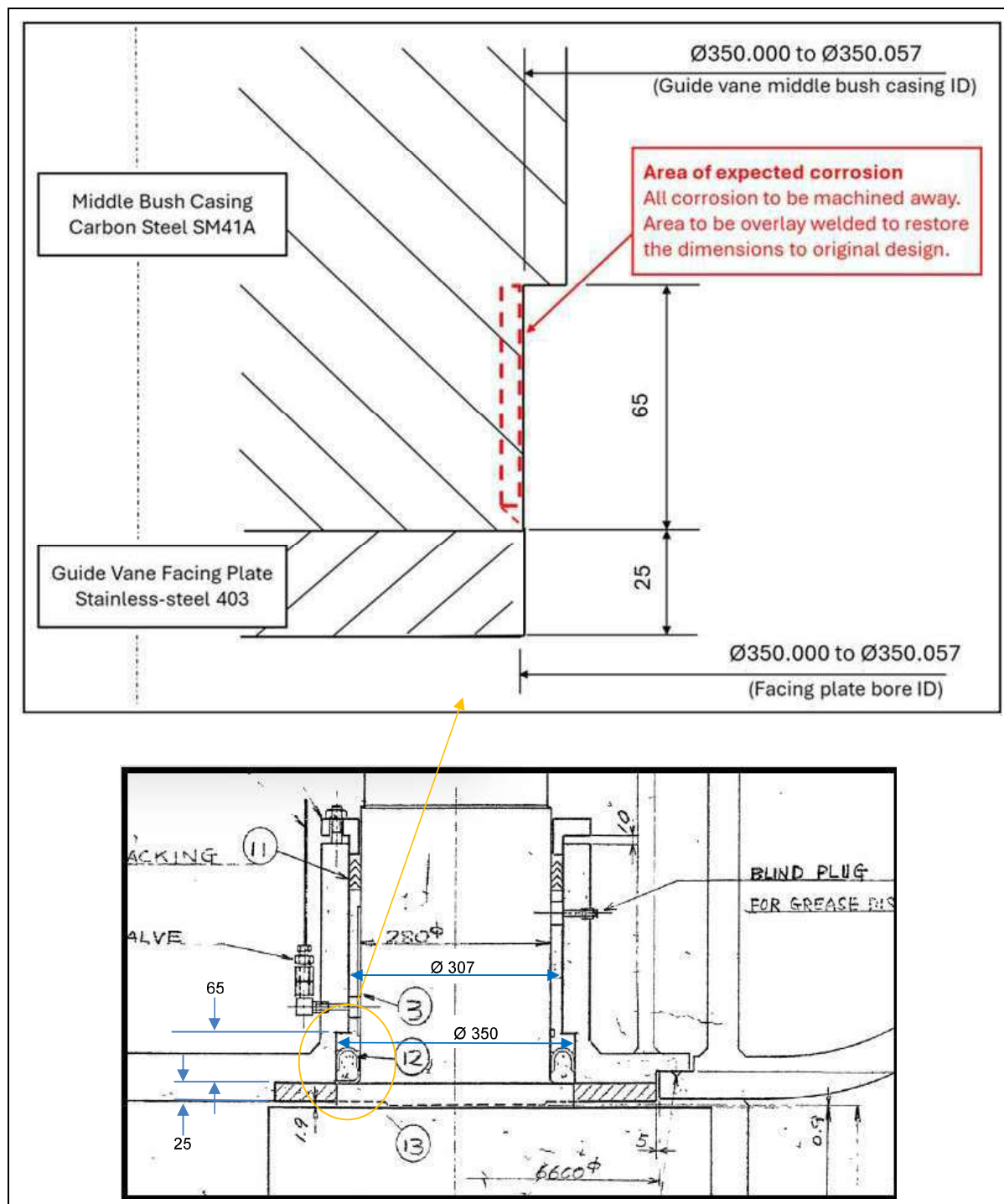


Figure 1: Guide vane middle bush casing repairs illustration

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

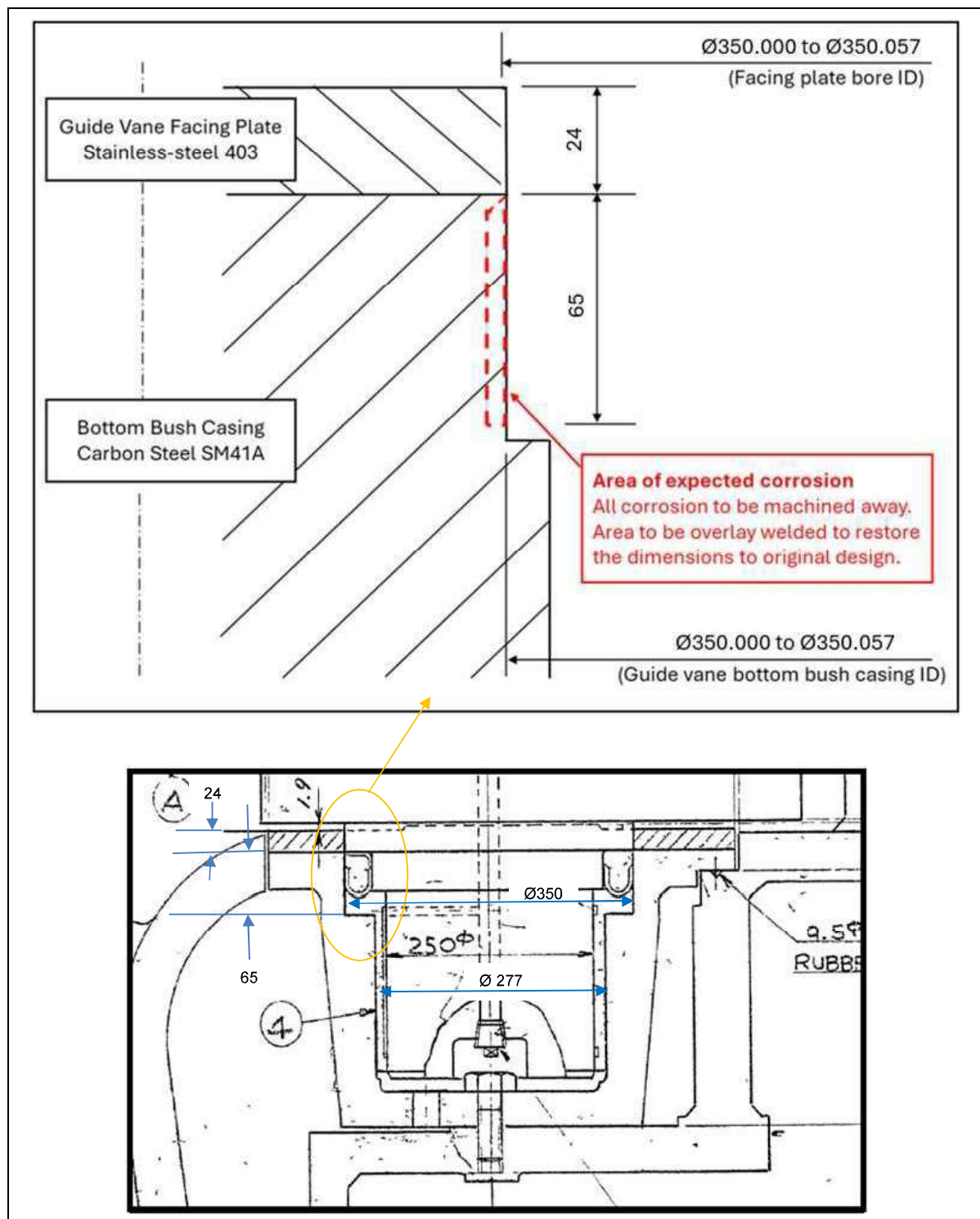


Figure 2: Guide vane bottom bush casing repair illustration

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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 2: Spiral casing, stay vanes and mandoor information

Item	Code	Dimensions [mm]	Material Specification	Drawing	Plant Parameters / Additional Information
¹ Spiral casing liner (shell plates)		Ø: 7000 to 3628 t: 25-43	BS 4360 Grade 50C	0.39/390 0.39/391 0.39/398 0.39/399 0.39/400	Temperature: Ambient Pressure: 7.45 Bar ⁴ Weld Position: Various ⁴ In-situ welding ⁴ Weld Type: Weld build-up ⁴ Weld Process: SMAW/TIG ⁴ Machining/Excavation: Grinding; Blending; Polishing ⁷ NDT Request: PT/MPI/UT
² Stay vanes	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	t: 30 length (l): 890 height (h): 1750	JIS G3106 SM50B	0.39/391	Temperature: Ambient Pressure: 7.2 Bar ⁵ Weld Position: Vertical ⁵ In-situ welding ⁵ Weld Type: Weld build-up ⁵ Weld Process: SMAW/TIG ⁵ Machining/Excavation: Grinding; Blending; Polishing ⁷ NDT Request: PT/MPI/UT
³ Spiral casing mandoor, flange and reinforcement pad		t: 25-90 Groove: 9 Door: 1110x1030	BS 4360 Grade 50C	0.39/656 0.39/399	Temperature: Ambient Pressure: 7.2 Bar ⁶ Weld Position: Various ⁶ Door can be removed ⁶ Weld Type: Weld build-up ⁶ Weld Process: SMAW/TIG ⁶ Machining: Excavation, Grinding, Specialised machining of O-ring groove ⁷ NDT Request: PT/MPI/UT
1	The spiral casing is a reducing steel lined spiral passage, that is completely coated internally and concrete embedded, and responsible for directing and balancing water from the penstock to the runner.				
2	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.				
3	Access to the spiral casing is obtained through a vertical orientated rectangular flanged access door that is coated internally. Sealing between the mandoor sealing surface and the spiral casing access flange is ensured by an O-ring installed into a "V-type" packing groove, situated on the spiral casing flange.				
4	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 <i>Contractor</i> 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 <i>Contractor</i> shall be manual SMAW or GTAW. The weld build-ups shall be ground/polished to suit the surrounding areas.				

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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. The welding required by the <i>Contractor</i> shall be in-situ weld build-ups by means of manual SMAW or GTAW 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.
6	The spiral casing mandoor defects, if any, typically includes localised damage of the general surface areas or deterioration of either the packing groove, situated on the spiral casing flange, reinforcement pad or the mandoor sealing surface. Sealing faces and general damage will be repaired by means of weld build-ups and ground flush to suit the surrounding areas. Packing groove damage will require in-situ weld repairs and groove machining, if found necessary, for restoration as per <u>Figure 10: Spiral casing mandoor flange with seal/packing groove</u> . Should the packing groove damage be too excessive or its function be redundant an engineering change decision might be made to replace the groove design with a gasket sealing arrangement, which will require a complete weld build-up of the entire circumferential groove and blending flush to the surrounding sealing face (this modification might have been done on some of the units already). All welding on the spiral casing mandoor flange and reinforcement pad will be in a vertical to 45-degree position, whereas all welding on the mandoor can be as required as the door can be removed. The preferred process to be utilised by the <i>Contractor</i> shall be manual SMAW or GTAW. Machining shall be required by the <i>Contractor</i> to conduct in-situ machining of the "V-type" packing groove, if found to be necessary. The packing groove dimensions shall be confirmed by the <i>Contractor</i> , once access is obtained, and agreed with the <i>Employer</i> prior to welding/machining. A surface finish of 0.8µm Ra or better for all sealing surfaces shall be achieved and the sealing surfaces following welding and machining, or blending, shall ensure proper sealing.
7	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths.
Refer to Addendum A Section 13.2: <u>Spiral Casing Liner, Stay Vanes and Mandoor Repairs</u> for additional figures and information pertaining to the spiral casing repairs: • <u>Figure 8: Spiral casing typical liner damage</u> • <u>Figure 9: Example of typical damage on vertical stay vane</u> • <u>Figure 10: Spiral casing mandoor flange with seal/packing groove</u> • <u>Figure 11: Spiral casing access mandoor in closed/sealed condition with spiral casing filled</u> • <u>Figure 17: VDK V-type Packing (O-ring) groove</u> – Example of "V-type" packing groove found at Vanderkloof	

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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 3: Draft tube and mandoor information

Item	Code	Dimensions [mm]	Material Specification	Drawing	Plant Parameters / Additional Information
¹ Draft tube liner (upper and lower)	Unknown: Refer to Section 3.2.2.2	T _{upper} : 20-25 Ø _{upper} : 5370-6085 Lower draft tube: Various, refer to drawings		0.39/386 0.39/396 0.39/392 0.39/393	Temperature: Ambient Pressure: 1.5 Bar ³ Weld Position: Various ³ In-situ welding ³ Weld Type: Weld build-ups ³ Weld Process: SMAW/TIG ³ Machining/Excavation: Grinding; Blending; Polishing ⁵ NDT Request: PT/MPI/UT
² Draft tube mandoor sealing faces	BS EN 15614-1 Level 2 or ASME IX	t: 15-30 Seal face width: 80 Door: 1080 x 1380 Groove: 12	BS4360 Grade 43A	0.39/396 0.39/397 0.39/657	Temperature: Ambient Pressure: 1.5Bar ⁴ Weld Position: Vertical ⁴ In-situ welding ⁴ Weld Type: Weld build-ups ⁴ Weld Process: SMAW/TIG ⁴ Machining: Excavation; Grinding; Blending; Polishing; Specialised machining of packing groove ⁵ NDT Request: PT/MPI/UT
1	The draft tube is a steel lined, coated and shape altering tube at the discharge of the turbine runner that is embedded in concrete. The draft tube varies from circular in shape with a vertical orientation (upper draft tube at turbine discharge) to an oval shape with a horizontal orientation (lower draft tube at turning point) to a rectangular shape with an upwards sloping orientation (lower draft tube to lower dam discharge) as it approaches the lower dam.				
2	Access to the draft tube is obtained through a vertical orientated rectangular flanged access door. Sealing is ensured by packing (O-ring) installed between the two sealing faces (draft tube flange face and door flange face). The packing groove, which is a "V-type" design, is situated on the draft tube flange.				
3	Typical draft tube liner defects can be either localised or spread over a wider area with an averaged depth of 5 mm. General maintenance 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 <i>Contractor</i> 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 <i>Contractor</i> shall be manual SMAW or GTAW. The weld build-ups shall be ground/polished to suit the surrounding areas.				

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

4	The draft tube mandoor defects, if any, typically include localised damage of the general surface areas, deterioration of the interfacing sealing surfaces and damage to the packing groove. Sealing faces and general damage will be repaired by means of weld build-ups and ground flush to suit the surrounding areas. Packing groove damage will require in-situ weld repairs and groove machining, if found necessary, for restoration as per <u>Figure 14: Draft tube mandoor flange with seal/packing groove</u>. Should the packing groove damage be too excessive or its function be redundant an engineering change decision might be made to replace the groove design with a gasket sealing arrangement, which will require a complete weld build-up of the entire circumferential groove and blending flush to the surrounding sealing face (this modification might have been done on some of the units already). Welding positions will most likely be in the vertical orientation. The preferred welding process to be utilised by the <i>Contractor</i> shall be manual SMAW or GTAW. Specialised machining shall be required by the <i>Contractor</i> to conduct in-situ machining of the packing groove, if found to be necessary. The "V-type" packing groove dimensions shall be confirmed by the <i>Contractor</i>, once access is obtained, and agreed with the <i>Employer</i> prior to welding/machining. A surface finish of 0.8µm Ra or better for sealing surfaces shall be achieved and the sealing surfaces following welding and machining shall ensure proper sealing.
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT or MPI and 15% UT for weld build-ups, depending on the build-up depths.
Refer to Addendum A Section <u>13.3: Draft Tube Liner and Mandoor Repairs</u> for additional figures and information pertaining to the draft tube repairs: • <u>Figure 12: Draft tube liner damage</u> • <u>Figure 13: Draft tube access mandoor in closed/seal condition with draft tube charged</u> • <u>Figure 14: Draft tube mandoor flange with seal/packing groove</u> • <u>Figure 15: Draft tube door current sealing arrangement</u> • <u>Figure 17: VDK V-type Packing (O-ring) groove</u> – Example of "V-type" packing groove found at Vanderkloof	

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.4 Turbine Head Cover Surface Repairs and O-ring Groove 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 summarises necessary information that will serve as input to the repair procedure.

Table 4: Turbine head cover, stay ring repairs and O-ring groove information

Item	Code	Dimensions [mm]		Material Spec	Drawing	Plant Parameters / Additional Information
¹ Turbine Head Cover and O-ring groove	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2	t: Ø:	Various; 20-80 7000	JIS G3106 SM41A	0.39/725 0.39/718 0.39/391	³ Weld position: Overhead and vertical ³ On-site welding ³ Weld Type: Weld build-ups ³ Machining: Excavating; Grinding; Polishing ³ Weld process: SMAW/TIG ⁵ NDT Request: PT/MPI/UT
² Stay Ring	or ASME IX	t:	Various; 15-55	JIS G3106 SM50B		⁴ Weld position: Flat and vertical ⁴ In-situ welding ⁴ Weld Type: Weld build-ups ⁴ Machining: Excavation; Grinding; Polishing ⁴ Weld process: SMAW/TIG ⁵ NDT Request: PT/MPI/UT
1	The turbine head cover, also referred to as the top cover, is a major structural component of the Francis turbine. It is a large metal cover fabricated from structural plates, of various thicknesses and similar material grouping, that encloses the top of the turbine runner all around the main shaft and the guide vanes assembly within the spiral casing and thus sealing the high-pressure water flow path. The head cover is lifted from the stay ring and supported around the main shaft during the turbine refurbishment outages. It has an overall outer diameter of approximately 7150mm.					
2	The stay ring has multiple critical functions as it provides a connecting interface for the head cover and additionally the stay ring contains stationary vanes (stay vanes) which directs the water flow to the turbine runner and helps to support the structure. It comprises of similar materials and has a critical "V-type" O-ring groove, for a 9.5mm O-ring, with an approximate diameter of 6700mm that ensures sealing between the head cover and stay ring. The turbine refurbishment outage grants access to the O-ring and groove every 20 years to allow for O-ring replacement and groove inspections and repairs.					
3	With regards to the turbine head cover, certain areas are subject to either corrosion, operational damage or possible assemble/disassembly damage and might require repair by means of welding, to be performed by the <i>Contractor</i> . The complete head cover shall be thoroughly inspected, including the O-ring sealing surface, by the <i>Employer</i> upon obtaining of access during the disassembly process and all identified damaged areas shall be handed over to the welding <i>Contractor</i> for assessment and repair proposal. Weld repairs shall generally consist of parent material excavation of the damaged area prior to weld build-ups. Should damage be noted on existing welds, the repairs shall be assessed and repaired accordingly. The weld build-up repairs shall be ground/polished to suit the surrounding areas and to achieve a surface finish of 0.8µm Ra or better. The <i>Contractor</i> shall weld by means of manual SMAW or GTAW. In terms of welding positions, the top cover will be lifted and supported in an elevated position above the stay ring, hence the O-ring sealing surfaces will be in the overhead position, while other areas to be repaired might be in the vertical position. Distortion shall be controlled and monitored by the <i>Contractor</i> .					

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

4	The stay ring, like the head cover, is subject to corrosion, operational damage and possible interfacing assembly/disassembly damage that shall be weld repaired by the <i>Contractor</i>. Upon obtaining of access during the turbine refurbishment outage, the <i>Employer</i> shall inspect the complete stay ring, including the critical "V-type" O-ring groove, and identify all concerning areas, which shall be handed over to the welding <i>Contractor</i> for repair method assessment and proposal. Damaged areas shall be excavated, and in-situ weld build-ups shall be performed by the <i>Contractor</i>. Weld build-ups shall be ground/polished to suit the surrounding areas. Should repairs be required on the "V-type" O-ring groove, machining shall be required by the <i>Contractor</i>, after performing the necessary excavations and weld repairs, to deliver the required groove dimensions. The O-ring groove sealing surfaces shall have a surface finish of 0.8µm Ra or better and the final dimensions shall be confirmed and agreed upon prior to final machining as per <u>Figure 16: Turbine head cover O-ring groove position and information</u>. Weld repairs and machining on the 'V-type' O-ring groove will be in the flat position, whereas other general repairs might possibly be in the flat and vertical positions. Manual SMAW or GTAW shall be utilised by the <i>Contractor</i>. Distortion shall be controlled and monitored by the <i>Contractor</i>.
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> 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. Refer to Addendum A Section 13.4: <u>Turbine Head Cover Surface Repairs and Stay Ring O-ring Groove, O-ring Lead-In and O-ring Sealing Surface Repairs</u> for additional figures and information pertaining to the turbine head cover repairs: • <u>Figure 16: Turbine head cover O-ring groove position and information</u> • <u>Figure 17: VDK V-type Packing (O-ring) groove</u>

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.5 Locking Plate Welding for Guide Vane Link Shear Pins, Servomotor Link Pins and Servomotor Rod Lock Nuts

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

Table 5: GV link pin and governor servomotor link pin locking plates information

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters
¹ GV link shear pin locking plates (20)	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	Locking plate t:	5	Link Arms: JIS G3106 SM41A	0.39/716	⁴ Weld position: Flat ⁴ In-situ welding ⁴ Weld type: Fillet weld ⁴ Weld process: SMAW ⁴ Machining: Fillet welds to be left as welded ⁵ NDT Request: PT or MPI
² Governor servomotor link pin locking plates (4)		GV link arm t:	40			
³ Governor servomotor piston rod lock nut locking plates (2)		Locking plate t:	5	Locking Plates: Carbon Steel/ Group 1.2	0.39/800	
	GV link arm t:	80				
		Locking plate/angle iron t:	5			
		Rod lock nut t:	180			
1	The linkage between the GV arm lever, link arm and operating ring is secured by a shear and eccentric pin. The position of these pins are essential and therefore various locking mechanisms are utilised to secure the pins in its installed position to prevent movement, as this can affect the positions of the guide vanes. Each eccentric pin is locked by means of a circular washer plate with bolts and locking tabs and does not require welding, however each shear pin is locked by means of a rectangular locking plate that requires a circumferential fillet weld. There are 20 guide vanes each with 1 shear pin, thus 20 shear pin locking plates in total that will require welding.					
2	The linkage between the servomotor rod link arm, connecting link bars and operating ring, is ensured by straight pins. The pin positions are each locked by means of a rectangular locking plate. There are 2 servomotors link bars each with 2 pins, thus a total of 4 locking plates per unit.					
3	Each servomotor's piston stroke range can be adjusted as the piston rod is threaded into the clevis, meaning that by fastening or loosening the piston rod (pistons rotate during this activity) the length of the entire lever arm is adjusted. Once the optimum length is obtained the rod is locked by means of a large locking nut. The position of the lock nut is ensured by a welded locking plate. Each unit has one lock nut per servomotor, thus 2 in total.					
4	The <i>Contractor</i> shall weld in-situ during the assembly phase of the turbine refurbishment outage, with manual SMAW, an approximate 5 mm (leg length) circumferential fillet weld around each of the locking plates in the flat position. The fillet welds shall be left in the as-welded condition.					
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, and shall consist of 100% PT or MPI for all fillet welds.					
Refer to Addendum A Section 13.5: <u>Locking Plate Welding for Guide Vane Link Shear Pins, Servomotor Link Pins and Servomotor Rod Lock Nuts</u> for additional information and figures pertaining to the locking plate welds:						
- Figure 18: Guide vane link shear pin locking plate details - Figure 19: Servomotor link pins' locking plate details - Figure 20: Servomotor rods' lock nuts locking plates						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.6 Operating Ring Repairs

Operating ring general repairs as well as 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.

Table 6: Operating ring journal and wear plates locking information

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters
¹ Operating ring general repairs	Unknown: Refer to Section 3.2.2.2	t:	>50	Operating ring: JIS G3106 SM41A	0.39/400 0.39/717	³ Weld position: Various ³ On-site welding ³ Weld type: Weld build-up ³ Machining: Excavating; Grinding; Blending; Polishing ³ Weld process: SMAW/TIG ⁵ NDT Request: PT
² Vertical and horizontal journals	BS EN 15614-1 Level 2 or ASME IX	t:	80	Head Cover & Operating Ring: JIS G3106 SM41A	0.39/717 0.39/718	⁴ Weld position: Vertical; Flat ⁴ On-site welding ⁴ Weld type: Weld build-up ⁴ Machining: Excavating; Grinding; Blending; Polishing ⁴ Weld process: SMAW/TIG ⁵ NDT Request: PT
1	The operating ring is a mechanical component, constructed from plate material, that is part of the governor guide vane system responsible for opening and closing of the guide vanes, simultaneously, to regulate the water flow rate. The operating ring is installed on top of the head cover with interfacing vertical and horizontal bronze wearing plates, also known as operating ring liners.					
2	The bronze wearing plates, that are installed/bolted onto the operating ring, interfaces with vertical and horizontal diameter journals located on the head cover. This ensures adequate movement and protection of all underlying surfaces of the operating ring as well as the head cover, as the wearing plates wear whilst being driven by the governor servomotors to position the guide vanes. Grease is supplied to both journals. The vertical journal diameter is 3500mm with a total height of 120mm, while the horizontal journal is located on the head cover with a diameter of 3500 to 3760mm.					
3	The complete operating ring shall be thoroughly inspected, by the <i>Employer</i> upon obtaining of access and after removal of the wearing plates. All identified damaged areas shall be handed over to the welding <i>Contractor</i> for assessment and repair proposal. Weld repairs shall generally consist of parent material excavation of the damaged area prior to weld build-ups. Should damage be noted on existing welds, the repairs shall be assessed and repaired accordingly. The weld build-up repairs shall be ground/polished to suit the surrounding areas and to achieve a surface finish of 0.8µm Ra or better. The <i>Contractor</i> shall weld by means of manual SMAW or GTAW. Depending on the weld repair location the welding positions will most likely consist of vertical, overhead and flat. The <i>Contractor</i> shall monitor and control distortion.					
4	The vertical and horizontal journals on the head cover will be inspected, and any damaged areas shall be repair welded by the <i>Contractor</i> , by means of weld build-ups. The weld build-up repairs shall be ground/polished to suit the surrounding journal areas and to achieve a surface finish of 0.8µm Ra or better. The <i>Contractor</i> shall weld by means of manual SMAW or GTAW. The welding positions includes vertical and flat.					
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> 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.					
Refer to Addendum A Section <u>13.6: Operating Ring Weld Repairs</u> for additional information and figures pertaining to the operating ring and head cover interface repair welds:						
• <u>Figure 21: Operating ring and head cover interface</u> • <u>Figure 22: Operating ring and servomotor and guide vane link interfaces</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.7 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 7: Guide vane facing plates information

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters / Additional Information
¹ Guide vane top and bottom facing plates	Unknown: Refer to Section 3.2.2.2	T _{top} :	25	JIS G4304 SUS 403	0.39/390 0.39/725 0.39/718	² Weld position: Flat and overhead
	BS EN 15614-1 Level 2	T _{bottom} :	24			² In-situ & on-site welding
	or					³ Weld type: Weld build-ups
	ASME IX					³ Machining: Excavating; Grinding; Blending; Polishing
						⁴ Weld process: GTAW (& PWHT)
						⁵ NDT Request: PT & UT
1	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. The Vanderkloof interface between the guide vanes and the top and bottom facing plates includes a rubber seal that is installed into a dovetail groove in the top and bottom facing plates.					
2	The top facing plate will be lifted with the top cover therefore, welding shall be done by the <i>Contractor</i> in the overhead position, while the bottom facing plate will remain in-situ (flat).					
3	Repairs shall be done by the <i>Contractor</i> 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 <i>Contractor</i> 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 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. Should any weld and machining repairs be required to the dovetail seal groove, the <i>Contractor</i> shall assess, repair and machine accordingly.					
4	The facing plates are critical components in the sense that they 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 <i>Contractor</i> shall be GTAW with the possibility of PWHT.					
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT and 15% UT for weld build-ups, depending on the build-up depths.					
Refer to Addendum A Section 13.7: <u>Guide Vanes Facing Plate Repairs</u> for additional information and figures pertaining to the facing plates weld repairs:						
<u>Figure 23: Typical pick-up damage on the guide vane facing plates</u> <u>Figure 24: Top and bottom facing plates and guide vane seals</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.8 Turbine Runner Blade Repairs

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

Table 8: Turbine runner information

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters / Additional Information
¹ Turbine runner	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	t:	70-200	Blades: High-Ni 13%Cr stainless steel casting Cone: JIS G3106 SM41A	0.39/714	² Weld position: Various ² In-situ on-site welding ³ Weld Type: Weld build-ups ³ Machining: Excavating; Grinding; Blending; Polishing ⁴ Weld process: GTAW & PWHT 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 mainly consists of 14 vane blades, manufactured from a high-nickel (Ni) stainless steel casting, and a runner cone comprising of JIS G3106 SM41A material. A PMI must be done by the <i>Contractor</i> to verify the material specification of the blades.					
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 <i>Contractor</i> .					
3	Typical localised blade defects can be up to 10 mm deep in extreme cases, while dispersed defects such as cavitation can be over a slightly larger area but generally do not reach depths of more than 5mm. The repairs 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. Typical cavitation damages noticed on each of the Vanderkloof runner blades include trailing edge cavitation and runner blade low-pressure area cavitation. The trailing edge cavitation generally consists of an approximate area of 30mm x 500mm with a depth of 5mm, while the low-pressure cavitation area repair covers an area of approximately 200mm in diameter with a depth of 5mm. An assessment to be done by the <i>Contractor</i> whether distortion, due to welding and PWHT, might affect turbine blade profile and turbine labyrinth clearances prior to welding.					
4	The runner is a stainless-steel casting and PWHT will be required in general, except if defects are very shallow and a welding procedure without PWHT have been qualified by the <i>Contractor</i> . GTAW will be performed for any runner repairs by the <i>Contractor</i> .					
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT and 15% UT for weld build-ups.					
Refer to Addendum A Section <u>13.8: Turbine Runner Blade Repairs</u> for additional information and figures pertaining to typical runner blade damage:						
• <u>Figure 25: Turbine blade trailing edge cavitation</u> • <u>Figure 26: Turbine blade low pressure area cavitation</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.9 Gate Lever (Guide Vane Head) Repairs

Gate lever (guide vane head) repairs shall be implemented by the *Contractor*. Inspections will be carried out by the *Employer*, upon gaining of access, to identify all defects and areas of concerns, that potentially requires repair welding by the *Contractor*. Information, to determine the most appropriate repair procedure, is given as per the following table.

Table 9: Guide vane head information

Item	Code	Dimensions [mm]		Material Specification	Drawing	Plant Parameters / Additional Information
¹ Gate levers (Guide vane heads)	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	t _{body} :	72.5	JIS G5101 SC46	0.39/725 0.39/718	² Weld position: Flat ² Offsite Repair – Due to machining required, but to be assessed by the <i>Contractor</i> ³ Weld type: Weld build-ups ³ Machining: Excavating; Grinding; Blending/Polishing; Lathe machining; Possibility of line- boring ⁴ Weld process: GTAW ⁵ NDT Request: PT & UT
		Ø _{in} :	270			
		Ø _{out} :	415			
		t _{flange} :	40-45			
1	Gate levers form a critical part of the guide vanes' driving mechanism as they are fixed to the guide vanes and transfer the driving forces from the servomotors, operating ring and link arms to the guide vanes to ensure the required movements during operation. There are a total of 20 guide vane gate levers. Each gate lever has a bottom flange that interfaces on both surfaces. The flange's top surface interfaces with the thrust collar (thrust bearing halves), while the bottom surface interfaces with the guide vane top bush.					
2	The gate levers will be removed during the turbine refurbishment outage and repairs shall take place off site at the <i>Contractor's</i> facility depending on the findings; therefore, placement will allow for any desired position.					
3	The active damaging mechanisms on the gate levers are corrosion, wear, mechanical fatigue, operational and handling damage. All general repairs on the gate lever body shall be done by the <i>Contractor</i> in the form of weld build-ups and machining to ensure the build-ups are ground flush according to the surrounding areas. Repairs specific to the bottom flange related to wear, shall be restored back to the original design by means of a full flange face weld build-up and machining to restore the desired flange surface finish and thickness. The <i>Contractor</i> takes note that these components are prone to distortion, based on previous experience and resulted in a few bores that had to be line bored to size. 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, if necessary, only, at the <i>Contractor's</i> (or sub- <i>Contractor's</i>) facilities, this will however be assessed by the <i>Contractor</i> . A surface finish of 0.8µm or better shall be achieved. The quantity, if any, of gate levers to be sent off site shall be confirmed upon completion of the <i>Employer's</i> inspections upon gaining of access. All other identified defects, by the <i>Employer</i> , on the guide vane head body, such as cracks, craters or unacceptable indications shall be build-up weld repaired and blended accordingly by the <i>Contractor</i> .					
4	The welding process to be implemented by the <i>Contractor</i> shall be GTAW.					
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> 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 <i>Employer's</i> NDT service provider.					
Refer to Addendum A Section 13.9: <u>Guide Vane Gate Levers (Guide Vane Heads) Repairs</u> for additional information and figures pertaining to guide vane gate levers (heads) weld repairs and distortion control:						
• <u>Figure 27: Guide vane gate lever (guide vane head) illustration and interfaces</u> • <u>Figure 28: Vanderkloof guide vane gate levers and interfaces with guide vane links to operating ring</u> • <u>Figure 29: Vanderkloof spare guide vane levers (heads)</u> • <u>Figure 30: Example of wear on the guide vane gate levers' bottom flange surfaces that interface with the top bush</u> • <u>Figure 31: Example of distortion that occurred on one of the guide vane gate levers (heads)</u> • <u>Figure 32: Example of check sheet for guide vane gate lever repair and distortion checks</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.10 Shaft Seal Sleeve Replacement

The shaft seal sleeve, for each unit, 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, by means of welding, a spare sleeve that will be supplied by the *Employer*. Relevant information to determine the most appropriate repair procedure, is summarised within the table below.

Table 10: Shaft seal sleeve information

Item	Code	Dimensions [mm]		Material Spec	Drawing	Plant Parameters / Additional Information
1 ¹ Shaft seal sleeve	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	t:	20	JIS G4304 SUS403	0.39/390 0.39/722 0.39/713 18.39/2789-1 18.392789-2	² Removal: Drilling & grinding
		Ø_ID:	1080(+0.105; -0)			³ Weld position: Vertical
		Ø_OD:	1120(+0.165; -0)			³ Weld type: Butt Weld
		L:	270			³ In-situ on-site welding
						⁴ Weld process: GTAW & PWHT
						⁴ NDT Request: PT & UT
					⁵ Machining: Grinding; 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 and is generally replaced during general overhaul outages. The shaft seal sleeve is manufactured and rolled from JIS 4304 SUS 403 plate, and the two halves are fitted together around the shaft and secured by 28 twist-off bolts (14 holes per section half) and two vertical butt welds between the two joints situated 180-degrees apart.					
2	The removal procedure, to be implemented by the <i>Contractor</i> , of the old shaft seal sleeve halves, consists of the following: - Remove the flush twist-off bolts with a punch in the direction of rotation (anticlockwise) from the access/ bolt head side. - Grind out the welds on the sleeve halves (under no circumstances grind deeper than 13 mm). - Using a nub nose chisel, break the remaining weld and remove the sleeve halves. - The <i>Contractor</i> to take note that each shaft sleeve half weighs approximately 71kg.					
3	Installation of the new shaft seal sleeve requires the <i>Contractor</i> to perform in-situ welding of the two shaft seal segments around the main machine shaft. The two vertical butt 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 <i>Contractor</i> .					
4	The welding process to be implemented by the <i>Contractor</i> 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 <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT and 100% UT.					

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

5	The installation & in-situ welding procedure, to be implemented by the <i>Contractor</i>, of the new shaft seal sleeve segment halves consists of the following: • 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 <i>Contractor</i> ensures the scouring pad is compatible with the stainless-steel shaft to prevent contamination. • The position of the countersunk holes in the segments is unknown and not reflected on the drawings. The holes shall be confirmed by the <i>Contractor</i> and accurately transferred and drilled into the sleeve halves upon gaining of access. There are 28 holes, for the twist-off bolts, to be marked, drilled and countersunk in the sleeve segments by the <i>Contractor</i>. The <i>Contractor</i> shall confirm the existing 28-hole pattern on the shaft and accurately transfer and drill each of the holes in both new shaft sleeve segments. • Countersink the holes, by using a centring guide bush. • Set the flush bolts by applying thread locking adhesive to the thread. Fit the 28 twist-off bolts on the sleeve halves to hold the sleeve in place around the shaft and confirm the fit of each segment half onto the shaft as well as in relation to each other to allow for the required root gaps. • Tighten the flush bolts until the bolt head shears off. • 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. • Clean and re-tap the existing threaded 28 holes, in the shaft, to accommodate the M20 x 60 mm length and 2.5mm pitch twist-off threaded bolts, to secure the sleeve onto the shaft prior to bolt head twist-off and blending according to the surrounding surfaces. Refer to drawings 18.39/2789-1 for the sleeve and 18.392789-2 for the twist-off bolts. • Before positioning the sleeve for final fitment apply a zinc-based primer (example white lead paint) on the shaft where the sleeve fits around the shaft, excluding the area near the weld joint. • Clean the inner surface of the sleeve with acetone, set and clamp the sleeve halves onto the shaft, in between the upper and lower shaft steps/shoulders, using two pull lifts and slings. • 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. • 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. • Confirm if the diameters are within tolerance, ($\varnothing 1080 +0.105; -0$) and the sleeve is fitted correctly, (i.e., concentric with the shaft). • Perform welding of the joints. • 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. • Before final polishing, perform 100% PT and 100% UT per weld to ensure no unacceptable defects exist. • In the event of defects, follow corrective action procedure, (grind, re-weld, test and polish). • Polish the complete surface of the sleeve with a fine grade (#500) oil stone. • Perform a final PT inspection of the welds. • In the event of defects, follow corrective action procedure, (grind re-weld test and polish) • Measure and record the diameter of the shaft seal sleeve. • Measurements are taken at three equally spaced heights and three diametric positions (120 degrees apart), including the welded areas.
Refer to Addendum A Section 13.10: <u>Shaft Seal Sleeve Replacement</u> for additional information and figures pertaining to the shaft seal sleeve welding: • <u>Figure 33: Example of new shaft seal sleeve segments</u> • <u>Figure 34: Example of old/removed shaft seal segments</u> • <u>Figure 35: Illustration of Vanderkloof shaft seal sleeve</u>	

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.11 Turbine Pit Walkway Platform Supports

The turbine pit walkway platform will be removed during the turbine refurbishment outages, to allow for lifting of the turbine head cover, and reinstalled upon completion. The *Contractor* shall perform the necessary cutting of the supports during the removal process and implement the required welding during reinstallation. The most appropriate procedure for the required welding shall be implemented by the *Contractor* based on the following summarised information as per the table below.

Table 11: Turbine pit walkway platform information

Item	Code	Dimensions [mm]		Material Spec	Drawing	Plant Parameters / Additional Information
¹ Turbine pit walkway platform supports	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	t:	10	L-type (angle iron) rerolled carbon steel	0.39/809	² Disassembly: Removal of bolts and cutting ³ Onsite welding ³ Weld position: Vertical; Possibly flat ³ Weld type: Fillet welds; Possible butt welds ³ Machining: Possible blending. ⁴ Weld process: SMAW ⁵ NDT Request: PT
1	The turbine pit walkway is a circular platform consisting of a steel floor plate, situated around the main shaft, and is held in position by 24 supports constructed from angle iron sections and bolts. Each support is welded to the turbine pit liner.					
2	The <i>Employer</i> will perform the disassembly of the walkway platform and remove the various components from the turbine pit. Cutting will be performed by the <i>Contractor</i> at the following areas where welding will be required during re-assembly, that will be identified by the <i>Employer</i>, pertaining to the walkway platform: - Existing fillet welds joints between the 24 supports and the turbine pit liner - Other possible sections on the walkway platform that might need to be split to allow for removal and that must be rejoined during assembly. This will ensure that cutting is performed properly, from a welding point of view, to prevent unnecessary material loss, parent material damage and allow for the required welding preparations during re-assembly. The cutting method shall comprise of grinder disk cutting.					
3	The onsite welding to be performed by the <i>Contractor</i> consists of vertical, horizontal and overhead fillet welds and to minor extend possible butt welds, should a support or beam be cut as such. All fillet welds shall be left in the as welded condition, while butt welds, if any, shall be ground flush according to the surrounding surface areas.					
4	The welding process to be implemented by the <i>Contractor</i> shall be SMAW.					
5	NDT will be requested by the <i>Contractor</i> , from the <i>Employer's</i> Outage Management, and shall consist of 100% PT for all welds.					
Refer to Addendum A Section <u>13.11: Turbine Pit Walkway Platform</u> for additional information and figures pertaining to the walkway platform supports:						
<u>Figure 36: Turbine pit walkway platform support</u> <u>Figure 37: Vanderkloof walkway platform around operating ring</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.12 Turbine Pit Entrance Stairway Steel Liner Removal and Replacement

The objective of the turbine refurbishment outages is to remove all the guide vanes, after 20 years of operation, for replacement. Removal of the guide vanes can only be done via the access entrance to the turbine pit, however due to dimensional limitations the entrance must be enlarged by removing a section of the entrance floor. The *Contractor* shall cut and remove the relevant section of the turbine pit steel liner, at the start of the outage, and re-install and weld the liner section upon completion of the turbine pit outage activities.

Table 12: Turbine Pit Entrance Stairway Steel Liner Information

Item	Code	Dimensions [mm]		Material Spec	Drawing	Plant Parameters / Additional Information
¹ Turbine pit entrance stairway steel liner	Unknown: Refer to Section 3.2.2.2 BS EN 15614-1 Level 2 or ASME IX	T_liner:	6	BS 4360 Grade 43A	0.39/403 0.39/809	² Plate removal: Cutting ³ Weld position: Vertical; Horizontal ³ Onsite in-situ welding ³ Weld type: Plate butt weld ³ Machining: Possible blending/polishing of weld beads, otherwise left as welded. ⁴ Weld process: SMAW / GTAW ⁵ NDT Request: PT
1	The turbine pit steel liner is BS 4360 Grade 43A plate material with a wall thickness of 6mm and diameter of 7200mm, embedded in concrete.					
2	The welding <i>Contractor</i> shall cut a liner section of 1500mm x 500mm, while the <i>Employer's</i> civil service provider shall perform the necessary concrete removal and civil <i>works</i> . This will ensure that cutting is performed properly, from a welding point of view, to prevent unnecessary material loss, parent material damage and allow for the required welding preparations during re-assembly. The cutting method shall comprise of grinder disk cutting. The cut and removed liner section shall be assessed by both the <i>Contractor</i> and <i>Employer</i> to determine whether it is reusable. In case of replacement, as part of the <i>works</i> , the <i>Contractor</i> shall supply a new steel plate section of 6mm wall thickness with a radius of 3600mm.					
3	The <i>Contractor</i> shall fit the steel liner section into position, to confirm dimensional fit-up, and secure by means of tack welds prior to commencement of the plate butt welds. The butt welds shall be left in the as welded condition, except if weld beads interfere with supports, walkway or other components in the vicinity. The plate section's butt welds will be in the vertical and horizontal orientation.					
4	The welding process to be implemented by the <i>Contractor</i> shall be either GTAW or SMAW. The <i>Contractor</i> shall control possible distortion.					
5	NDT shall be requested by the <i>Contractor</i> , from the <i>Employer's</i> Outage Management, and shall consist of 100% PT.					
Refer to Addendum A Section <u>13.12: Turbine Pit Entrance Stairway Steel Liner Removal and Replacement</u> 13.8 for additional information and figures pertaining to the turbine pit entrance stairwell liner plate that must be removed and rewelded:						
• <u>Figure 38: Turbine pit stairway steel liner plate for removal</u> • <u>Figure 39: Stairway portion and steel plate liner removal</u> • <u>Figure 40: Alternative view of entrance to turbine pit</u> • <u>Figure 41: Turbine pit liner 6mm wall thickness</u>						

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.13 Governor Servomotor Repairs

The governor servomotors at Vanderkloof hydroelectric power station are generally in a good condition, however due to the unknown internal condition of the barrel cylinders and pistons, certain anticipated repairs, to be implemented by the *Contractor*, are included. The listed repair shall only be implemented based on actual inspection findings and if necessary. Refer to the table below for summarised information required to determine the most appropriate repair procedures.

Table 13: Governor servomotor information

Item	Code	Dimensions [mm]		Material Spec	Drawing	Plant Parameters / Additional Information
¹ Servomotor cylinder (barrel)	Unknown: Refer to Section 3.2.2.2	Ø_ID:	720	JIS G3454 STPG38	0.39/800	³ Repairs: Various
	BS EN 15614-1 Level 2	Ø_OD:	800	JIS G3106 SM41A		³ Weld position: Various
² Piston	or ASME IX	t:	40			³ Offsite and/or on-site welding
		Ø_OD:	720	JIS G5501 FC25		³ Weld type: Weld build-ups
		L:	695			³ Machining: Excavating; Line boring; Blending; Polishing; Possible lathe machining.
						⁴ Repair process: SMAW / GTAW; Possible other applicable automated welding processes; Possible metal spray
						⁵ NDT Request: PT/UT
1	The Vanderkloof units are equipped with 2 hydraulic servomotors each, responsible for guide vane operation by means of hydraulic pressure. Each servomotor consists of a thick-walled barrel, with the rear end attached to the turbine pit liner and the front end enclosed by a cover that accommodates a sealing arrangement to enable the piston rod's stroke without hydraulic pressure loss. The barrel material is specified as JIS G3106 SM41A, while the inlet and outlet piping are manufactured from JIS G3454 STPG38, with both material grades deemed weldable.					
2	The piston rod is secured to an internal piston, which features carbon rings seated in circumferential grooves at its outer periphery, maintaining a desired sealing and wearing interface with the barrel's inner diameter. The piston is manufactured from JIS G5501 FC25, which is a grey cast iron and generally difficult to weld repair.					
3	The servomotors shall be disassembled and removed, by the <i>Employer</i> , from the turbine pit. The <i>Employer</i> shall thoroughly perform the initial visual and dimensional inspections, upon gaining of access, and handover the barrel to the <i>Contractor</i> to perform the necessary repairs, if any. The anticipated damage likely to require repair by the <i>Contractor</i> is expected to consist of one or combinations of the following:					
3.1	Barrel internal wall loss due to wear: The <i>Contractor</i> to perform the necessary internal bore weld build-ups and implement the necessary internal machining by means of line-boring, which can be subcontracted to a capable and competent sub-<i>Contractor</i>, to restore the barrel to its original design. The barrel can, if necessary, be removed from site for the intended repairs.					
3.2	Piston outer diameter and/or carbon ring groove material loss, wear or damage due to unwanted contact with the barrel: This is highly unlikely, however should this type of damage be found by the <i>Employer</i>, the pistons shall be handed over to the <i>Contractor</i> for assessment to determine the best possible repair method. Should welding not be advisable, due to the material grade, the <i>Contractor</i> shall consider metal spray repairing methods, or similar repairs, which can be subcontracted to a competent and reputable sub-<i>Contractor</i>, to perform the necessary material restoration and associated machining. The pistons can, if necessary, be removed from site for the intended repairs.					

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.3	Other possible damage found on the servomotor components, such as the outer diameter of the barrel, front cover, backing plates, supports and piston rod that requires weld repairs and associated machining by the <i>Contractor</i>: These types of repairs will generally consist of weld build-ups and blending according to the surrounding areas to ensure a surface finish of 0.8µm Ra or better. The <i>Contractor</i> shall assess the damaged areas to determine the correct weld repair procedure. The components can, if necessary, be removed from site for the intended repairs.
4	The welding processes to be utilised by the <i>Contractor</i> shall consist of preferably GTAW and SMAW, however depending on the damage and component application, possible automated welding techniques may also be proposed by the <i>Contractor</i>, subject to the <i>Employer's</i> acceptance.
5	The <i>Contractor</i> shall request NDT, from the <i>Employer's</i> Outage Management, consisting of 100% PT for and 15% UT, depending on the repair type.
Refer to Addendum A Section <u>13.13: Governor Servomotors Repairs</u> for additional information and figures pertaining to the governor guide vane servomotors: <u>Figure 42: Servomotor Unit 1 B</u> <u>Figure 43: Servomotor Unit 1 A</u> <u>Figure 44: Vanderkloof servomotor barrel and piston arrangement cross-section</u>	

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.1.14 Installed Guide Vane Bush Line Boring

The line boring of the installed guide vane bushes require in-situ specialised machining by the *Contractor* and therefore do not require any repairs or welding apart from general tac welding to ensure the line boring equipment is rigid. The line boring of the guide vane bushes is part of the *Employer's* program of overhauling the turbines. The *works* of this activity is described as the in-situ line boring of the guide vane bushes as summarised per the table below.

Table 14: Installed guide vane bush line boring information

A) Scope of Work				
1	The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> provides, installs and sets up aligning equipment to an assembly which has a proven accuracy of at least 0.003 mm/m on at least four points of the turbine head cover after it has been lifted, and the old bushes have been removed and new ones fitted. The <i>Contractor</i> provides readings of the misalignment between the bushes (middle and top) in the turbine head cover and the bushes in the stay ring (bottom). These readings will be used to move the turbine head cover until the turbine head cover bushes (middle and top) centrelines are concentric with the bottom bush centrelines (located in the stay ring) to less than 0.050 mm on all four readings. When the turbine head cover bolts are tightened in stages, the <i>Contractor</i> provides misalignment readings to detect any movement of the turbine head cover.			
2	The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> re-drills and reams the 8 dowel holes that align the turbine head cover to the stay ring. The dowel holes are for Ø30 mm dowel pins on a PCD of Ø6860 mm as illustrated per drawings 0.39/725 and 0.39/718. With the information at hand, it is unclear whether the dowels are straight or tapered, thus the <i>Contractor</i> must be prepared to ream for both scenarios, as this detail shall be confirmed by the <i>Employer</i> upon gaining of access. The <i>Contractor</i> supplies the reamers, and the final responsibility is with the <i>Contractor</i> to ensure that the holes are properly reamed.			
3	The <i>Contractor</i> provides, installs and sets up boring equipment which can machine all three guide vane bushes (top, middle and bottom) concentrically. Refer to Figure 3: Guide vane bush line boring example setup illustration for an example of a similar setup as well as Figure 4: Vanderkloof dimensional illustration of guide vane bushes pertaining to the required line-boring . It will be required to fit a boring bar long enough to reach from the top of the turbine head cover to the bottom of the stay ring where the guide vane bottom bush is located. It might be required to have two boring bars connected with a precision coupling. For the guide vane bottom bush blind bore, a special tool is required to reach down to the bottom of the bottom bush.			
4	The bushes to be machined are manufactured from Bronze (Cu-Sn10P - 90/10 Phosphor Bronze casting as per SANS 200:2008, PB1 as per BS EN 1982 or similar).			
5	The <i>Contractor</i> ensures the boring bar is plumb from the top bush centre using equipment that has a proven accuracy of at least 0.003 mm/m.			
6	The <i>Contractor</i> uses the middle or top bush inner diameter as a datum to align the boring bar radially.			
7	The <i>Contractor</i> line bores the top, middle and lower bushes concentrically. The acceptance criteria for any eccentricity is 0.050 mm or less.			
8	The internal diameter is manufactured to be 1 mm undersized to allow for machining. The undersized drawings will be supplied to the <i>Contractor</i> subject to the signing of a non-disclosure agreement (NDA).			
9	After final machining the inner diameters of the bushes are within 0.050 mm of the required diameter. The estimated final inner diameters of the guide vane bushes, with a g6/H7 fit, are listed below:			
	Item	Basic diameter [mm]	Upper limit diameter [mm]	Lower limit diameter [mm]
	GV Top Bush	275	275.052	275.000
	GV Middle Bush	280	280.052	280.000
	GV Bottom Bush	250	250.046	250.000
10	The maximum taper over the length of the bush is 0.050 mm.			
11	The surface finish of the machined internal diameter is 0.8 µm R _a or better.			

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

12	The <i>Contractor</i> removes all burrs and sharp edges from the grease grooves in the bushings after final machining and polishes the edges to obtain a smooth profile. The <i>Contractor</i> machines the grease grooves manually with pencil grinders to ensure a grease groove depth range of 3.2 - 3.3mm and a grease groove width range of 7.78 - 8mm. Refer to <u>Figure 46: Guide vane bushes grease groove widths and depths</u> measurements taken on site from spare Vanderkloof bushes and <u>Figure 47: Dimensional cross section of guide vane bush grease groove</u> pertaining to the grease groove design.
13	The <i>Contractor</i> completes the work in less than ten calendar days.
14	Upon Completion, the <i>Contractor</i> removes all temporary <i>works</i> and unused materials. The <i>Contractor</i> removes all tack welds by grinding the areas flush and repairing the areas with corrosion protection, subject to approval by the <i>Employer</i> .
d) Line-Boring Design	
The welding <i>Contractor's</i> line-boring sub- <i>Contractor</i> designs the following parts of the <i>works</i> :	
1	The <i>Contractor</i> designs and provides all equipment and jigs necessary to align the boring bar and to keep it steady during machining. The jigs can be bolted down using the following bolt holes (all measurements in mm): • There are twenty guide vanes equally spaced on PCD 6000mm. • The total distance between the guide vane top and guide vane bottom bush is 2940mm. • At each of the guide vane top bushes, 8 x M30 bolt holes on PCD Ø500mm (not equally spaced) can be utilised for bolting of the jig. Refer to drawings 0.39/725 and 0.39/718. Alternatively, the jig can also be tack welded to the top cover subject to the usage of the correct Welding Procedure Specification and grinding off the tack welds to ensure a flush surface after removal • At the middle bush housing, jigs can be tack welded to the top cover. All tack welds are required to be ground clean and repaired with corrosion protection to a standard accepted by the <i>Employer</i>. The guide vane middle bush gland packing follower bolt holes can also be used to locate the jig of the line-boring sub-<i>Contractor</i>. There are a total of 6 equally spaced holes, 24mm diameter for M20 bolts, on a PCD of Ø355mm, as per drawings 0.39/725 and 0.39/718. Alternatively, a jig can also be tack welded to the top guide vane facing plate, subject to the usage of the correct Welding Procedure Specification and grinding off the tack welds to ensure a flush surface after removal. The facing plates have an inner diameter of Ø5474mm and an outer diameter of Ø6595mm. • The height between the bottom and top facing plates is 1748.8mm with the turbine cover in position. • At the bottom bush, there are 40 x M20 bolts, for lifting, equally spaced on PCD 6440mm, which can be utilised. Another option is to utilise the bolt holes for the guide vane seals, which will be removed, that is spaced in between the bottom bush holes on the bottom facing plate as per drawings 0.39/725 and 0.39/718. There are a total of 120 holes for M16 bolts. Alternatively, a jig can also be tack welded to the bottom guide vane facing plate, subject to the usage of the correct Welding Procedure Specification and grinding off the tack welds to ensure a flush surface after removal. The facing plates have an inner diameter of Ø5474mm and an outer diameter of Ø6595mm.
2	Only new, close tolerance bearings for line boring equipment are to be used.
3	The following are particulars of the design which are to be submitted as a Technical Returnable for acceptance. • Layout of jigs and assemblies. • Installation details of the sub-<i>Contractor's</i> line-boring equipment and tools consisting of the fastening methods (bolting and/or tack welding) to the <i>Employer's</i> plant infrastructure and equipment.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

e) Tests and Inspections

The welding *Contractor* subcontracts the quality control to a third-party company who records the following dimensions:

1	The welding <i>Contractor</i> subcontracts the quality control to a third-party company who records all findings and dimensions in a data pack subject to the <i>Employer's</i> approval.
2	Inner diameters with a calibrated micrometre. Two readings perpendicular to each other are taken at the upper, middle and lower parts of each bush.
3	Concentricity checks by means of run-out.
4	The surface finish of the bushes after final machining are tested with a calibrated instrument.
5	All measurements are recorded and can be witnessed by the <i>Employer</i> .
6	All recorded measurements are submitted to the <i>Employer</i> within 1 (one) day of being recorded for review and acceptance.

Refer to Addendum A Section 13.14: Installed Guide Vane Bush Line Boring for additional information and figures pertaining to the guide vane bush line boring:

- Figure 45: Examples of line-boring setups for the bush casing internal machining
- Figure 46: Guide vane bushes grease groove widths and depths
- Figure 47: Dimensional cross section of guide vane bush grease groove
- Figure 48: Example of line-boring check sheet

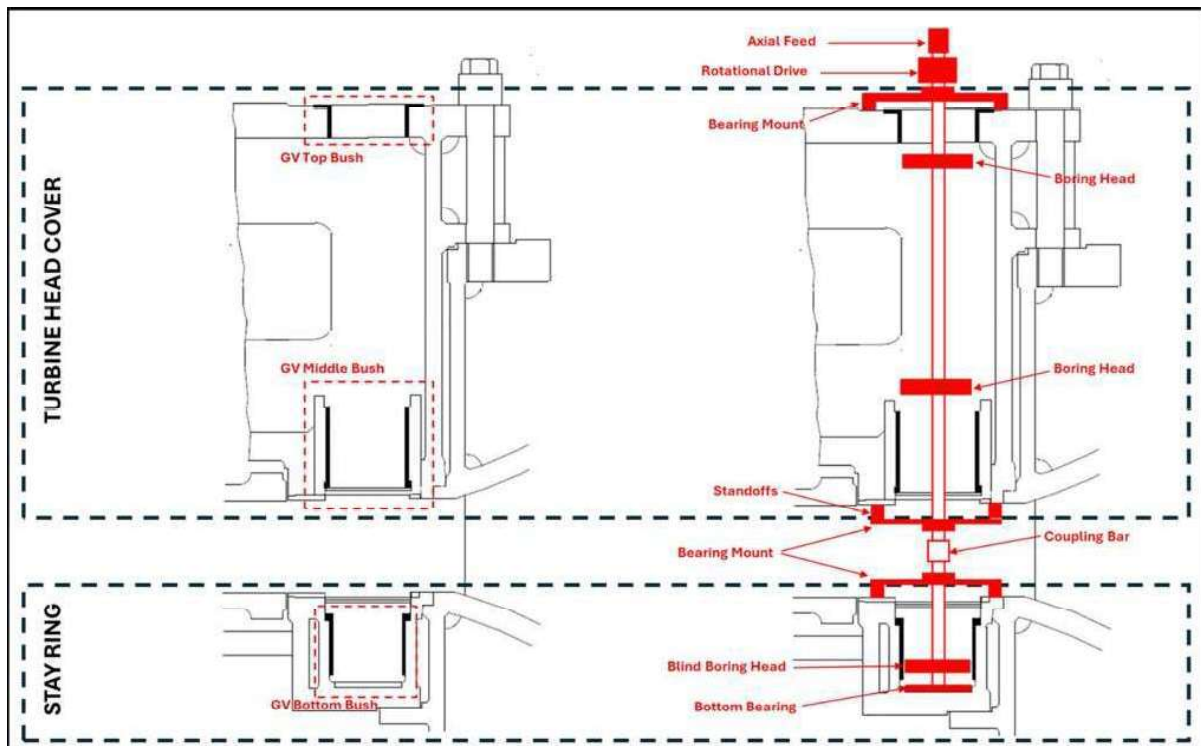


Figure 3: Guide vane bush line boring example setup illustration

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

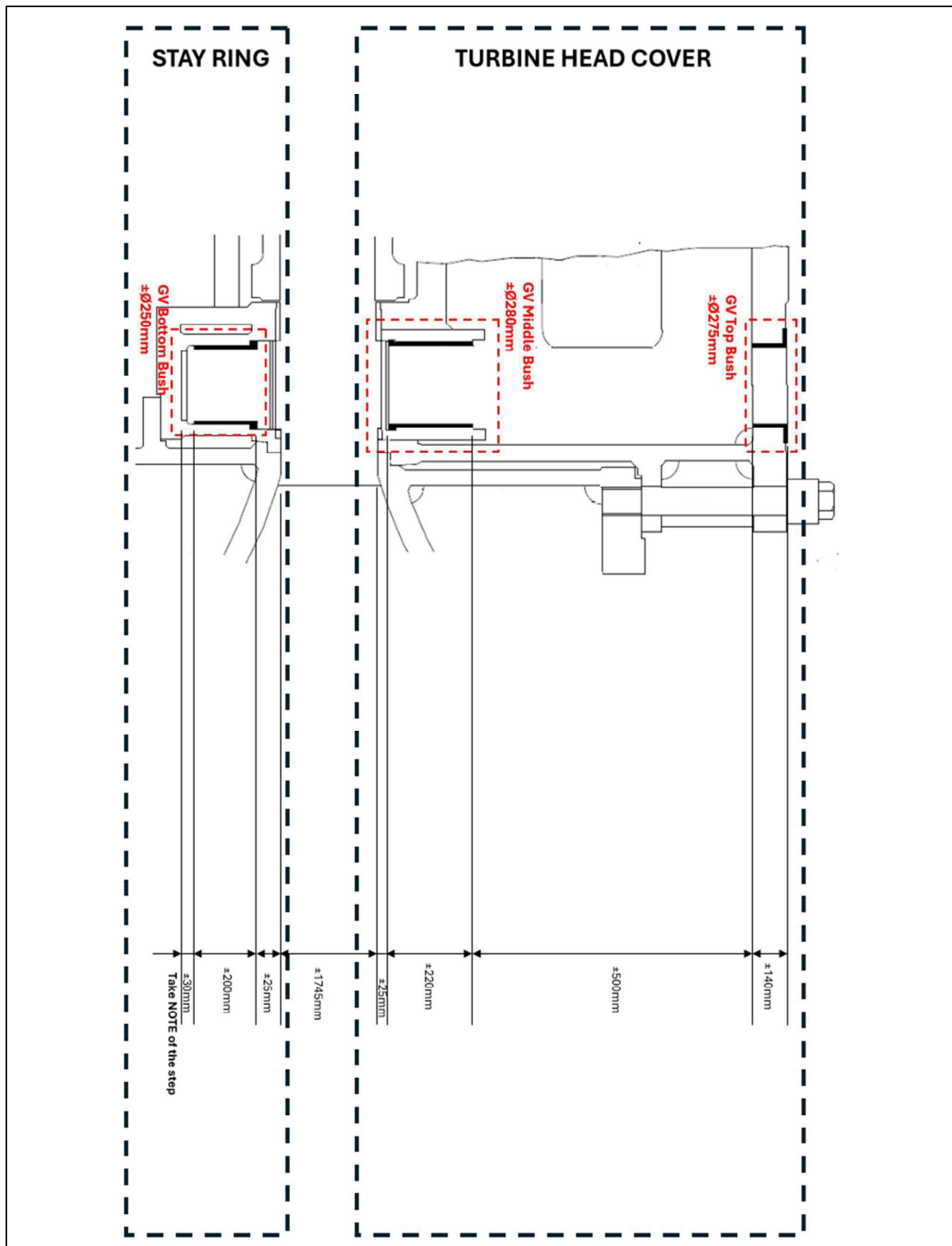


Figure 4: Vanderkloof dimensional illustration of guide vane bushes pertaining to the required line-boring

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.2 Welding Requirements

3.2.2.1 General Welding Requirements

The following requirements are applicable for all welding:

- The *Contractor* responsible for the welding shall be ISO 3834-2 certified (current) and approved, in terms of the relevant Product/Construction Standards, Welding Processes and required Parent Material Groups, by the *Employer* to perform Level 1 plant welding related work (maintenance, refurbishment and fabrication).
- All welding shall be performed in accordance with 240-106628253 Standard for Welding Requirements on Eskom Plant, including all referenced standards therein.
- The *Contractor* can subcontract other companies to carry out certain services, such as Heat Treatment (HT) and machining, given that these companies are adequately qualified. The *Contractor* will remain responsible for the final product.
- The *Contractor* shall provide all necessary tools, equipment, resources, consumables and relevant services to complete the works.
- The *Contractor* shall carry out site-based and off-site work as required. The *Contractor* shall clearly indicate which components and sections of the works will be performed off-site at the facilities of the *Contractor* or sub-*Contractor*.
- The *Contractor* must be able to qualify Welding Procedure Specifications 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 and approval by the *Employer*. The *Contractor* takes note that should the lathe not be available at any given point in time during the outage, due to planned machining of other components, the responsibility remains with the *Contractor* to ensure the necessary machining, as part of the welding repairs, are completed to deliver the final product within the allocated time. The *Contractor* shall indicate during the negotiations phase whether they plan to make use of the *Employer's* lathe and to what extent.
- 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.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- The *Contractor* shall control and monitor for distortion during welding.
- The necessary heat treatment (pre-heat, interpass, PWHT and bake-outs), as and when required, according to the parent material and qualified welding procedure shall be thoroughly implemented. Tempilstiks (or other proven methods), where possible, to be utilized for quality control purposes.
- General cleaning, including removal of slag where necessary, upon completion of welding shall be implemented.
- The *Contractor* shall perform and document the necessary inspections, consisting of visual and dimensional inspections, throughout the welding process.
- The *Contractor* shall request the necessary Non-Destructive Testing (NDT) throughout the welding, repair and machining process, as and when required, from the *Employer's* Outage Management department.
- The implementation of proper stainless-steel pickling and passivation, where necessary.
- The *Contractor* takes note that all drawings will be made available upon request and after signing of a non-disclosure agreement (NDA). All drawings shall be discarded off after tender award, should the tenderers not be successful, or after the contract period, should the tenderer be successful.

3.2.2.2 Codes & Standards and Specifications Requirements

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

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

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

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

3.2.2.3 Non-Destructive Testing (NDT) & Acceptance Criteria

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

The *Contractor*, for the *works* as per this welding technical specification, is responsible for the inspection of welding set-ups, welding preparations and NDT inspection requests, to the *Employer's* Outage 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,

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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, alternatively the acceptance criteria of the WPS qualification/construction code will also be acceptable.

3.2.2.4 Heat Treatment Requirements

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

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

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

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

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

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

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

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- Resistance heating or induction heating is allowed, and preferred depending on the application and practicality, and must be done in accordance with an approved HT procedure subject to the *Employer's* acceptance.
- The temperature ranges, for the applicable material, must be according to the applicable design/construction code, material specification, or according to the agreed code for cases where the design/construction code is unknown.
- The welds and areas to be heat treated must be free from any products such as grease, lubricants and coatings that can adversely affect the HT process.
- The areas to be heat treated and surroundings must be protected against oxidation and mechanical damage.
- Where applicable open ends are closed off to prevent the cooling associated with draughts.
- The *Contractor* ensures that insulation is securely fastened using the appropriate strapping technique suitable for the intended temperature range and that no gaps from insulation to component and insulation to heating pads are present.
- The type of thermocouples and the relevant attachment method must be provided by the *Contractor* and must be in accordance with the requirements of the thermocouples, heating band and insulation. Additional thermocouples must be fitted at each controlling point as back up for use in the event of primary thermocouple failing. A detailed sketch must be provided by the *Contractor*.
- The heating pads must be securely strapped to the component for the duration of the heating cycle.
- Time at soaking temperature is measured from the time when the last thermocouple reading reaches the min temperature of the specified range.
- The *Contractor* must ensure constant supervision, and that HT equipment is attended to by suitably qualified technicians and operators, provided by the Heat Treatment sub-*Contractor*, should this service be subcontracted, if not, by the *Contractor* themselves.
- The equipment must be of a proper make suitable for HT and it shall bear proper electrical power input/output.
- Upon completion of the PWHT cycle, the *Contractor* shall:
 - Examine the component for distortion, discolouring, damage and arching.
 - Clean/polish the thermocouple attachment areas and conduct surface crack inspections (PT).
 - Ensure review and signature of the PWHT chart by the *Contractor's* IWE/IWT.
- Repair welding after PWHT shall not be permitted.
- The *Contractor* shall provide a PWHT method statement, specific to each relevant weld and subject to the *Employer's* acceptance prior to commencement of the work, as per the following minimum requirements:
 - Compiled strictly in accordance with the applicable qualified WPS and signed 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.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- 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*, where applicable according to each refurbishment item, as per Section 3.2.1, 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 (HNO₃) 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% HNO₃ 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.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

3.2.2.9 Equipment Requirements

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

The *Contractor* takes note of an equipment power supply regulation relevant to all equipment and machinery utilised within the unitised cylindrical steel liner enclosing the turbine, turbine pit and generator throughout all the floor levels. No 380V supply is allowed inside the abovementioned areas. 380V must be inverted to 220V with the inverter situated outside the abovementioned area. Power cables (leads) are allowed from the inverter or power supply to the different required equipment to be used inside the abovementioned area but limited to the maximum 220V AC or DC. All equipment and machinery used must meet the requirements of the Electrical Machinery Regulations in terms of their design, construction and earthing. The power supply details for each of the *Contractor's* equipment and machinery and setup, including voltage and current distribution within each cable, is subject to the *Employer's* review and approval. Most of the in-situ welding repairs will be implemented within the abovementioned area.

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 (160A/11111-P3-C) will not be considered.

3.2.3 Line-Boring Requirements

3.2.3.1 General Line-Boring, Specialised Machining and General Machining Requirements

The following requirements are applicable for all line-boring and specialised machining:

- Specialised machining includes all machining such as, but not limited to, line-boring and lathe machining, which is not generally implemented as part of welding preparations or weld bead and build-up blending, profiling, polishing with a grinder and or pencil grinder.
- General machining is associated with all welding preparations, blending, polishing, cutting, etc. related to perform and complete a weld or repair as per the requirement of this technical specification.
- The line-boring and possible lathe machining required as per this technical specification is specific to on-site machining, in-situ machining and in certain cases off-site machining, if necessary.
- The *Contractor* can consider utilising the *Employer's* on-site lathe where applicable, to a certain extent, depending on availability and approval by the *Employer*. The *Contractor* takes note that should the lathe not be available at any given point in time during the outage, due to planned machining of other components, the responsibility remains with the *Contractor* to ensure the necessary machining, as part of the welding repairs, are completed to deliver the final product within the allocated time. The *Contractor* shall indicate during the negotiations phase whether they plan to make use of the *Employer's* lathe and to what extent.
- The *Contractor* is responsible for line-boring and lathe machining, which can be subcontracted to a reputable and competent sub-*Contractor*. The *Contractor* will remain responsible for the final product.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- The *Contractor* subcontracts the quality control to a third-party company who records all necessary dimensions, specific to the relevant items as specified in section 3.2.1. The *Contractor* will remain responsible for the final product.
- The *Contractor* shall provide all necessary tools, equipment, resources, consumables, measuring equipment and relevant services to complete the works.
- All documentation will be subject to acceptance by the *Employer*.
- 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 contamination and adverse effects.
- Proper cleaning and degreasing of the identified areas shall be implemented prior to and following machining.
- The *Contractor* shall perform and document the necessary inspections, consisting of visual and dimensional inspections, throughout the line-boring process.
- The *Contractor* takes note that all drawings will be made available upon request and after signing of a non-disclosure agreement (NDA).

3.2.3.2 Equipment Requirements

The *Contractor* and sub-*Contractors* supply all equipment, tools, measuring equipment, machining bits and gear required to complete the *works* with the desired surface finishes, sizes and tolerances. The *Contractor's* equipment must be correct and in a reliable, maintained and calibrated condition to deliver the *works* and quality requirements, including, but not limited to, recording equipment, power tools, measuring equipment, line boring and machining equipment as well as safety equipment and protective clothing.

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. Apart from welding consumables the following material to be supplied as part of this Technical Specification:

- Turbine pit liner plate for a section of 1500 x 500 x 6mm wall thickness, only if the removed section is not re-usable, as per Section 3.2.1.12: Turbine Pit Entrance Stairway Steel Liner Removal and Replacement.

4.4 NDT

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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 Vanderkloof Hydroelectric Power Station.

5.2 Maintenance philosophy

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

6. DRAWINGS

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

Drawing Number*	Title
0.39/725	Details of guide vane and packing box
0.39/390	Sectional view of hydraulic turbine
0.39/719	Bottom ring
0.39/718	Top cover
0.39/398	Spiral case and transition pipe
0.39/399	Details of spiral case
0.39/400	Spiral case sections
0.39/391	Stay ring
0.39/386	NEAT line of Draft Tube
0.39/392	Lower draft tube liner
0.39/393	Details of lower draft tube liner
0.39/396	Upper draft tube liner
0.39/397	Draft tube mandoor
0.39/657	Dimensions of mandoor for upper draft tube liner
0.39/716	Assembly drawing of gate operating mechanism
0.39/800	Gate servomotor
0.39/400	Spiral Casing Sections
0.39/717	Gate Operating Ring
0.39/718	Top Cover
0.39/723	Bottom Ring (Bottom Facing Plate)
0.39/714	Turbine Runner
0.39/809	Details of turbine pit walkway platform
0.39/403	Pit Liner
0.39/800	Gate Servomotor

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

0.39/713	Main Shaft (including Shaft Seal Sleeve)
18.39/2789-1	Shaft Seal Sleeve Segments
18.392789-2	M20 x 80 Countersink Twist off bolts

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

7. SPECIFICATIONS

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

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

BS EN ISO 5817	Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality Levels for Imperfections	2023	✓
EN 10204	Metallic products – Types of inspections	2004	✓
SABS 10238	Welding and Thermal Cutting Processes - Health and Safety	2011	✓
OHSA No. 85 of 1993	Occupational Health and Safety Act. ()	1993	✓
NEMA Act. 107 of 1998	National Environmental Management Act	1988	✓

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

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

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

8.1 Identification

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

8.2 Visual and Dimensional Inspections

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

8.3 Loading and Offloading

The *Contractor* is responsible for loading and offloading of tools, equipment as well as all the *Employer's* components that are sent offsite as part of the *works* such as welding-, machining-, line-boring- 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 backdating will be allowed.
- The *Contractor* will notify the *Employer* of interventions at least 24 hours in advance for on-site interventions and 72 hours for off-site interventions.
- 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)

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- PMI (Positive Material Identification) (H)
- NDT Procedures and Operators (H)
- Weld Maps (R)
- WPS/WPQR (H)
- Welder Qualifications (H)
- Welding Consumable Material Certificate (H)
- Material Verification (H) (for supplied material where applicable)
- Machining (W) (including general machining and line-boring, 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 (Vanderkloof Hydroelectric Power Station).
- The *Contractor* provides all the required safety and personal protective equipment to his staff for the duration of the contract.

8.6 Environmental management

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

8.7 Security

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

8.8 Other construction activities

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

8.9 Title to site materials

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

8.10 Documentation

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

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- 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*.
- Approved Concessions
 - All requested concessions, with the *Employer'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.
- Specialised machining
 - This includes specialised machining such as lathe machining, line-boring, etc. It includes machining methods that is not general cutting, grinding, polishing and blending of weld repairs and build-ups.
 - The *Contractor* provides all required specialised machining information as required for the relevant items listed per section 3.2.1.
 - All line-boring scope of work to be executed, shall be quality controlled by an independent third-party sub-*Contractor*, appointed by the *Contractor*. The measured dimensions, before and after machining, inspection findings and final sizes shall be included as part of the required data pack documentation.

8.11 Rectification of Defects

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

8.12 Completion

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

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

9. REQUIREMENTS FOR THE PROGRAM

9.1 Welding Requirements for the Program

- a) The *Contractor* submits a quality control plan for the *Employer's* acceptance.
- b) The *Contractor* submits the 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:

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- 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 program.

9.2 Specialised Machining 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 the line boring, as per Section 3.2.1, the *Contractor's* work to be included in the program submitted for acceptance are:
- Site establishment.
 - Installation of aligning equipment.
 - Alignment of top cover referenced to 4 x guide vane bush centrelines.
 - Reaming of the turbine head cover taper dowel pins.
 - Installation and setting up of boring equipment.
 - Aligning the boring bar.
 - Line boring of the guide vane top bush.
 - Line boring of the guide vane middle bush.
 - Line boring of the guide vane bottom bush.
 - Measurements.
 - De-burring and polishing of grease grooves (possible machining of grease grooves).
 - The time required from notification of work to obtaining material and starting on Site.
 - Statutory and other non-working days included in the contract period and occurring just after the contract period.
- e) With regards to the guide vane bush casings repairs, as per Section 3.2.1.1, the *Contractor's* work to be included in the program submitted for acceptance are:
- Site establishment.
 - Installation of aligning equipment.
 - Installation and setting up of boring equipment.
 - Aligning the boring bar.
 - Line boring of the guide vane middle bush casings - preparation.
 - Bore welding of guide vane middle bush casings – butter layer.
 - Bore welding of guide vane middle bush casings – final overlay layer.
 - Final machining of guide vane middle bush casings.
 - Line boring of the guide vane bottom bush casings - preparation.
 - Bore welding of guide vane bottom bush casings – butter layer.
 - Bore welding of guide vane bottom bush casings – final overlay layer.
 - Final machining of guide vane bottom bush casings.
 - Measurements.
 - NDT.
 - The time required from notification of work to obtaining material and starting on Site.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

- Statutory and other non-working days included in the contract period and occurring just after the contract period.
- f) Similar requirements for the program, as per the bushes and bush casings above, shall be included by the *Contractor* for the servomotor repairs, should line-boring and or lathe machining be required.
- g) The *Contractor* confirms that current test certificates apply to all Equipment identified in the program.

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

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

10.1 Overhead Crane

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

10.2 Area for site establishment and storage

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

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

11. AUTHORISATION

In addition to the signatories on the title page, this document has been seen and accepted by:

Name	Designation	Signature
Jaco van Zyl	Senior Engineer – Turbine Engineering	
Isak Meyer	Senior Engineer – Turbine Engineering	
Edmond Dumema	Chief Engineer (Mechanical) – Peaking Asset Management	<i>B. C. Dumema</i>

12. REVISIONS

Date	Rev.	Compiler	Remarks
December 2025	1	CP du Preez	Document registered as official document.

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.ADDENDUM A

The *Contractor* takes note that some examples of Drakenberg (DRP), Palmiet (PTP) and Gariep (GRP) Pumped Storage Schemes (PSS) are included within Addendum A, only where relevant and clearly indicated, for similar expected damage or scope of work. This is to ensure the *Contractor's* understanding of the Vanderkloof (VDK) requirements.

13.1 Guide Vane Bush Casing (Middle and Bottom) Repairs

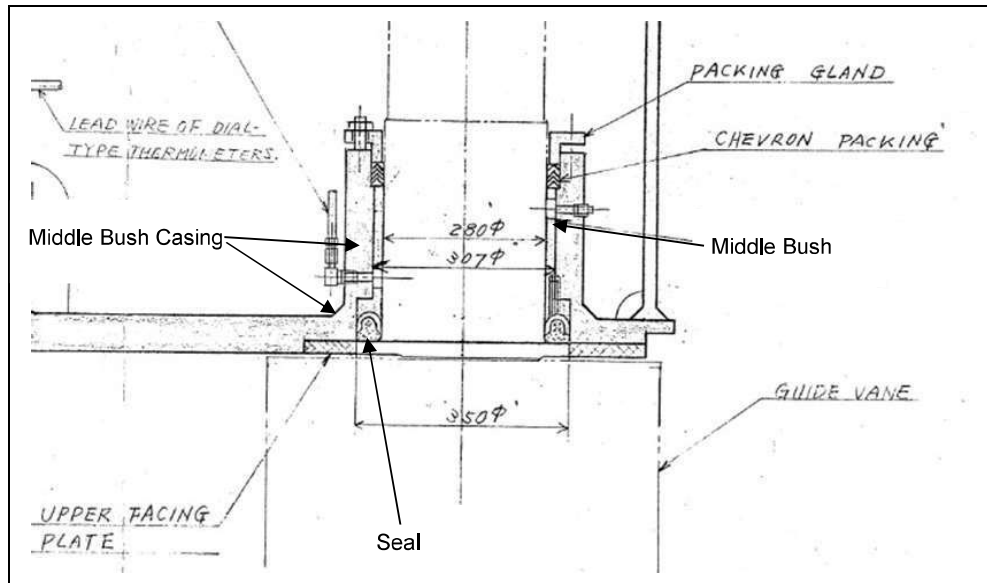


Figure 5: Vanderkloof middle bush casing with installed middle bush and seal

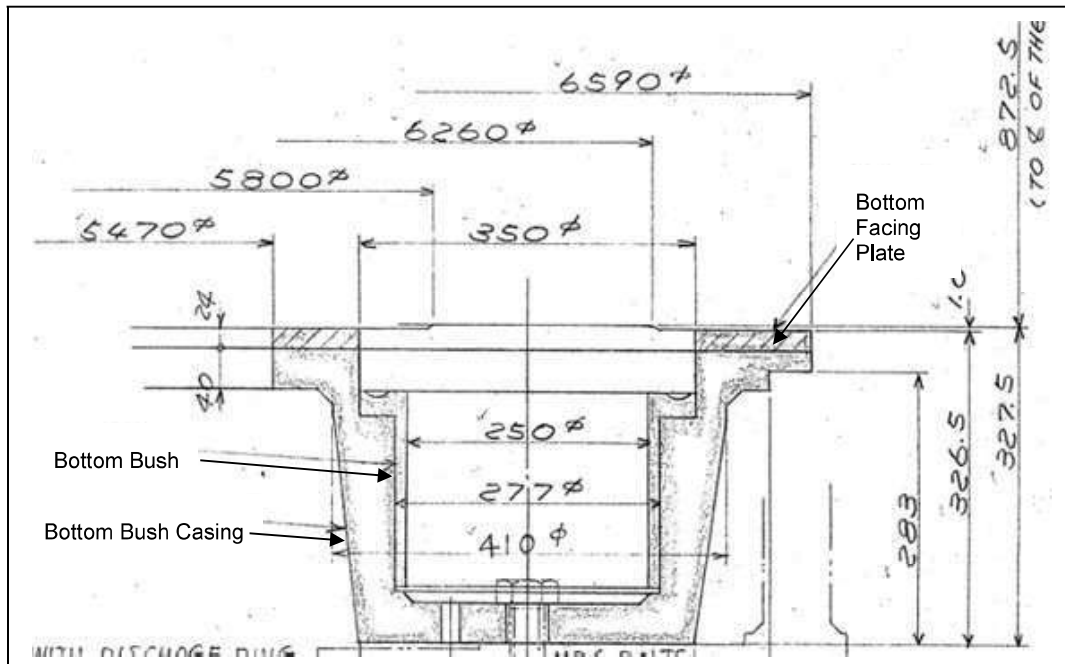


Figure 6: Vanderkloof bottom bush casing with installed bottom bush

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Figure 7: Example of similar guide vane middle bush casing repairs

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.2 Spiral Casing Liner, Stay Vanes and Mandoor Repairs

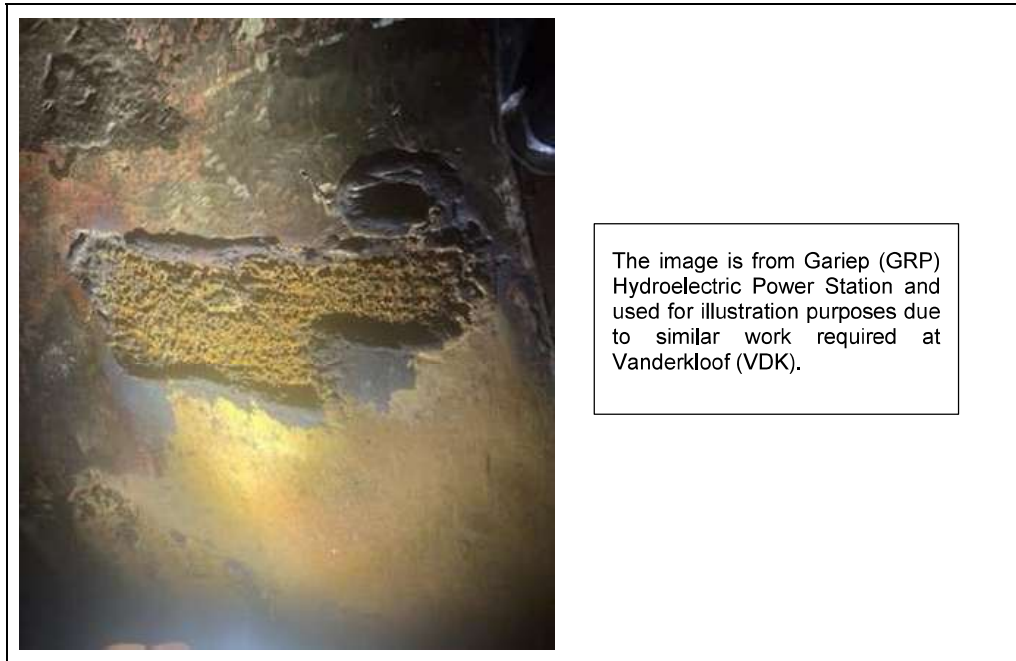


Figure 8: Spiral casing typical liner damage

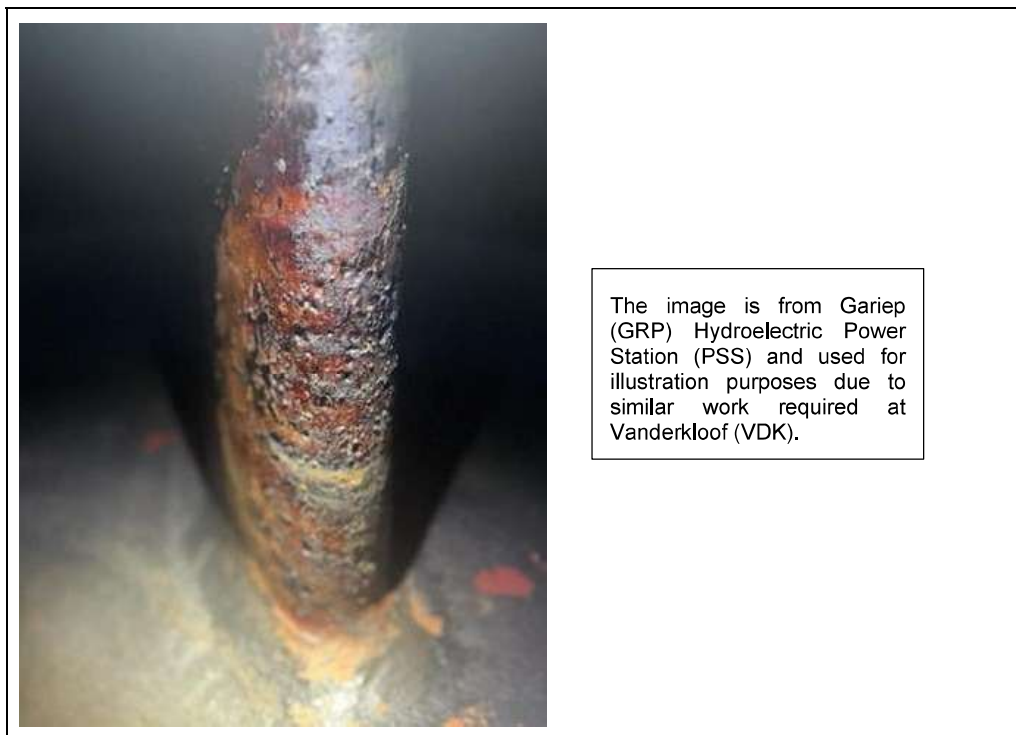


Figure 9: Example of typical damage on vertical stay vane

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

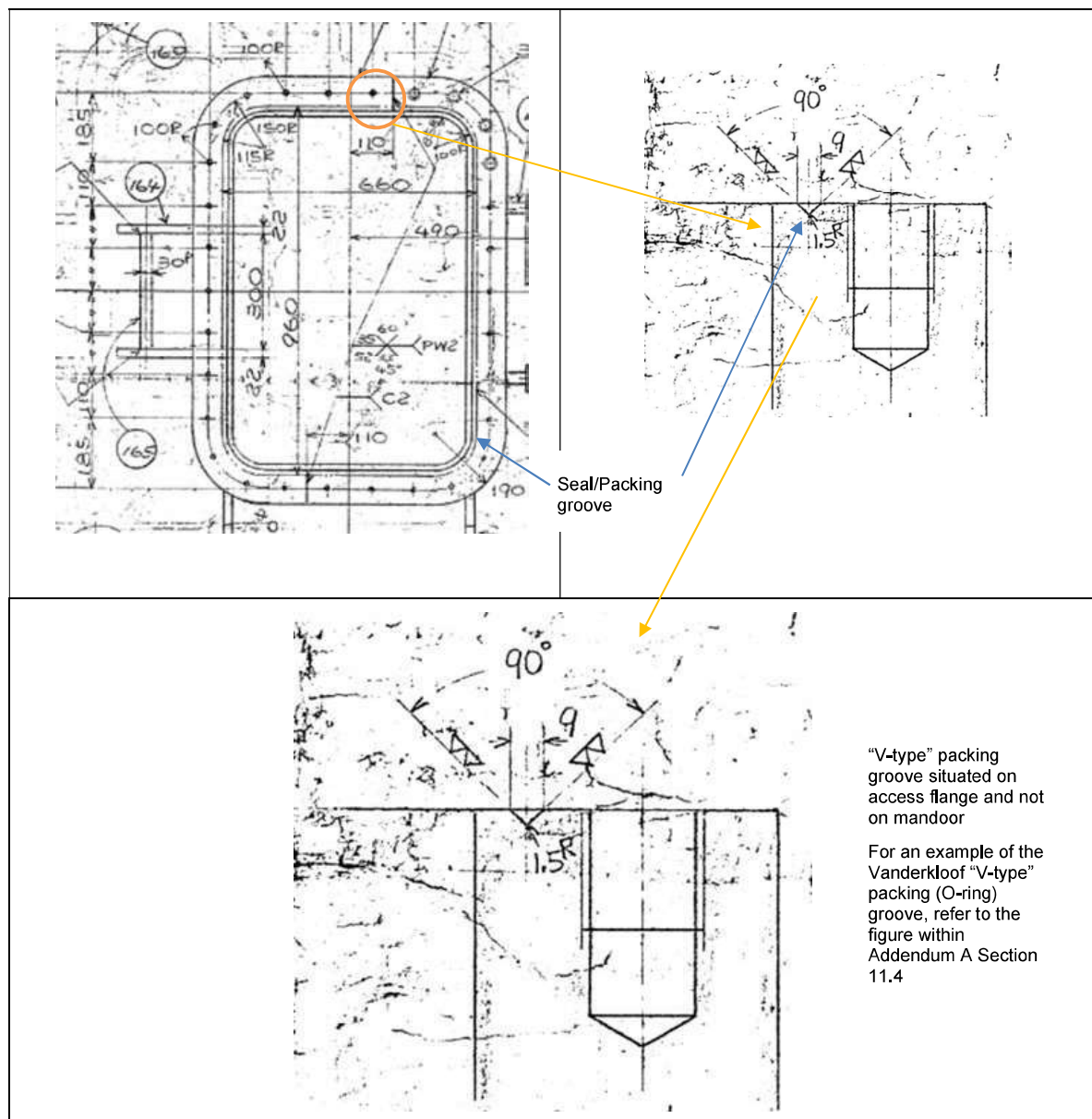


Figure 10: Spiral casing mandoor flange with seal/packing groove

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Figure 11: Spiral casing access mandoor in closed/sealed condition with spiral casing filled

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.3 Draft Tube Liner and Mandoor Repairs



Figure 12: Draft tube liner damage



Figure 13: Draft tube access mandoor in closed/seal condition with draft tube charged

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

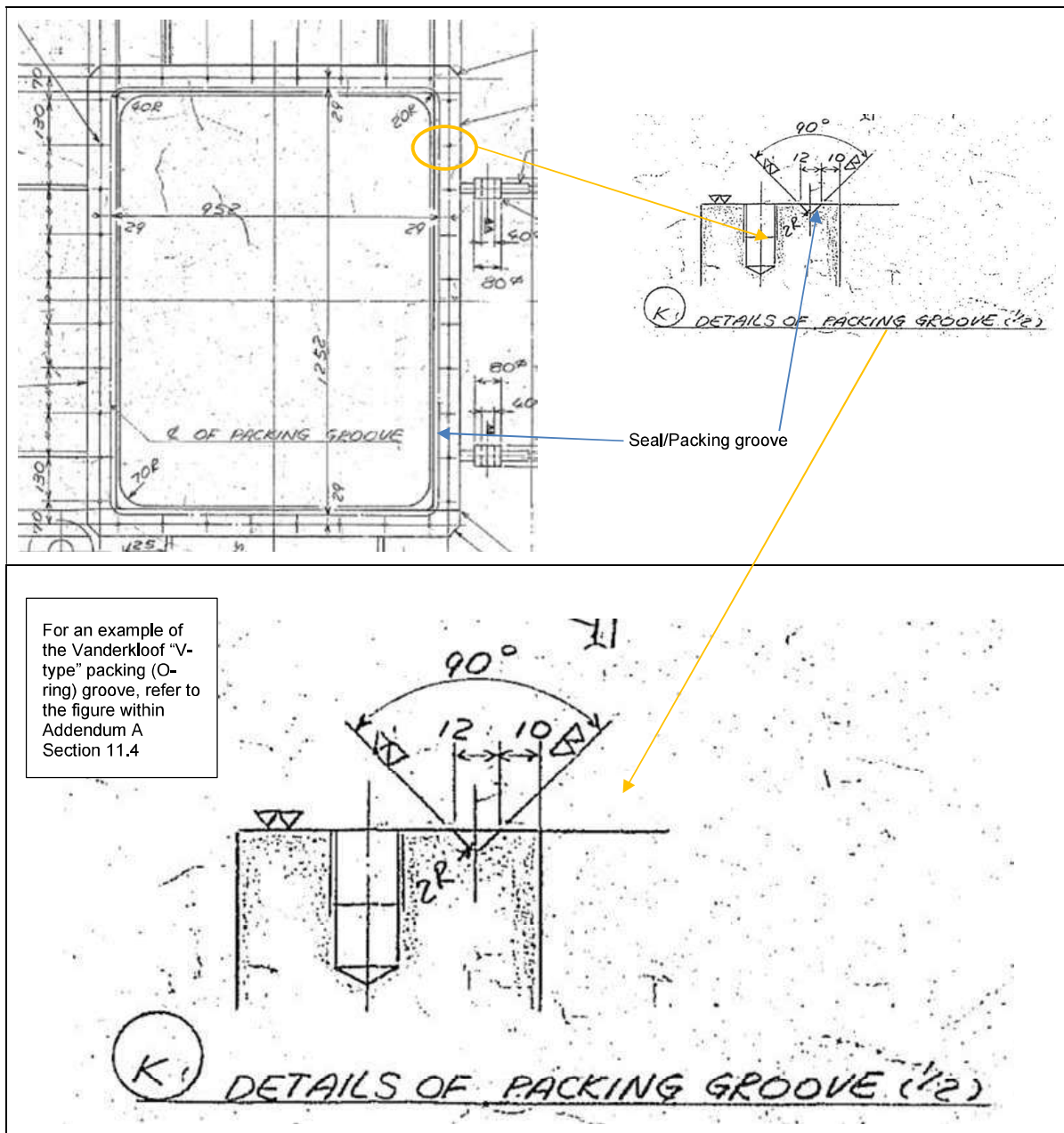


Figure 14: Draft tube mandoor flange with seal/packing groove

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Currently gaskets are installed and not seals/packing (O-rings), which contradicts the original design. Inspections, once access is obtained, and findings will determine whether the seal/packing groove will be repaired, build-up or left as is.

Figure 15: Draft tube door current sealing arrangement

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

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

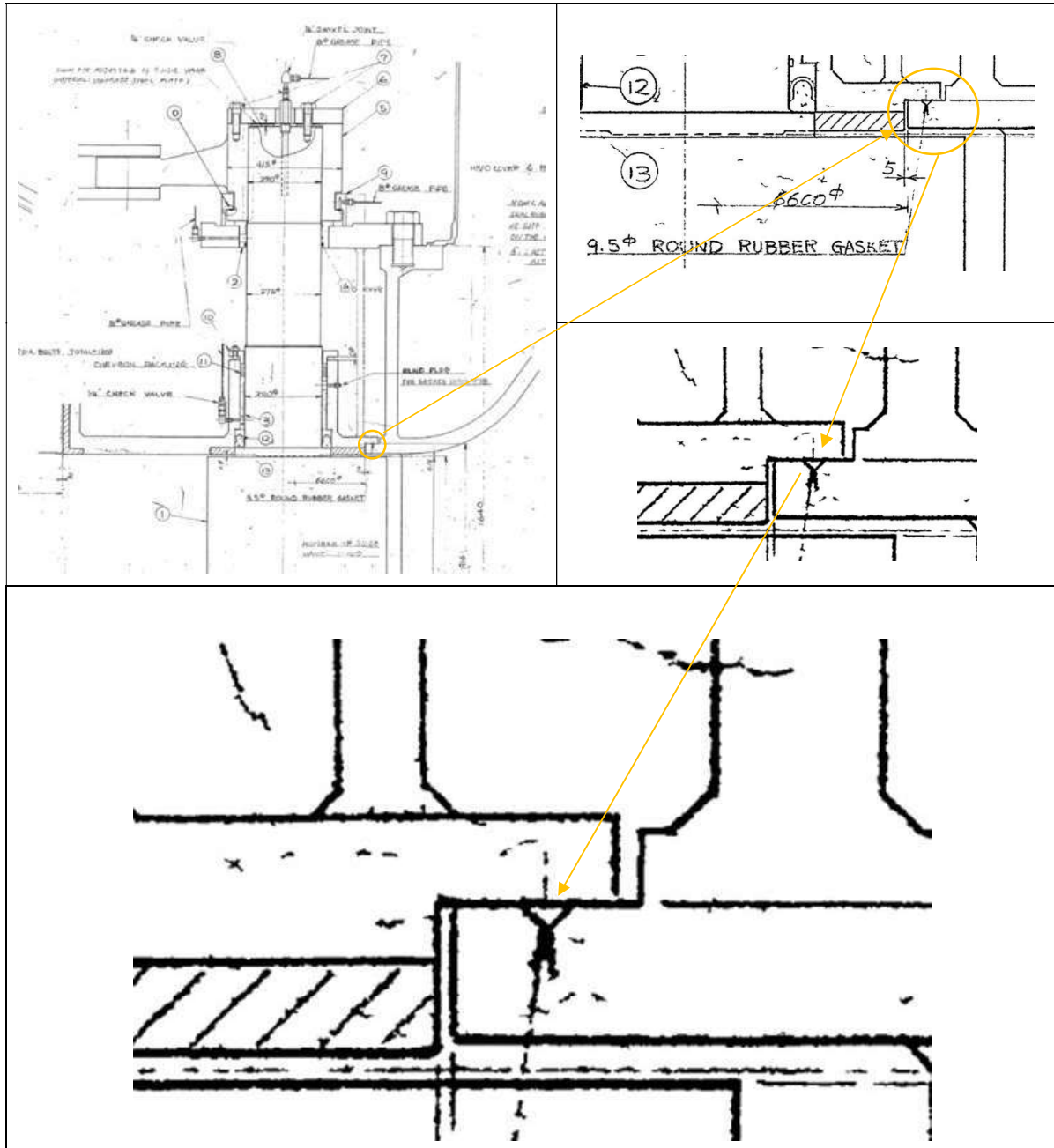


Figure 16: Turbine head cover O-ring groove position and information

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Figure 17: VDK V-type Packing (O-ring) groove

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.5 Locking Plate Welding for Guide Vane Link Shear Pins, Servomotor Link Pins and Servomotor Rod Lock Nuts

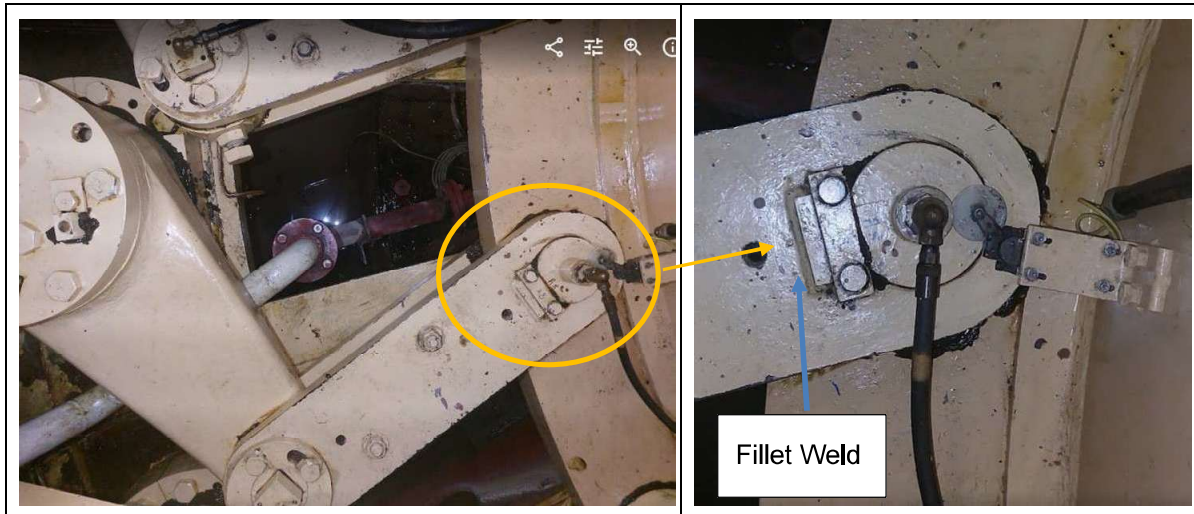


Figure 18: Guide vane link shear pin locking plate details

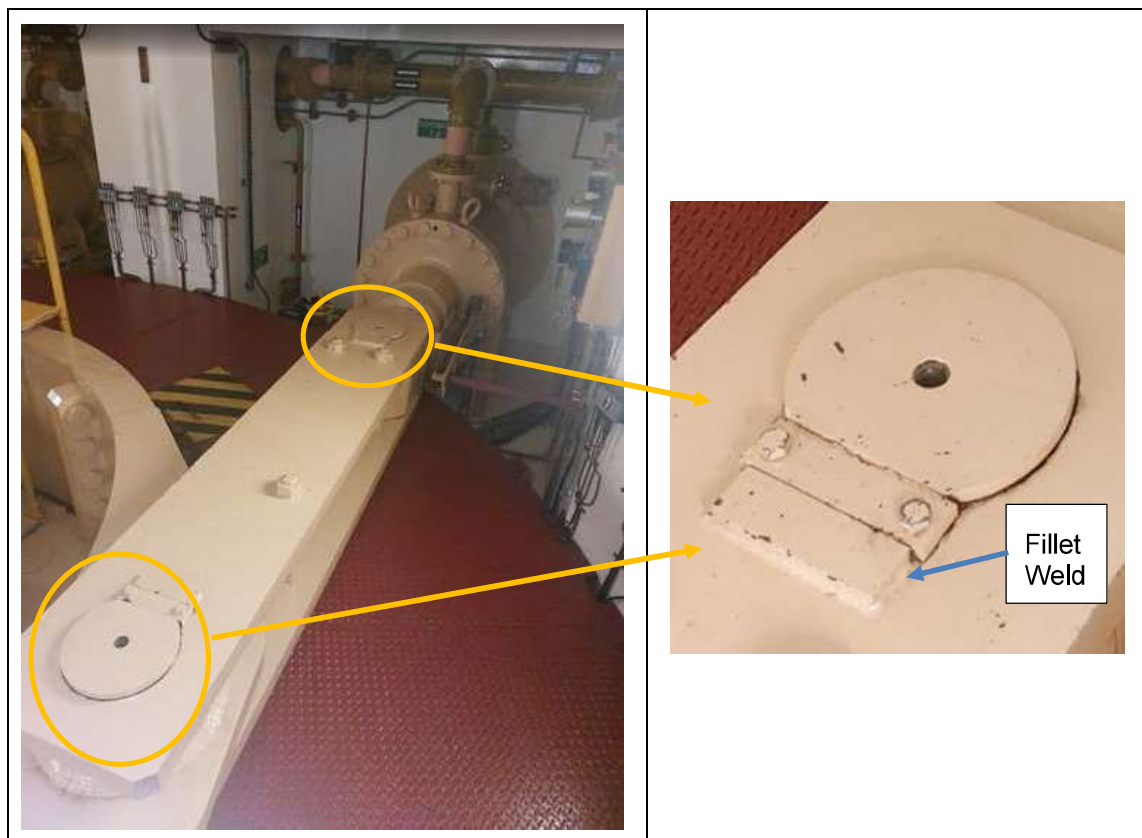


Figure 19: Servomotor link pins' locking plate details

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

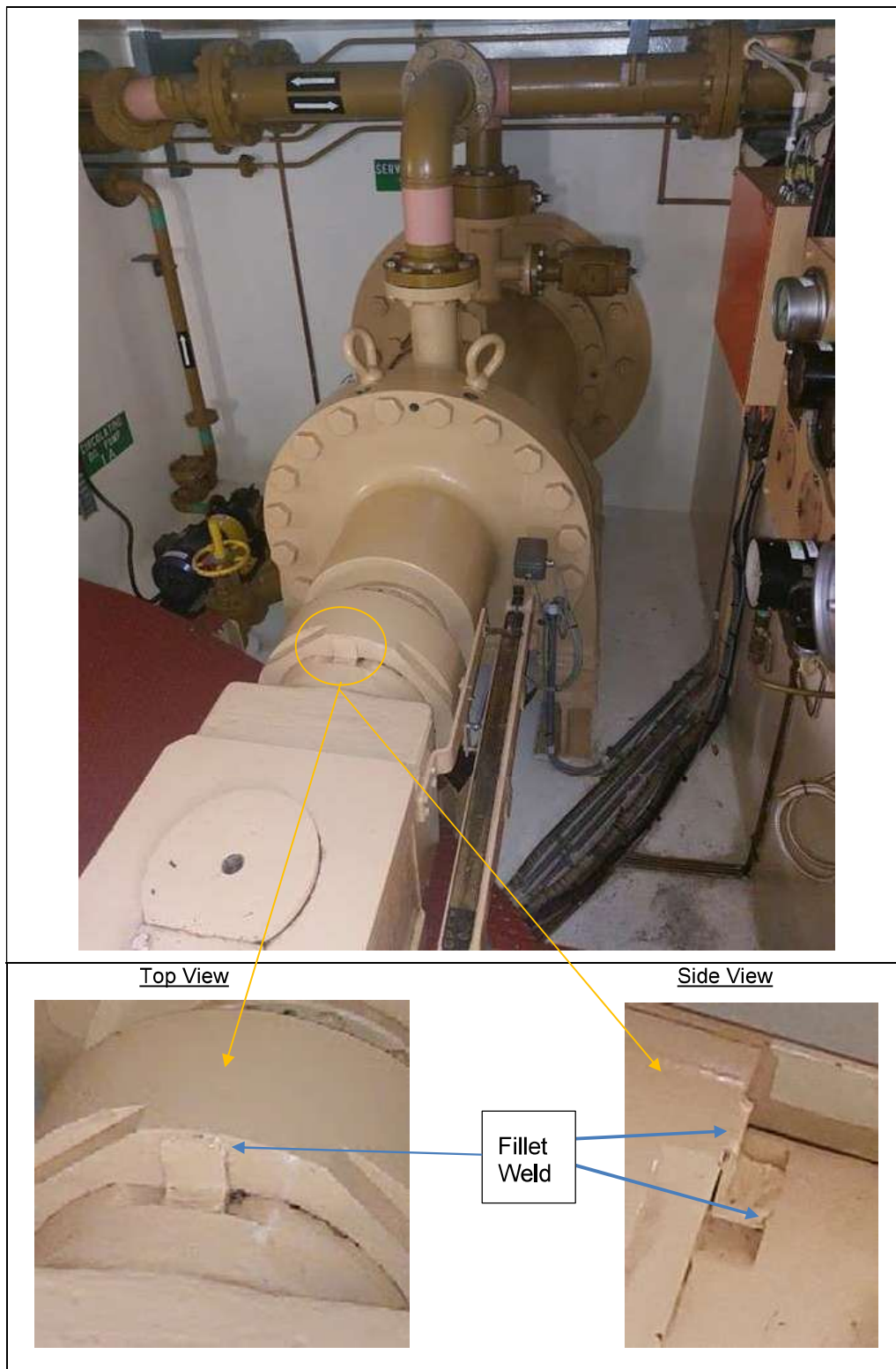


Figure 20: Servomotor rods' lock nuts locking plates

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.6 Operating Ring Weld Repairs

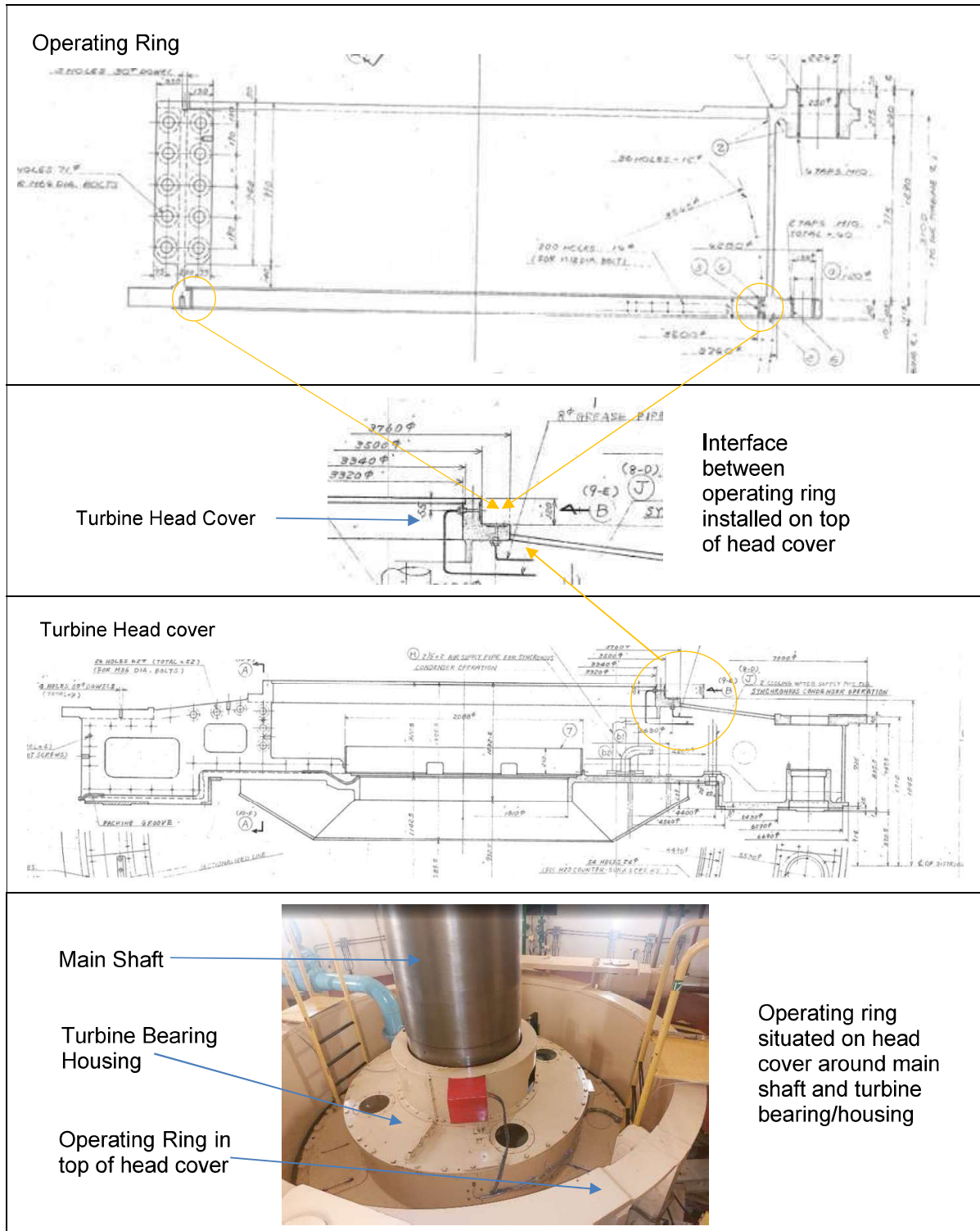


Figure 21: Operating ring and head cover interface

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Figure 22: Operating ring and servomotor and guide vane link interfaces

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.7 Guide Vanes Facing Plate Repairs



The image is from Palmet (PTP) PSS and used for illustration purposes due to possible similar work required at f VDK.

Figure 23: Typical pick-up damage on the guide vane facing plates

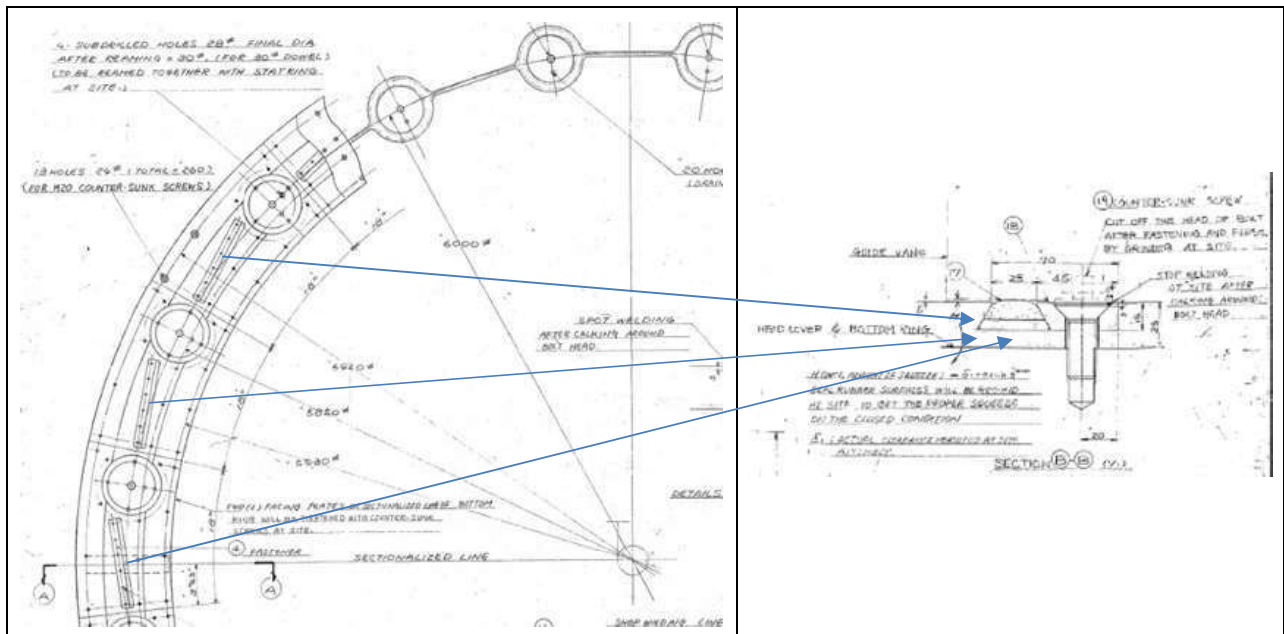


Figure 24: Top and bottom facing plates and guide vane seals

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.8 Turbine Runner Blade Repairs

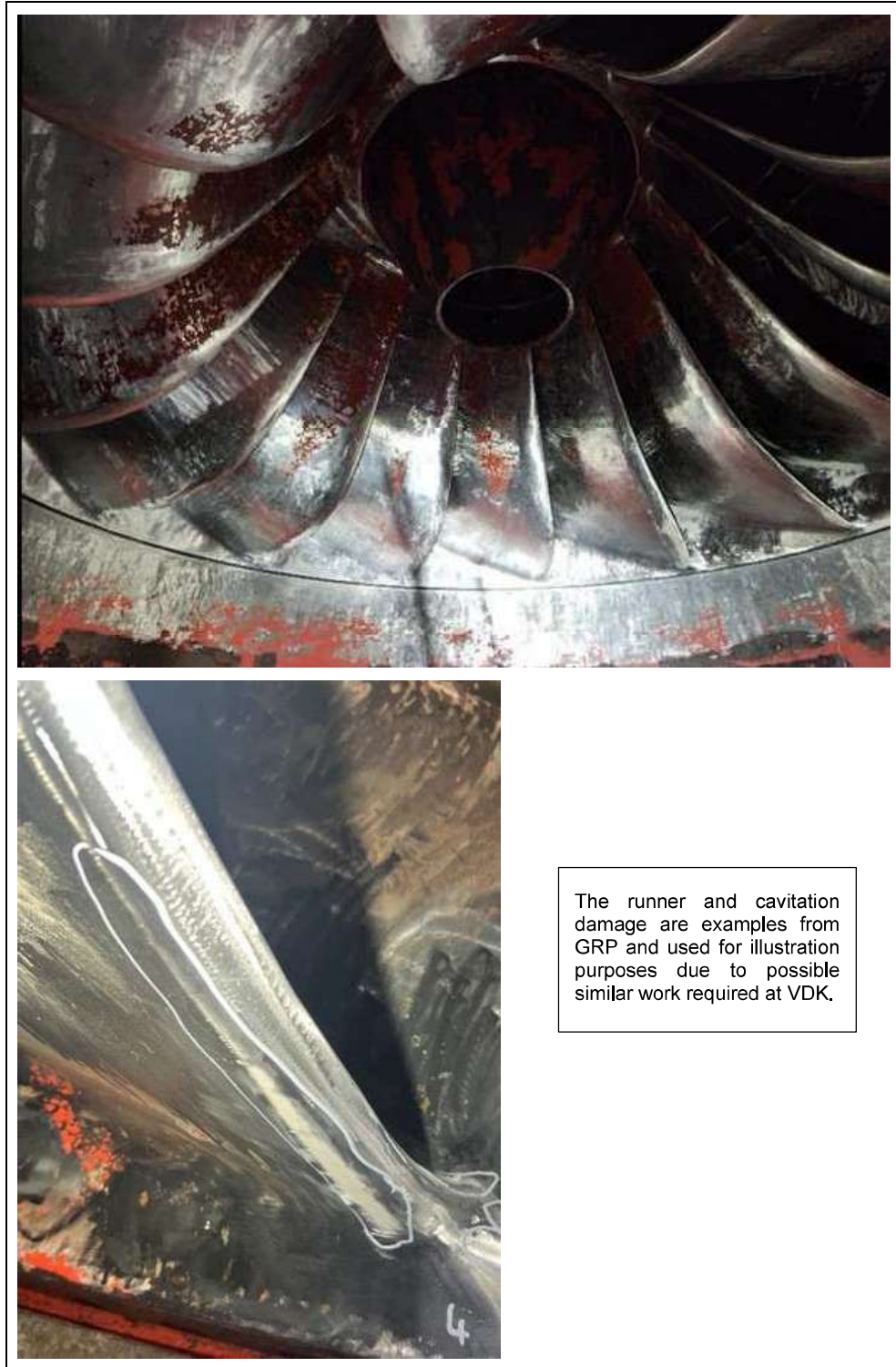


Figure 25: Turbine blade trailing edge cavitation

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



The turbine blade low pressure area cavitation damage is an image from GRP and used for illustration purposes due to possible similar work required at f VDK.

Figure 26: Turbine blade low pressure area cavitation

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.9 Guide Vane Gate Levers (Guide Vane Heads) Repairs

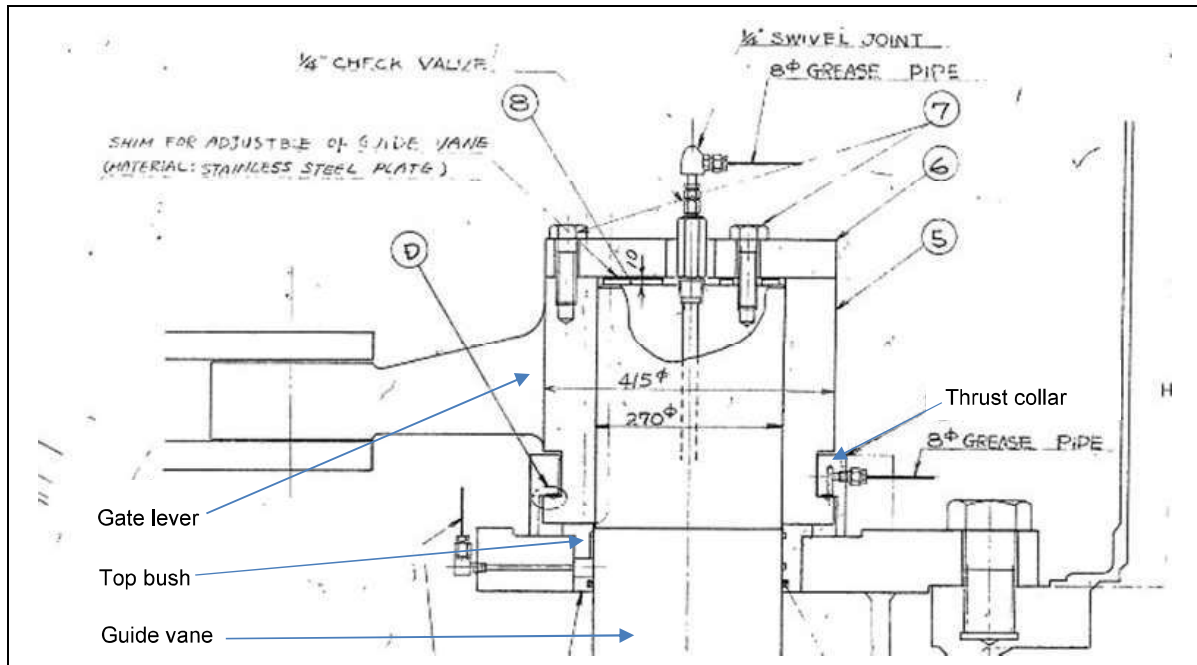


Figure 27: Guide vane gate lever (guide vane head) illustration and interfaces

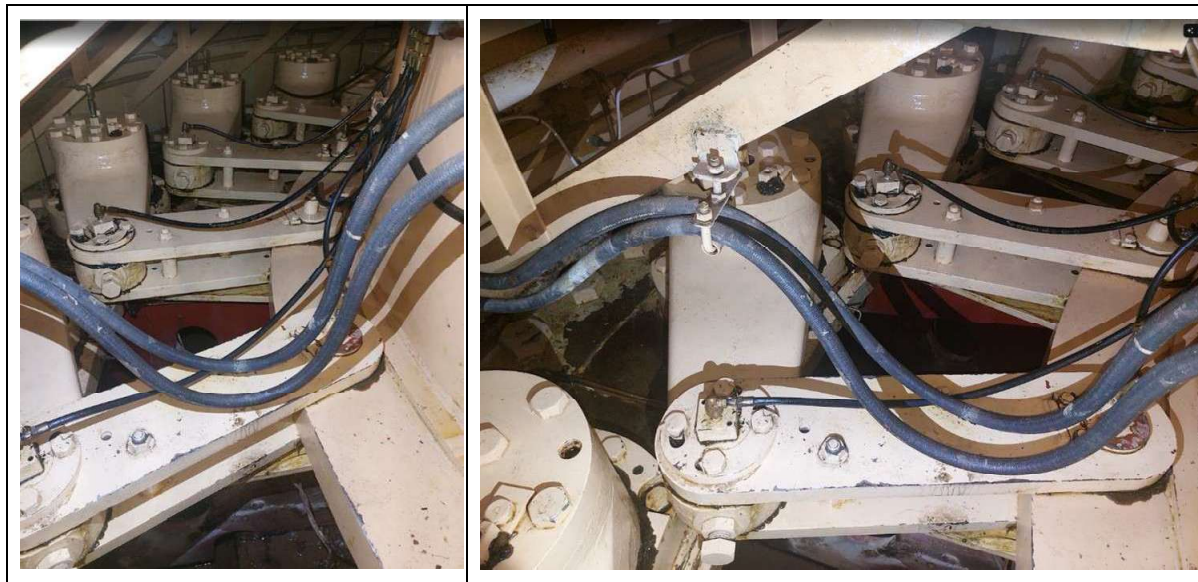


Figure 28: Vanderkloof guide vane gate levers and interfaces with guide vane links to operating ring

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Figure 29: Vanderkloof spare guide vane levers (heads)



These two images are examples of wear on the bottom flanges of the guide vane gate levers as experienced at DRP. This is to illustrate the possible repairs that might required at VDK as well.

Figure 30: Example of wear on the guide vane gate levers' bottom flange surfaces that interface with the top bush

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

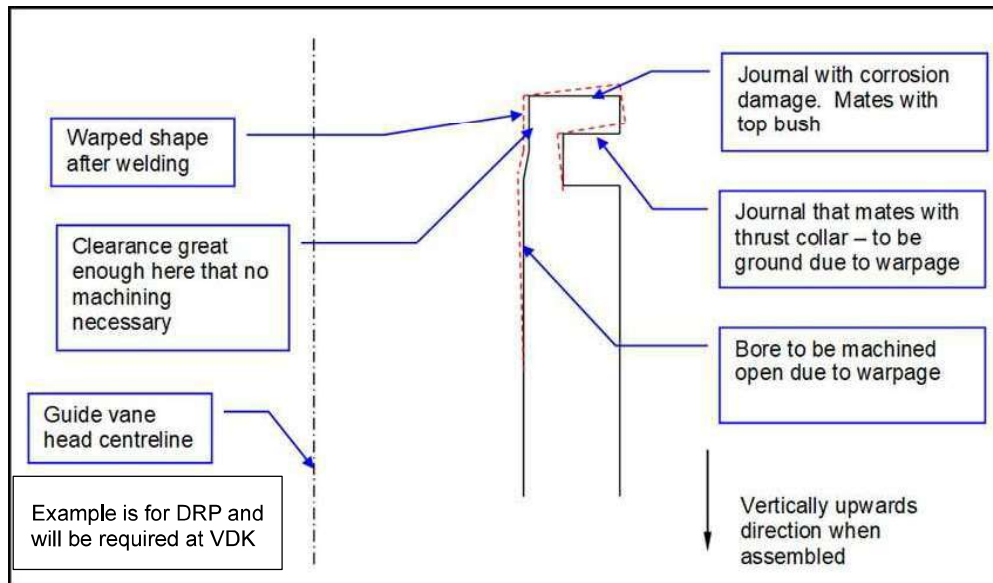


Figure 31: Example of distortion that occurred on one of the guide vane gate levers (heads)

Example is for DRP and will be required at VDK

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	
		Acceptance criteria	X	Y	Date		Signature	Date	Signature	
1	Set up run-out in bore	<0.03			I					
2	Collar thickness A	40.000 - 39.975			I					
3	Overall length B	473.20 - 472.80			I					
4	Collar ID C	416.00 - 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					
					I					

APPROVED BY: _____
SIGNED: _____
DATE: _____

Figure 32: Example of check sheet for guide vane gate lever repair and distortion checks

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.10 Shaft Seal Sleeve Replacement



Example is for DRP and will be similar for VDK. Take note the twist-off bolt holes will be at different positions. There are 28 in total for VDK whereas DRP only as 12 in total.

Figure 33: Example of new shaft seal sleeve segments



Example is for DRP and will be similar for VDK. Take note the twist-off bolt holes will be at different positions. There are 28 in total for VDK whereas DRP only has 12 in total.

Figure 34: Example of old/removed shaft seal segments

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

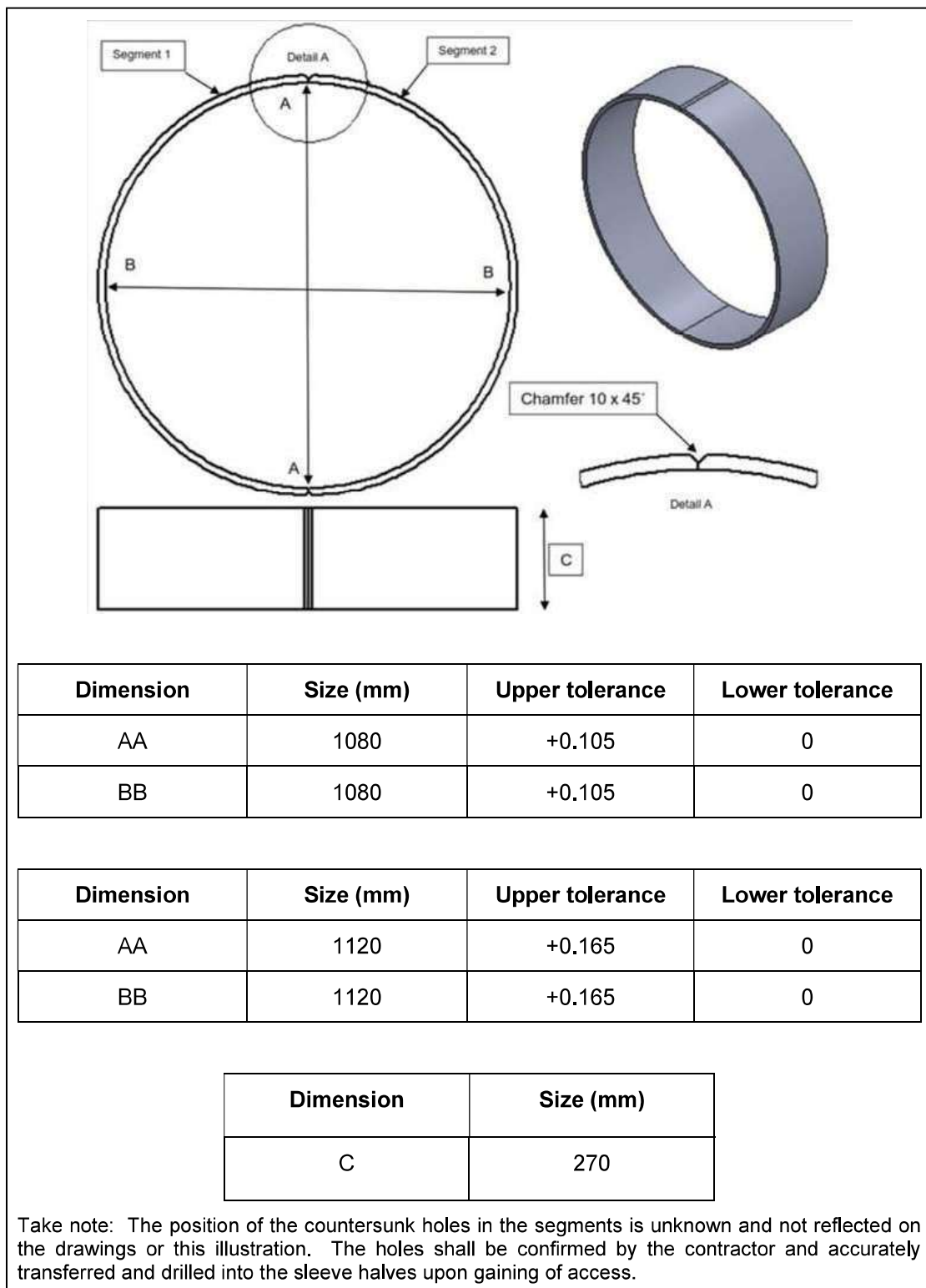


Figure 35: Illustration of Vanderkloof shaft seal sleeve

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.11 Turbine Pit Walkway Platform

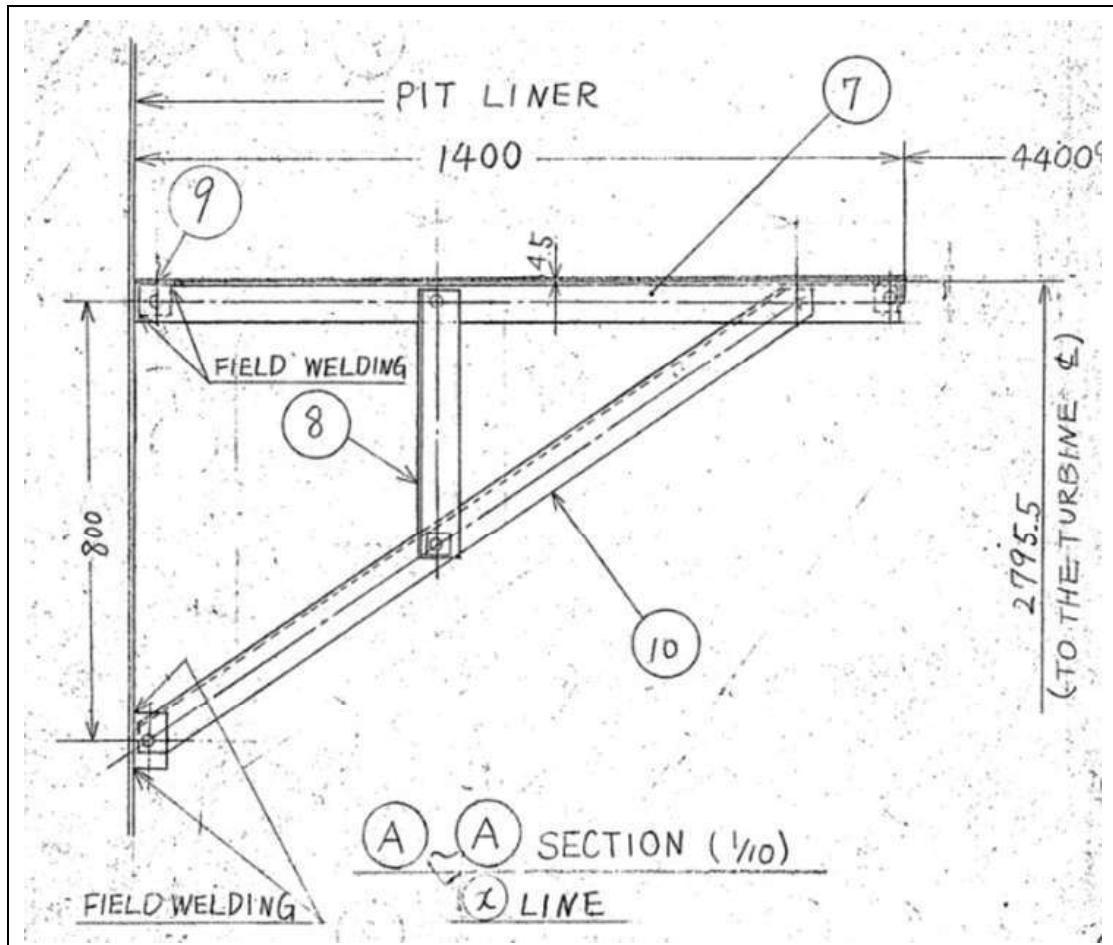


Figure 36: Turbine pit walkway platform support

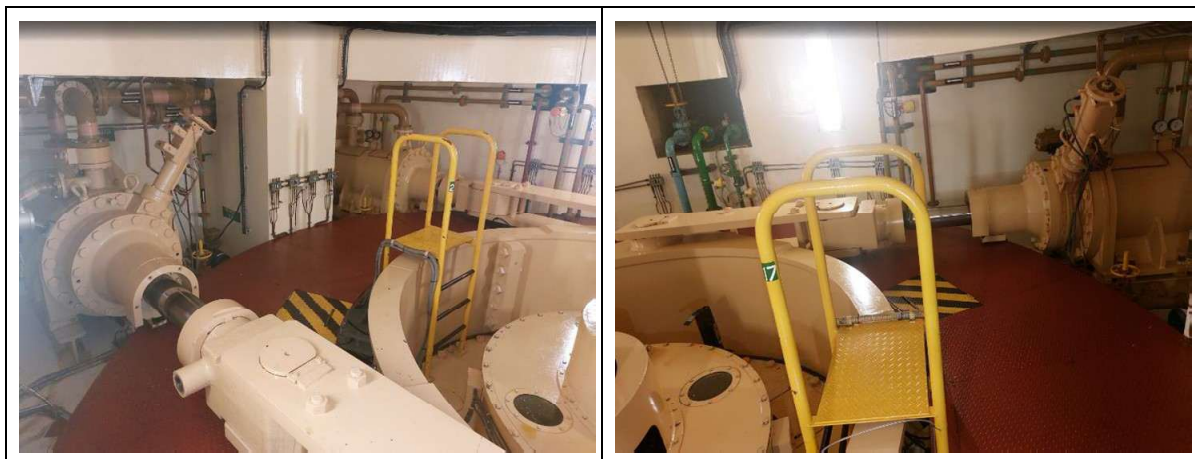


Figure 37: Vanderkloof walkway platform around operating ring

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.12 Turbine Pit Entrance Stairway Steel Liner Removal and Replacement



Figure 38: Turbine pit stairway steel liner plate for removal

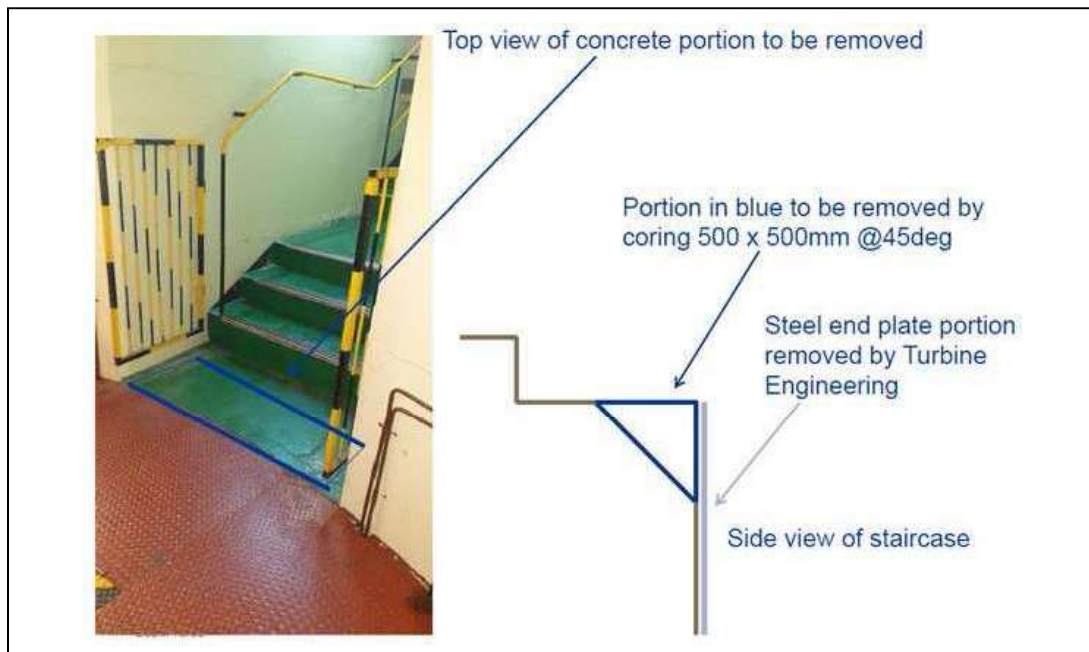


Figure 39: Stairway portion and steel plate liner removal

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

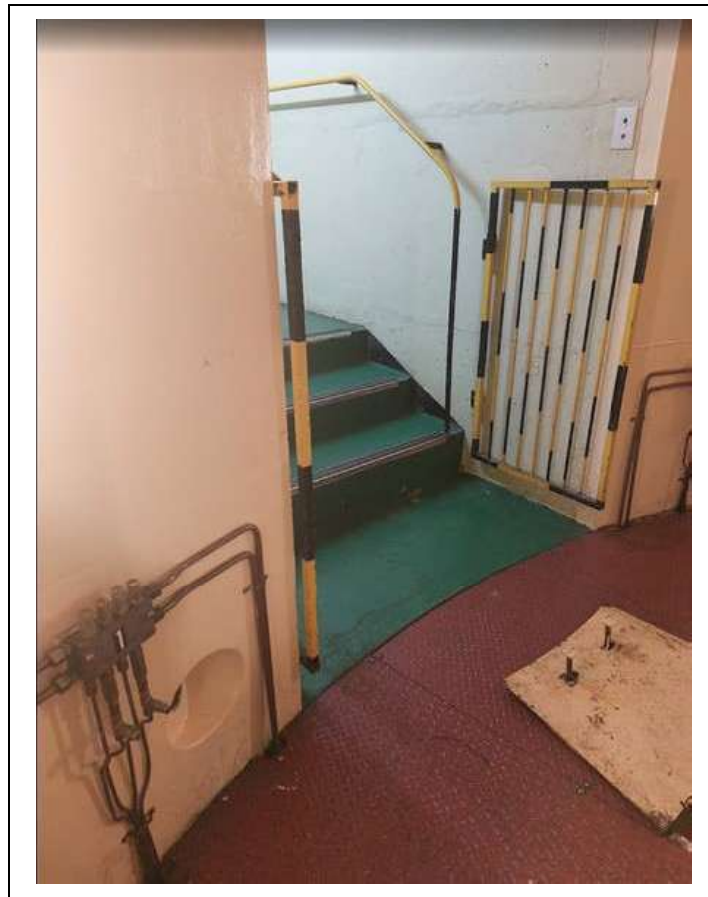


Figure 40: Alternative view of entrance to turbine pit

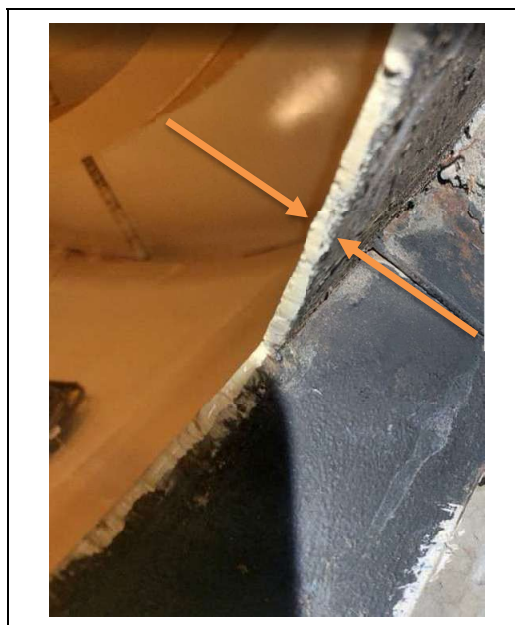


Figure 41: Turbine pit liner 6mm wall thickness

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

13.13 Governor Servomotors Repairs



Figure 42: Servomotor Unit 1 B



Figure 43: Servomotor Unit 1 A

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

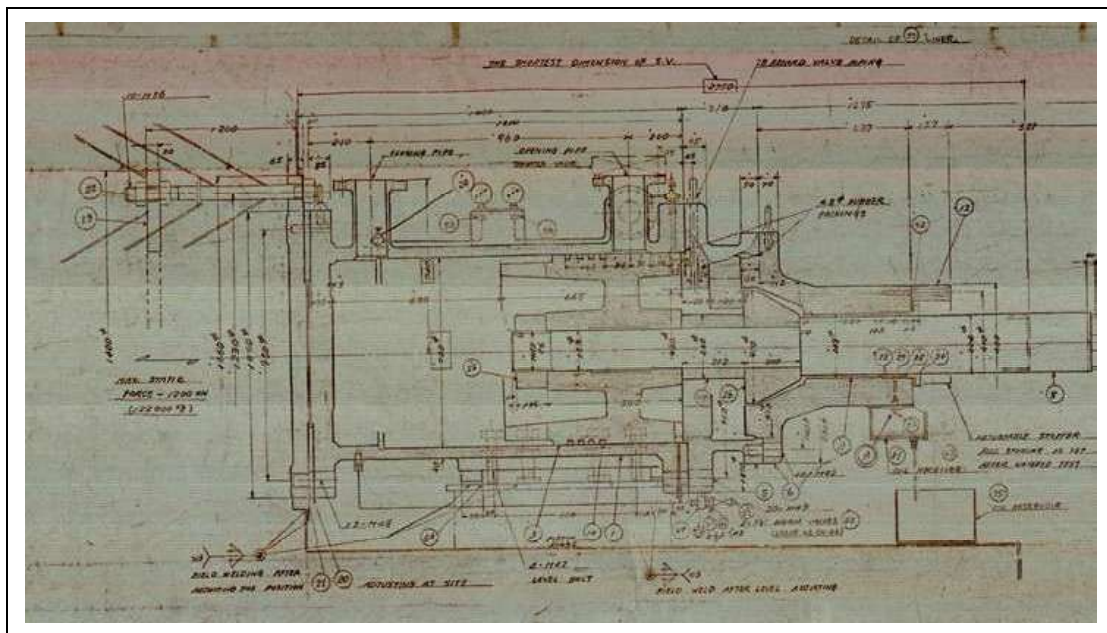


Figure 44: Vanderkloof servomotor barrel and piston arrangement cross-section

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

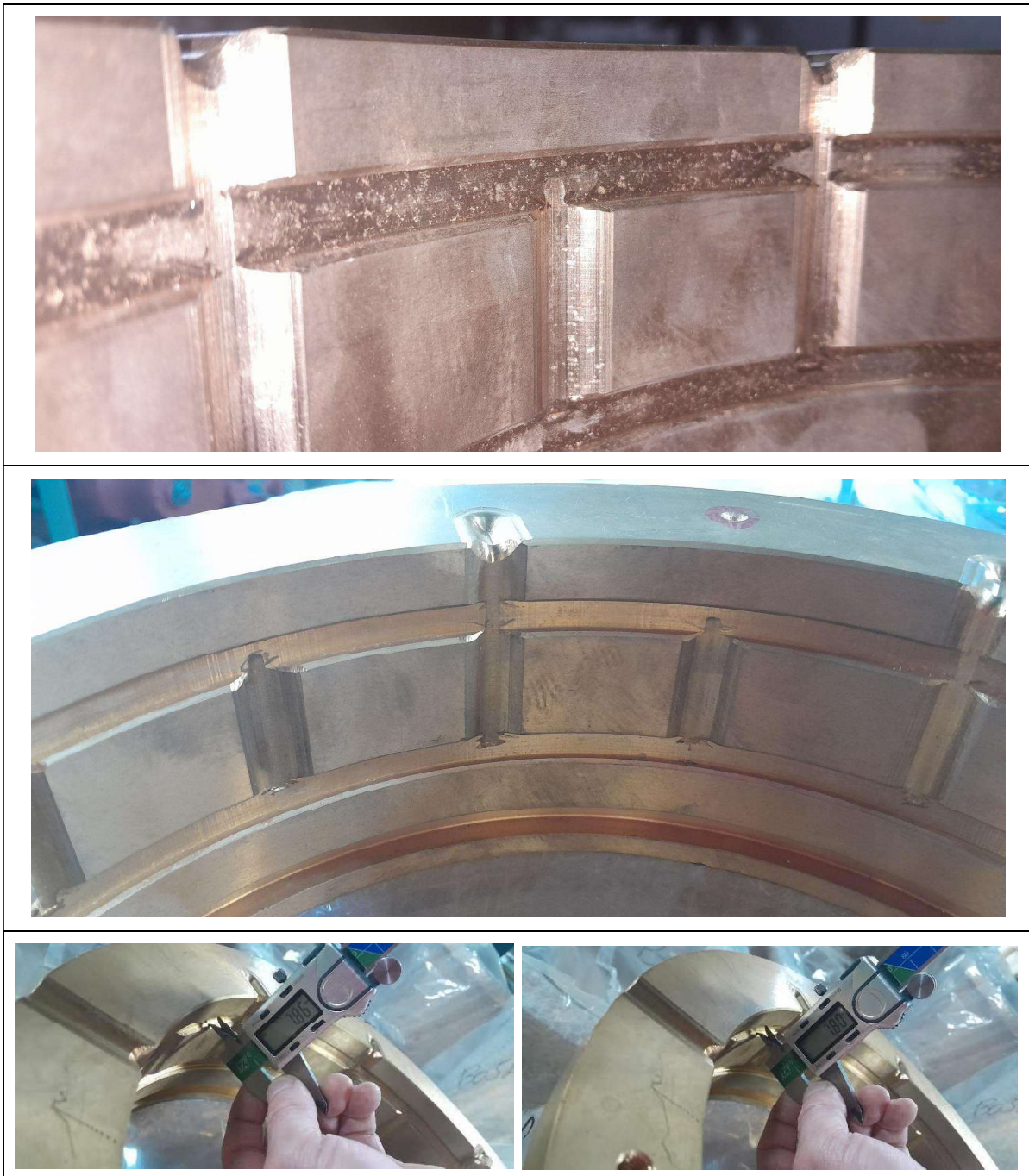
13.14 Installed Guide Vane Bush Line Boring



Figure 45: Examples of line-boring setups for the bush casing internal machining

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.



Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

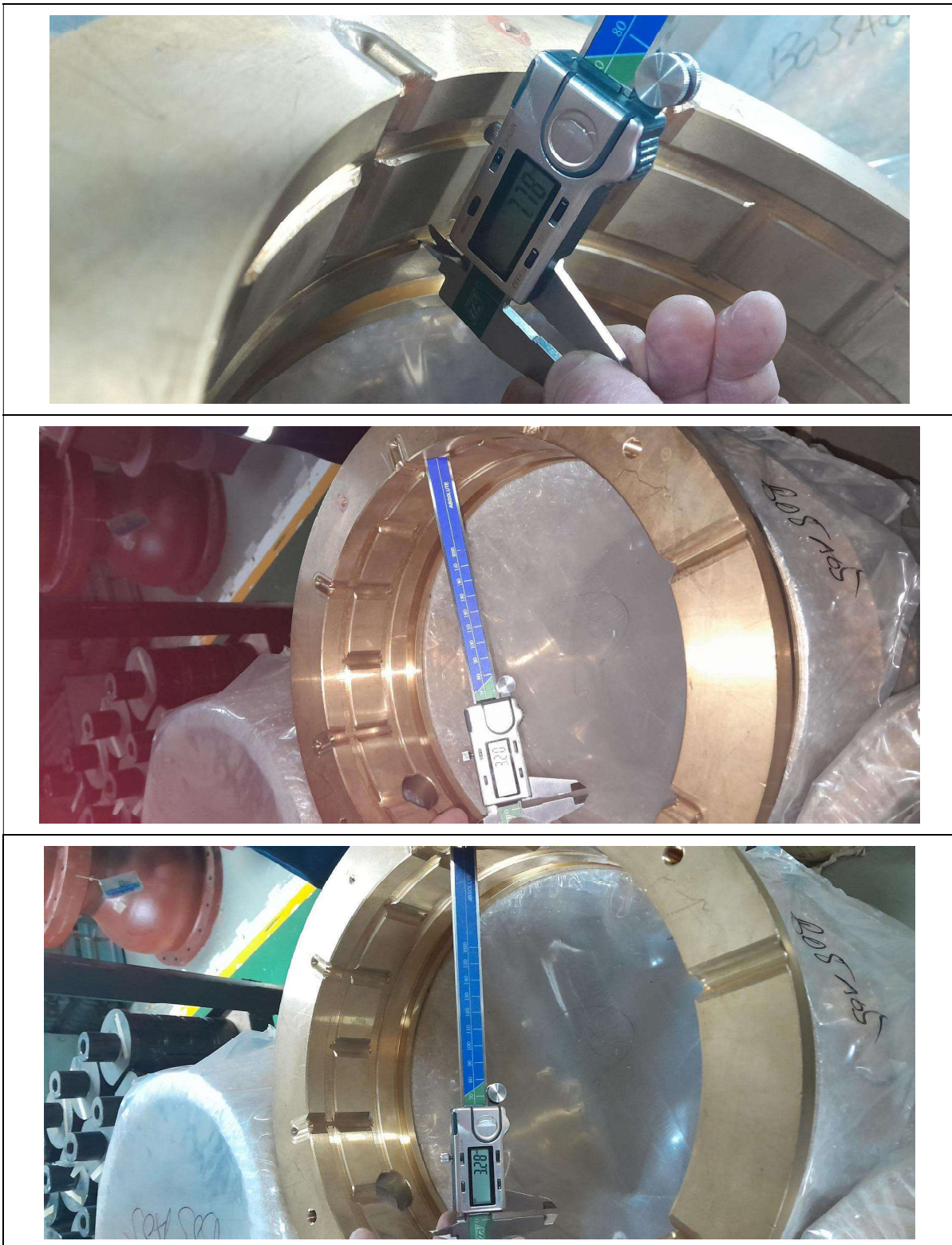


Figure 46: Guide vane bushes grease groove widths and depths

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

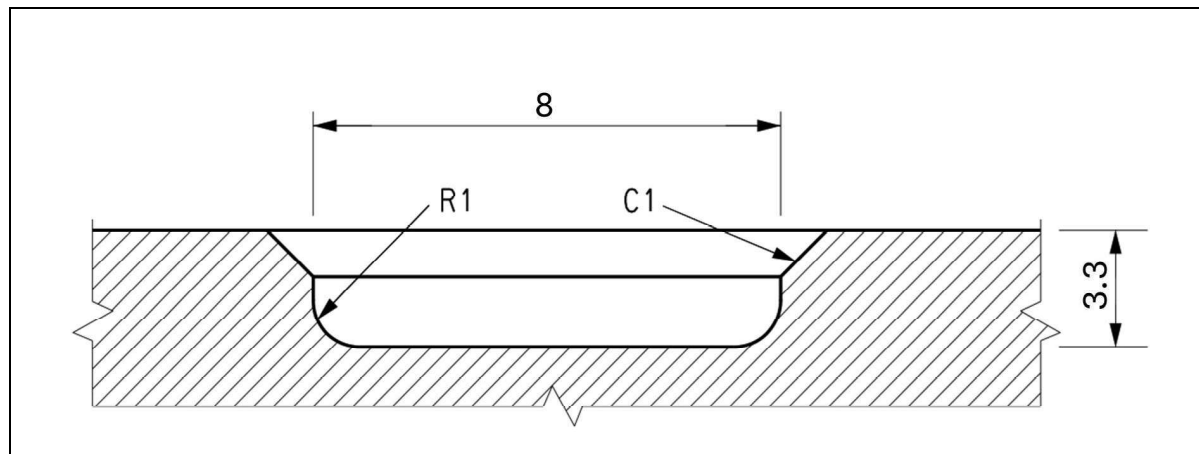


Figure 47: Dimensional cross section of guide vane bush grease groove

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	Upper		Lower		Inspection status	Contractor		Accepted by ESKOM	
		Acceptance criteria	X	Y	X	Y		Date	Signature	Date	Signature
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 48: Example of line-boring check sheet

Controlled Disclosure

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.