 Eskom	Specification	Matimba Power Station
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Manufacturing Technical
Specification Report**

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Compiled by



Francois Nel
ACC System Engineer

Date: 2021/09/07

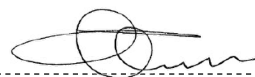
Accepted by



Leslie Barker
Chief Technologist

Date: 2021/09/07

Authorized by



Jacky Mathobela
**Matimba Engineering
Manager**

Date: 2021/09/10

CONTENTS

	Page
1 INTRODUCTION	3
2 SUPPORTING CLAUSES.....	4
2.1SCOPE	4
2.1.1 Purpose	4
2.1.2 Applicability	4
2.2NORMATIVE/INFORMATIVE REFERENCES.....	4
2.2.1 Normative	4
2.2.2 Informative	4
2.2.3 Disclosure Classification	4
2.3ABBREVIATIONS.....	4
2.4ROLES AND RESPONSIBILITIES.....	4
2.5PROCESS FOR MONITORING.....	4
2.6RELATED/SUPPORTING DOCUMENTS.....	4
3 THE WORKS.....	5
3.1BACKGROUND.....	5
3.2DESCRIPTION OF THE WORKS.....	5
3.3MANUFACTURING CAPABILITY	5
3.3.1 ISO 9001 certified	6
3.3.2 gear Cutting and grinding.....	6
3.3.3 heat treatment.....	6
3.3.4 Delivery	6
3.3.5 Qualifications of key personnel	7
3.3.6 Non destructive testing	7
4 TECHNICAL EVALUATION	8
4.1TENDER RETURNABLES	8
4.2TENDER TECHNICAL EVALUATION	9
4.2.1 Tender evalaution - Mandatory technical requirements.....	9
4.2.2 Tender evalaution - technical Evaluation criteria	9
4.2.1 Tender evalaution - technical Evaluation score card	11
4.3FACTORY TECHNICAL EVALUATION	11
4.3.1 Factory evalaution - Mandatory technical requirements	11
4.3.1 Factory evalaution - technical Evaluation criteria	12
4.3.1 Factory evalaution - technical Evaluation score card	13
5 AUTHORISATION.....	13
6 REVISIONS	13
7 DEVELOPMENT TEAM	13
8 ACKNOWLEDGEMENTS	13

FIGURES

Figure 1: Basic working principle of an ACC module	3
Figure 2: Show the start up power as measured on the motor terminals.....	3

TABLES

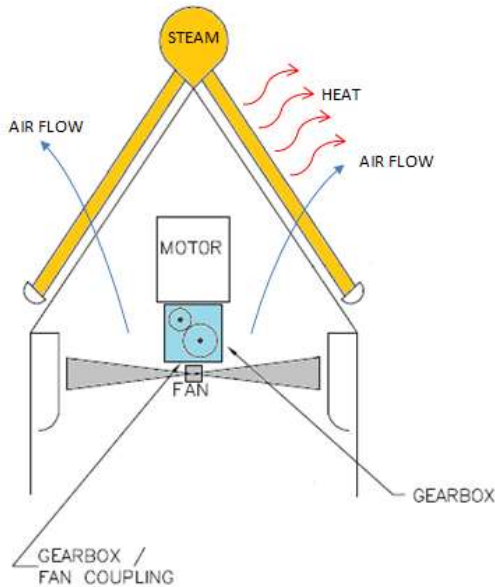
Table 1: Material description and estimated quantity	5
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1 INTRODUCTION

The figure below illustrates the basic working principle of the fan drive and heat transfer bundle for the Matimba ACC. Forced air flow is responsible for heat transfer between the air and the steam. From the illustration it is clear that if the gearbox is affected it will affect the heat transfer capabilities of the bundle and ultimately have a negative effect on the ACC's performance.



As can be seen on Figure 2 below, the power consumption during start up is over 750kW with the normal operating power over 230kW. The large diameter fans (9.13m) is subjected to severe wind loads which subjects the gearbox to various fluctuating loads where the power often goes up to 270kW. It is therefore important that the manufacturer of the gears be skilled in manufacturing such high capacity gears.

Figure 1: Basic working principle of an ACC module

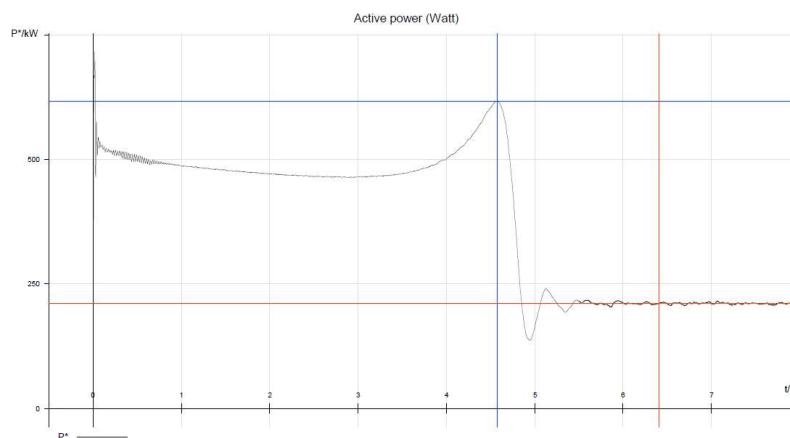


Figure 2: Show the start up power as measured on the motor terminals

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2 SUPPORTING CLAUSES

2.1 SCOPE

The report covers the technical specification for the manufacturing of the Matimba ACC gearbox gears.

2.1.1 PURPOSE

The purpose of the document is to provide technical requirements for the scope of work w.r.t. the manufacturing and supply of gears used on the Matimba ACC gearboxes.

2.1.2 APPLICABILITY

This document shall apply to Matimba Power Station.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed below:

2.2.1 NORMATIVE

- [1] ISO 9001 Quality Management Systems
- [2] OHS Act 85 of 1993

2.2.2 INFORMATIVE

- [3] NA

2.2.3 DISCLOSURE CLASSIFICATION

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.3 ABBREVIATIONS

Abbreviation & Acronyms	Description
ACC	Air-cooled Condenser
QCP	Quality Control Plan
FAT	Factory Acceptance Test
ISO	International Organization for Standardization

2.4 ROLES AND RESPONSIBILITIES

N/A

2.5 PROCESS FOR MONITORING

N/A

2.6 RELATED/SUPPORTING DOCUMENTS

N/A

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3 THE WORKS

3.1 BACKGROUND

Matimba has 288 x 280kW double reduction, helical gearboxes installed which is used to drive 288 axial fans as can be seen in Figure 1. These gearboxes have been experiencing a high failure rate due to ageing as well as inadequate manufacturing from suppliers. This document is intended to specify the manufacturing capabilities required by suppliers in order to ensure that gears supplied will be of superior quality and conform to the technical specifications supplied.

3.2 DESCRIPTION OF THE WORKS

The *Works* consists of the supply of gears specified in the following Table. The contractor is to complete the table during tender giving the unit price and total price for each component.

Table 1: Material description and estimated quantity

Item no	Material no	Qty	Material descriptions and texts	UMC	Unit Price	Total Price
1	27224	10	"PINION GEAR: TYPE: PINION HELICAL INPUT LENGTH: 1.298 M MATERIAL: STL OD: 180MM, FOR USE ON FLENDER GEARBOX TYPE: XSBN 350 DRAWING NO: ESKOM 20.58/54882 PART NO: 850349	EA		
2	27225	10	PINION GEAR: TYPE PINION HELICAL INTERMEDIATE, 610 MM LENGTH, MATERIAL STEEL, FFT: PINION SHAFT: O/DIAMETER 110MM, 19 TEETH, FOR USE ON FLENDER GEARBOX TYPE XSBN 350, RATIO: 11,839, RP350,0/369, ITEM 300 ON DRAWING 5740478, ESKOM DRAWING NO: 20.58/54881, PART NUMBER: 85038	EA		
3	27226	10	GEAR, HELICAL: 61 TEETH, 0.1789 DIAMETRAL PITCH, 125 MM BORE, 80 MM FACE WIDTH, 340.67 MM PITCH DIAMETER, MATERIAL STEEL, FFT: INTERMEDIATE HELICAL GEAR WHEEL, FOR FLENDER GEARBOX TYPE XSBN 350, RP 225,C/3,21, RATIO: 11,839, ITEM 302 ON DRAWING NO: 5740478, FLENDER PART DRAWING NO: 5740751, ESKOM DRAWING: 20.58/54880, PART NUMBER: 850388	EA		
4	27230	10	GEAR, HELICAL: 59 TEETH, 0.11 DIAMETRAL PITCH, 113 MM FACE WIDTH, 536 MM PITCH DIAMETER, MATERIAL STEEL, FFT: HELICAL GEAR WHEEL OUTPUT, FOR USE ON FLENDER GEARBOX, TYPE: XSBN, SIZE: 350, RATIO: 11,839, LEFTHAND PART: 350,0/3,69, O/DIAMETER: 550 MM, ITEM 202 ON DRAWING 5740478, FLENDER PART DRAWING 5740749, PART NUMBER: 852357	EA		

3.3 MANUFACTURING CAPABILITY

It is required that all contractors or sub contractor submit proof of the following (During tender). It is the responsibility of the main contractor tendering to obtain all information for all subcontractors.

1. All contractors and sub-contractors shall have at least 5 years experience in the respective SOW for:
 - a. Supply of material with 3.1 material certificate.
 - b. Manufacturing of gears.
 - c. Heat treatment.
2. The supplier shall at least be able to supply 10 sets of each gear listed in Table 1 per month.

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3. The gear manufacturing contractor shall proof that they have at least manufactured gears exceeding 300 kW in the last 2 years. Referances shall be supplied during tender and shall be verified by the employer during tender.
4. All CNC machines that will be used for the manufacturing of the gears shall be calibrated at least every 2 years. Calibration certificates shall be supplied during tender and shall be verified and reviews as and when necessary. Calibration shall be done by a 3rd party inspector according to the necessary AGMA standards.
5. The supplier shall have internationally recognised CAD software to design and model gears according to AGMA standards.

3.3.1 ISO 9001 CERTIFIED

In order to ensure that the gears are manufactured to the highest quality all contractors and sub-contractors are to supply a valid ISO9001 certificate. That is for the following:

1. The contractor who will be supplying the material.
2. The contractor who will be machining/cutting/grinding the gears.
3. The contractor who will be doing the heat treatment, if different.
4. The contractor who does the calibration of the CNC gear cutting and grinding machines. Shall be a 3rd party contractor.

3.3.2 GEAR CUTTING AND GRINDING

The following is mandatory and shall be verified during a factory acceptance visit during tender evaluations.

1. All gears will be cut and ground using only CNC machining and shall be calibrated at least every 2 years according to relevant AGMA standards.
2. There shall at least be two CNC machines that can cut and grind the gears. This is to ensure that manufacturing will continue in the event that once machine is out of service.
3. All CNC operators shall be qualified to operate gear cutting and grinding machines and shall at least have 5 years post qualification experience on gear cutting and grinding.
4. Gears shall be carburised and ground to an AGMA quality of at least AGMA 10 as per AGMA 2000 A-88.
5. Dimensional verification shall be done by 3D dimensional verification capability.

3.3.3 HEAT TREATMENT

1. Heat treatment shall be done as per the specified drawings.
2. There shall at least be two test sample per batch heat treated.
3. All test samples shall be analysed by a qualified metallurgist with at least 5 years experience post qualification on heat treatment.
4. Each gear shall have a heat number traceable to the batch heat treated where the heat treatment can be verified by the test sample report.
5. If heat treatment is subcontracted, the facility will also be inspected and evaluated. The metallurgical evaluations require Hardness test capability and microstructure and material composition capability.

3.3.4 DELIVERY

1. Gears will be inspected and verified by the employer before delivery. All necessary documentation shall be present and supplied on request.

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2. Each gear shall be delivered with a stamped serial number (SN) and a Quality Control Pack (QCP) report that contains the following information:
 - a. Gear SN traceable to the gear manufacturer.
 - b. Heat number traceable to the test sample for each batch heat treated.
 - c. Heat treatment results as supplied by the heat treatment supplier signed off by the metallurgist.
 - d. Dimensional verification of the gear pitch, pressure angle, helical angle, surface finish signed off by the quality inspector.
 - e. 3.1 Material certification traceable to the gear SN.
3. Each gear shall be coated with Tectyl rust protection compound.
4. Each gear and QCP shall be wrapped with bubble wrap to prevent scratches during transport.
5. Each gear shall be packed in a wooden frame. Multiple gears can be fitted inside the wooden frame, but each shall be separated by wooden slots.
6. Each wooden frame shall not contain more than 5 gears.
7. Each wooden frame shall have a hinged lid that closes off the gears to rain and UV.
8. Each wooden frame shall be transported via a forklift.

3.3.5 QUALIFICATIONS OF KEY PERSONNEL

It is required that the following key personnel have the following qualification and experience:

1. The person signing off the QCP has at least 5 years experiencing in the manufacturing of gears.
2. The person signing off the metallurgical report for the heat treatment be at least a qualified metallurgist with at least 5 years experience post qualification in the respective field of heat treatment.
3. All CNC operators shall have certified training on operating the CNC machines with at least 5 years experience in operating the CNC machines for the cutting and grinding of gears.

3.3.6 NON DESTRUCTIVE TESTING

The contractor is to ensure that all supplied gears are free from any cracks by performing the appropriate NDT as specified by AGMA before and after rough machining.

4 TECHNICAL EVALUATION

4.1 TENDER RETURNABLES

The technical evaluations will be done in two phases. The first is to conduct technical evaluations as per the returnables for this contract. The second will be done on all suppliers that achieved a score of 70% and above for the technical evaluation criteria specified below. The second evaluation will consist of an audit/factory acceptance test on the supplier at his premises. This must be done at the premises of the gear manufacturing supplier.

Tender returnables: It is recommended that the contractor uses a file index divider system when submitting the tender. Each of the following returnables should be in its own section with divider. This will assist in finding information. The file index dividers must correspond to the tender returnables. If the following tender returnables are not submitted, the tender cannot be evaluated and deemed unresponsive

Item	Returnables	Expectations
1	Gatekeeper 1	Verifiable references for the following: Valid ISO9001 certificate for the contractor that will be machining, cutting and grinding the gears. Valid ISO9001 certificate for the contractor that will be doing the heat treatment. Valid ISO9001 certificate for the contractor performing the calibration of the gear cutting and grinding machines.
2	Gatekeeper 2	Proof that all contractors or sub contractors has at least 5 years experience in the respective SOW in the last 5 years.
3	Gatekeeper 3	Proof that the gear manufacturer has manufactured gears exceeding 300kW in the last 2 years.
4	Exclusions	Thoroughly examine and read Section 3 of the Matimba ACC Fan Gearbox Gears Manufacturing Technical Specification (240-164960278). Indicate any exclusions or deviations to Section 3 of the Matimba ACC Fan Gearbox Gears Manufacturing Technical Specification that cannot/will not be achieved. If there are no exclusions, include a statement stating such. e.g. If gear grinding is not done on a CNC grinder, this will be an exclusion as it is stated that only CNC grinded gears will be accepted.
5	Qualifications of key personnel	As per Section 3.3.5 of (240-164960278), submit the CV and qualification of the following key personnel: 1 - Person signing off the QCP 2 - Person signing off the metallurgical report for the heat treatment report 3 - All CNC operators that will be cutting and grinding the gears Sufficient evidence must be supplied to ensure compliance.
6	Calibration certificates	Submit calibration certificates of the CNC gear cutting and grinding machines that will be used to cut and grind the gears to be manufactured. These shall not be older than 2 years. These will be verified during the site visit.
7	Verification of dimensional accuracy	Give a method statement of how the verification of gear cut/grind accuracy is achieved by discussing the following: AGMA standard requirements, cumulative pitch error, adjacent pitch errors, pitch profile accuracy and comparisons, run-outs) to ensure that an AGMA quality of at least AGMA 10 as per AGMA 2000 A-88 is achieved.
8	Calibration certificates of the dimensional verification tools and equipment	Submit calibration certificates of the 3D measurement equipment used for dimensional verification to ensure that all manufactured gears are within specification. These shall not be older than 2 years. These will be verified during the site visit.

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9	Lead times	Give a method statement of how the contractor will ensure that the lead times will be achieved to ensure that 15 of each gears will be supplied per month. The supplier shall have at least 2 CNC machines to cut and grind gears.
10	Material accuracy	Specify how Chemical/material analysis/composition is done to ensure that the correct material is used before manufacturing
11	NDT	Give a method statement of how NDT will be done to ensure that there are no cracks before and after rough machining.
12	Hardness verification	Give a method statement of how material hardness and material microstructure is verified after heat treatment to ensure that the components were hardened to the correct specification. Test samples shall be used as well. Also specify if the hardness verification is done by only the contractor performing the hardness or also by the gear manufacturer.
13	Detailed QCP	A detailed QCP shall be supplied during tender. This shall be done for each one of the four gears to be manufactured. This shall include the duration between tasks.
14	Sample data pack	Supply a complete detailed data pack of a gear manufactured that has been heat treated, has a helical profile, pressure angle of 20 deg, face width of at least 50mm and pitch diameter of at least 100mm.
15	Long lead items	Supply a list of all long lead items, specifying the duration thereof
16	Gear design software	Confirm the Internationally recognised software being used to design and model gear design

4.2 TENDER TECHNICAL EVALUATION

The following specifies the technical evaluation during the tender phase.

4.2.1 TENDER EVALAUTION - MANDATORY TECHNICAL REQUIREMENTS

<p>Gatekeeper 1: Verifiable references for the following: Valid ISO9001certificate for the contractor that will be machining, cutting and grinding the gears. Valid ISO9001certificate for the contractor that will be doing the heat treatment. Valid ISO9001certificate for the contractor performing the calibration of the gear cutting and grinding machines.</p>
<p>Gatekeeper 2: Proof that all contractors or sub contractors has at least 5 years experience in the respective SOW in the last 5 years.</p>
<p>Gatekeeper 3: Proof that the gear manufacturer has manufactured gears exceeding 300kW in the last 2 years.</p>

4.2.2 TENDER EVALAUTION - TECHNICAL EVALUATION CRITERIA

Technical Evaluation Score Criteria/Tender returnable			
Item	Technical Aspect / Deliverable	Criteria	Points
1	The contractor indicate any exclusions or deviations to Section 3 of the Matimba ACC Fan Gearbox Gears Manufacturing Technical Specification that cannot/will not be achieved. If there are no exclusions, a statement	Fully compliant	5
		Acceptable risks	4
		Unacceptable risks - See Table below "Unacceptable Risks" Item 1 -6	2
		Deficient or non-responsive	0

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	stating such is included. e.g. If gear grinding is not done on a CNC grinder, this will be an exclusion as it is stated that only CNC grinded gears will be accepted.		
2	CNC operators qualification	All CNC operators has at least 5 years experience post qualification.	5
		All CNC operators has at least 4 years experience post qualification.	4
		Deficient or non-responsive	0
3	QCP personnel qualification	All persons signing off the QCP report has at least 5 years experience in gear manufacturing	5
		All persons signing off the QCP report has at least 4 years experience in gear manufacturing	4
		All persons signing off the QCP report has at least 3 years experience in gear manufacturing	2
		Deficient or non-responsive	0
4	Heat treatment verification	Heat treatment verification is done by the supplier doing the heat treatment or by a 3rd party inspector and the gear manufacturer	5
		Heat treatment verification is done by only the supplier doing the heat treatment	4
		Heat treatment verification is done by only the gear manufacturer	2
		Deficient or non-responsive	0

Unacceptable Risks		
Obtained from which returnable	Item	The following are unacceptable technical risk as they are technical requirements of which the SOW cannot be executed or will defeat the purpose of this SOW or can physically not operate on the plant.
5	1	The persons performing the material microstructure analysis/verification as well as the hardness verification after heat treatment shall be at least a certified metallurgist with at least 5 years experience post qualification
7	2	If the suppliers propose to use other machines other than CNC machines to cut and grind gears
9	3	The supplier does not have at least two CNC machines for cutting or grinding the gears. This has a risk of not being able to supply gears during down time of one of the machines.
12	4	No test samples are used during heat treatment
7	5	The supplier cannot guarantee an AGMA quality of at least AGMA 10 as per AGMA 2000 A-88 is achieved.
14	6	The sample data pack does not include a detailed heat treatment certificate, material composition report and 3D dimensional verification report as measured on a 3D dimensional profiling machine to ensure the specified technical specifications has been achieved.
16	7	The supplier does not have an internationally recognised gear design and modelling software to design gears for manufacturing.

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4.2.1 TENDER EVALAUTION - TECHNICAL EVALUATION SCORE CARD

Technical Evaluation Score: Note: If the final score of the Tender is below 70% the Tender will be considered technically unacceptably. All suppliers that passed the technical evaluations will be subjected to technical evaluation at the suppliers factory.		Tender 1		
	Technical Aspects:	Points	Weight	Score
	TECHNICAL			
1	Exclusions or deviations - See: Score Criteria Tender - Item 1		51	0
2	CNC operators qualification - See: Score Criteria Tender - Item 2		15	0
3	QCP personnel qualification - See: Score Criteria Tender - Item 3		15	0
4	Heat treatment verification - See: Score Criteria Tender - Item 4		19	0
	Score for Technical Aspects:			0%
		TOTAL	100	Fail

4.3 FACTORY TECHNICAL EVALUATION

The following specifies the factory inspection and evaluation. This will only be applicable for suppliers that achieved 70% and above for the Technical evaluation – Score card.

4.3.1 FACTORY EVALAUTION - MANDATORY TECHNICAL REQUIREMENTS

Gatekeeper 1: The calibration certificate for the gear cutting and grinding machines are not valid or was not done by a 3rd party inspector who is ISO 9001 certified.
Gatekeeper 2: The supplier does not have at least two CNC machines that can cut and grind the gears at the same time. This poses a risk of meeting demand.
Gatekeeper 3: The supplier cannot demonstrate at least 2 different gears (Bigger than 100mm PCD) already cut and ground ready for delivery to verify the quality of the gears manufactured. These shall be traceable to the QCP
Gatekeeper 4: There is no record that the persons performing the QCP and CNC operators of whom the CV's were supplied during tender is working for the company.
Gatekeeper 5: There is no evidence that the supplier can manufacture gears in excess of 300kW
Gatekeeper 6: The supplier cannot demonstrate the capability to accurately measure and verify dimensional accuracy after manufacturing using a 3D dimensional verification machine.

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4.3.1 FACTORY EVALAUTION - TECHNICAL EVALUATION CRITERIA

Technical Evaluation Score Criteria - Factory Inspection			
Item	Technical Aspect / Deliverable	Criteria	Points
1	Record keeping of sample heat treatment	The supplier has very good record keeping of heat treatment certificates easily traceable to the batch number and sample.	5
		The supplier had to cross reference various files and document to obtain the necessary information	4
		Document management is not well managed	2
		Deficient or non-responsive	0
2	Control over sub-contractors	Control of: QCP's, data packs, NCR's, work orders, auditing etc is very well managed. All information is readily available and in numbered/labelled files. All information was supplied in less than 15 minutes.	5
		Control of: QCP's, data packs, NCR's, work orders, auditing etc is acceptable managed. All information was not readily available. The supplier had to search for the information. Finding all information took longer than 30 minutes.	4
		Control of: QCP's, data packs, NCR's, work orders, auditing etc is poorly managed or not available. All information is not readily available and in numbered/labelled files. The supplier had to search for longer than 40 minutes to obtain the information.	2
		Deficient or non-responsive	0
3	Quality control procedures	There is evidence that QCP's are being followed in the workshop and that the necessary hold and witness points are followed before work continues. All findings are well recorded on the QCPS	5
		There is evidence that QCP's are being completed afterwards in order to satisfy the process.	2
		Deficient or non-responsive	0
4	Record keeping	Record keeping dates back to demonstrate that the gear manufacturer has been manufacturing gears for at least 5 years. Records are well managed	5
		Record keeping dates back to demonstrate that the gear manufacturer has not been manufacturing gears for at east 5 years.	2
		Deficient or non-responsive	0
5	Workshop neatness	The workshop is very neat	5
		The workshop is cluttered with objects posing tripping hazards	2

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4.3.1 FACTORY EVALAUTION - TECHNICAL EVALUATION SCORE CARD

Final Technical Evaluation Score: Note: If the final score of the site visit is below 70% the Tender will be considered technically unacceptably. All suppliers that passed the site visit will be considered technically suitable for the SOW.		Tender 1		
		Points	Weight	Score
	Technical Aspects:			
	TECHNICAL			
1	Record keeping of sample heat treatment - See: Score Criteria Site Visit - Item 1		20	
2	Control over sub-contractors - See: Score Criteria Site Visit - Item 2		20	
3	Quality control procedures - See: Score Criteria Site Visit - Item 3		20	
4	Record keeping - See: Score Criteria Site Visit - Item 4		20	
5	Workshop neatness - See: Score Criteria Site Visit - Item 5		20	
	Score for Technical Aspects:			100%
		TOTAL	100	Fail

5 AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Francois Nel	System Engineer: Matimba
Leslie Barker	Chief Technologist: Engineering

6 REVISIONS

Date	Rev.	Compiler	Remarks
September 2021	1	FP Nel	First draft

7 DEVELOPMENT TEAM

NA

8 ACKNOWLEDGEMENTS

N/A

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