

	Specification	Technology
---	----------------------	-------------------

Title: Technical Specification for the Procurement of Boiler Tubing Across the Eskom Generation Fleet of Coal-Fired Power Plants

Unique Identifier: 474-12132

Alternative Reference Number: N/A

Area of Applicability: Engineering

Documentation Type: Specification

Revision: 1

Total Pages: 9

Next Review Date: N/A

Disclosure Classification: CONTROLLED DISCLOSURE

APPROVED FOR AUTHORISATION
 TECHNOLOGY ENGINEERING
 DOCUMENT CENTRE ☎ X4962

Compiled by	Functional Responsibility	Authorised by
 N.S.P. Dlamini Chief Engineer (Metallurgy) – PEI—Materials, Welding, NDT & RBI Date: 20/08/2019	 M.M. Maroga Senior Manager (Acting) - PEI—Materials, Welding, NDT & RBI Date: 21/08/2019	 Y. Singh General Manager (Acting) – Production Engineering Integration (PEI) Date: 21/08/2019

CONTENTS

	Page
1. INTRODUCTION	3
2. SUPPORTING CLAUSES.....	3
2.1 SCOPE	3
2.1.1 Purpose	3
2.1.2 Applicability.....	3
2.2 NORMATIVE/INFORMATIVE REFERENCES.....	3
2.2.1 Normative	3
2.2.2 Informative.....	4
2.3 DEFINITIONS.....	4
2.3.1 Disclosure Classification	4
2.4 ABBREVIATIONS.....	4
2.5 ROLES AND RESPONSIBILITIES.....	4
2.6 PROCESS FOR MONITORING.....	4
2.7 RELATED/SUPPORTING DOCUMENTS.....	4
3. REQUIREMENTS.....	4
3.1 GENERAL.....	4
3.2 MANDATORY REQUIREMENTS	5
3.3 SPECIFIC REQUIREMENTS.....	5
3.3.1 Details of manufacturing plant.....	5
3.3.2 Steel-making process.....	5
3.3.3 Heat Treatment.....	6
3.3.4 Chemical composition	6
3.3.5 Mechanical Properties	7
3.3.6 Creep data.....	7
3.3.7 Non-destructive examination.....	7
3.3.8 Certification.....	8
3.3.9 Protection against corrosion.....	8
3.3.10 Marking.....	8
3.3.11 Surface condition.....	8
3.3.12 Delivery documents.....	8
4. AUTHORISATION.....	9
5. REVISIONS	9
6. DEVELOPMENT TEAM	9
7. ACKNOWLEDGEMENTS	9

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

1. INTRODUCTION

Boiler tubing forms part of critical spares for power stations across the Eskom Generation fleet. The procurement of boiler tubing must comply with strict technical requirements in order to ensure that tubing of suitable quality is procured and delivered. Poor quality tubing will have an adverse effect on plant availability due to increased risk of boiler tube failures. In order to assure adequate quality of boiler tubing, appropriate technical delivery conditions, usually specified in international materials specifications such as EN 10216 and Section II of the ASME Boiler and Pressure Vessel Code must be followed. However, these international specifications include several options concerning tests that may be specified by the end user. In addition, more stringent technical requirements may be warranted for some materials in exceptional circumstances in order to minimize known risks that aren't properly mitigated by requirements contained in the international specifications.

This document aims to fill the gaps identified above, and to clearly define technical requirements that will be considered mandatory and qualitative criteria for the purposes of procurement of boiler tubing.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document covers technical requirements to be followed when procuring seamless tubing intended for use in boiler pressure-parts at elevated temperatures and pressures. These requirements shall apply to tubing procured in accordance with the technical delivery conditions specified in EN 10216 and/or ASME Boiler and Pressure Vessel Code, Section II Part A.

2.1.1 Purpose

To ensure that tubing of adequate quality and condition is procured for use in Eskom's fleet of coal-fired power stations.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions for the procurement of boiler tubing.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems.
- [2] EN 764-5: Pressure Equipment – Part 5: Inspection Documentation of metallic materials and compliance with the materials specification.
- [3] EN 10216: Seamless steel tubes for pressure purposes – Technical delivery conditions – Parts 1-5
- [4] EN 10204: Metallic Products – Types of inspection documents
- [5] EN 12952: Water-tube boilers and auxiliary installations – Parts 2, 5, and 6
- [6] VdTÜV material data sheet (WB) 547 – for *DMV 347H FG*
- [7] VdTÜV material data sheet (WB) 560/2 – for *VM12*
- [8] ASME Boiler & Pressure Vessel Code, Section II Part A and D

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2.2.2 Informative

[9] VGB-S-109-00-2012-08-DE-EN: Material specification for components under pressure in fossil-fired power plants.

2.3 DEFINITIONS

Not applicable

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Not applicable

2.5 ROLES AND RESPONSIBILITIES

The responsible technical lead (TL) or engineering design work lead (EDWL) for procurement of boiler tubing shall ensure that this document or its requirements is or are (wholly) incorporated in documents sent out to the market.

The Technical Evaluation Team (TET) members shall ensure compliance with this document during tender evaluations.

The Pressure Parts System Engineer and/or responsible Site Metallurgical Engineer/Representative, along with the designated QC personnel for a power station receiving tubing procured in line with the requirements of this specification shall ensure compliance with the delivery requirements set out in 3.3.12.

2.6 PROCESS FOR MONITORING

Technical tender evaluation audits/independent reviews (as and when needed) by duly appointed personnel to ensure that tender evaluations were conducted in compliance to the technical requirements specified in this document.

2.7 RELATED/SUPPORTING DOCUMENTS

Not applicable.

3. REQUIREMENTS

3.1 GENERAL

Boiler tubing shall generally be procured in accordance with the requirements EN 10216 (whichever part is relevant) for boilers designed according to EuroNorm (EN) design codes (such as EN 12952, BS 1113 etc) and in accordance with the requirements of Section II Part A of the ASME Boiler and Pressure Code (BPVC) for boilers designed to the ASME BPVC.

For boiler tubing procured in accordance with the EN 10216 specification, test category 2 (TC2) of Table 10 (part 4), Table 13 (part 2) and Table 15 (parts 3 and 5) shall apply, with all the optional tests except for option 5 (EN 10216-2) and option 23 (EN 10216-5).

For tubing procured in accordance with Section II of the ASME BPVC, similar tests as those of EN 10216 TC2 above shall be performed, while still ensuring that all applicable tests and requirements specified in the ASME BPCV Section II are observed. Any apparent conflicts between the tests prescribed in EN

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

10216 TC2 and those prescribed in the ASME BPVC Section II Part A shall be submitted to the Eskom for clarification

3.2 MANDATORY REQUIREMENTS

The following mandatory information from the material manufacturer shall be supplied as part of the tender returnable documents:

- i. A valid or current Third Party/Notified Body certification (as contemplated in EN 764-5 Clause 4) that the plant from which tubing is to be produced has been audited and authorised as having a quality assurance system for material manufacture in accordance with PED 97/23/EC or 2014/68/EU (Pressure Equipment Directive) to produce the material grades and dimension ranges consistent with those tendered for or quoted in tender returnables.
- ii. List of previous supply of materials and dimensions tendered for or quoted in tender returnable documents, within the last **five** years. The list should include, at the very least, the following details: dates of delivery, material grade, dimensions, tonnage/quantity and user contact details.

3.3 SPECIFIC REQUIREMENTS

The following requirements shall apply in addition to the requirements stipulated in the relevant international material specifications mentioned in section 3.1 of this document.

3.3.1 Details of manufacturing plant

The following information shall be provided to Eskom with tender returnable documents: trading or formal business name of the manufacturing plant, street and postal addresses, contact names and telephone numbers of top/senior plant managers, along with their respective organizational roles. *The site of manufacturing, inspection, testing, and release – if any activity is done at a different location or facility other than at the main manufacturing plant shall also be listed.*

Note: It is Eskom's intent to conduct an evaluation or assessment of the mills or manufacturing plants as part of the tender evaluation process (or to arrange for an audit by a third party). Under no circumstances can material be manufactured elsewhere without Eskom's written approval.

3.3.2 Steel-making process

The foundries used to supply cast billets for the manufacture of all tubing shall be listed in the tender returnable documents. Raw materials and scrap control by foundries shall demonstrate control measures that are in place to ensure low contamination levels from trace, dangerous (poisonous and radioactive) and any other undesirable elements.

The material manufacturer shall provide Eskom with a short technical description of its steel-making process to ensure the production of "clean" steel.

Only fully killed steels shall be acceptable to Eskom.

Material manufacturers shall provide details of all raw material suppliers along with relevant certification of the suppliers' quality management system/processes, such as valid or current ISO 9001 certificates or comprehensive quality manuals (where an ISO 9001 certificate is not available). This information shall be provided with tender returnable documents.

CONTROLLED DISCLOSURE

3.3.3 Heat Treatment

The following requirements pertaining to heat treatment shall apply:

- i. Valid or current calibration certificate(s) for facilities used for the heat treatment of tubing shall be provided with tender returnable documents.
- ii. Heat treatment plans or schedules for each material tendered for or quoted shall be provided with tender returnable documents. The heat treatment plans or schedules shall, at least, include the following information: heating and cooling rates (and the heating and cooling methods and mediums), holding temperatures and holding times. The heat treatment plans may be provided in the form of schematic heat treatment dummy charts.
- iii. Loading of tubes in heat treatment facilities shall be done so as to avoid non-uniform heating and cooling, which could result in non-uniform material properties. A short description of heat treatment control measures which will or are already in place in order to achieve this shall be included with tender returnable documents.
- iv. Where heat treatment is performed in large batch furnace enclosures, the manufacturer shall provide with, in the tender returnable documents, detailed heat treatment control and furnace calibration procedures that clearly show how temperature is controlled and monitored across all horizontal, vertical and diagonal dimensions of the furnace. For the Eskom order, a temperature differential in any direction of no more than 20°C shall be observed. Proof of this shall be provided as part of the delivery documents stipulated in 3.3.12.

3.3.4 Chemical composition

- (a) When executing the Eskom order (after contract award), both cast/melt and product analyses shall be performed on the same heat/sample used for mechanical testing.
- (b) For all steel grades the following trace elements shall be controlled and reported (on mill material certificates) with adherence to the following limits:
 - Phosphorus (P) $\leq 0,015\%$
 - Sulphur (S) $\leq 0,005\%$
- (c) The following trace elements shall be reported on mill material certificates (generated in accordance with EN 10204):
 - Arsenic (As)
 - Antimony (Sb)
 - Lead (Pb)
- (d) The following limits shall apply for both cast and product analyses of X10CrMoVnb9-1, X20CrMoV11-1 and VM12 steels:
 - Nickel (Ni) ≤ 0.20 ; Nitrogen ≥ 0.035 ; N/Al > 4 (for X10CrMoVnb9-1 **only**)
 - Copper (Cu) $\leq 0.10\%$
 - Tin (Sn) $\leq 0,010\%$

In addition, adequate measures for the control of Delta Ferrite formation in these steels shall be put in place and provided to Eskom as part of the tender returnable documents. When executing the Eskom order after contract award, the following formulas shall be adhered to in order to control Delta Ferrite formation:

$$(Cr + 6Si + 4Mo + 1,5W + 11V + 5Nb + 9Ti + 12Al) - (40C + 30N + 4Ni + 2Mn + 1Cu) < 12$$

CONTROLLED DISCLOSURE

3.3.5 Mechanical Properties

Mechanical testing shall be done in accordance with the relevant part (and applicable optional tests) of EN 10216 or the relevant part of Section II of the ASME BPVC, subject to suitability of dimensions in line with the provisions of the relevant specification.

- (a) *Tensile testing at elevated temperatures* shall be carried out for all materials used in time-independent designs (hot yield strength range). A temperature of 550°C shall be used. The measured mechanical properties shall comply with the values in the applicable specification. Yield strength (or 0,2% proof strength), ultimate tensile strength, elongation and reduction in area shall be reported.
- (b) *Hardness testing* (macro-Vickers with 10kg load) shall be carried out on a cross section, close to the outside surface (0,5 - 1mm), in the centre and close to the inside surface (0,5 - 1mm) of each sample. Care must be taken to polish away the cold work effects from cutting of the samples. The following hardness range shall be used as the acceptance criteria for the respective material grades:
- | | |
|---------------------|---------------|
| 16Mo3 | 140 to 190 HV |
| 13CrMo4-5 | 135 to 185 HV |
| 10CrMo9-10 | 140 to 190 HV |
| 7CrMoVTiB10-10 | 175 to 260 HV |
| X12CrCoWMoVNb12-2-2 | 205 to 260 HV |
| X20CrMoV11-1 | 215 to 265 HV |
| X10CrMoVNb9-1 | 215 to 260 HV |
- (c) *Impact testing* shall be done in the transverse direction except where dimension do not allow. The sample orientation must be noted on the test report. Impact properties shall comply with code values.

3.3.6 Creep data

In line with the provisions of Appendix B of EN 12952-2, the material manufacturer shall furnish to Eskom verification of the creep test results for materials intended for operation in the creep range ($\geq 450^{\circ}\text{C}$). The creep tests results shall be based on tests conducted by the material manufacturer from heats of a given material produced from its own plant. The creep tests results shall be based on actual data for each material grade tendered for or quoted in tender returnable documents. The minimum test duration for the actual creep test shall be 40 000 hrs.

The material manufacturer shall provide this data with the tender returnable documents or provide a written declaration that the data will be made available to Eskom personnel during a factory or site assessment or at any stage prior to contract award.

3.3.7 Non-destructive examination

Magnetic particle testing (MT) shall be carried out on all tubes.

In all cases leak tightness testing shall be performed using electromagnetic testing. The electromagnetic testing shall be fully capable of detecting longitudinal defects.

CONTROLLED DISCLOSURE

3.3.8 Certification

Certification shall be in accordance with EN 10204 3.1 in all cases. A selection of the tests to be performed, which shall be agreed prior to contract placement, shall be witnessed by a person duly appointed by Eskom for this purpose. To this end, when executing an Eskom order after contract award, a detailed manufacturing and testing schedule shall be provided with sufficient advance notice to Eskom for timely mobilization efforts.

3.3.9 Protection against corrosion

Tubes shall be dry, free of corrosion, and a temporary protective coating shall be applied on each tube for long term protection during storage under atmospheric conditions (open storage). Tube ends shall be covered with tight fitting end caps and desiccant bags or suitable inhibitor shall be placed on the inside of each tube to protect it for long term storage under atmospheric conditions (outside storage). The manufacturer shall supply details of the coating and desiccant /inhibitor that will be applied with tender returnable documents.

3.3.10 Marking

Standard and clear legible marking must be applied to all tubes on both ends of each tube. All marking shall be in accordance with the relevant delivery conditions specification/standard.

3.3.11 Surface condition

The surfaces of all tubes shall be such that all required NDT can be carried out without restriction or limitations relating to surface condition.

All tubes shall be delivered free of external and internal scale.

3.3.12 Delivery documents

The following information shall be fulfilled with the delivery of each order:

- (a) Order requirements and specifications (including declaration of conformity that all technical requirements were met or fulfilled)
- (b) PED certification
- (c) Signed quality control documentation
- (d) Steel making process(es) and foundry material certificate.
- (e) Certificates (all certified mill test reports) according to EN 10204 3.1, including all detailed results for destructive and non-destructive testing.
- (f) Heat treatment charts (austenizing and tempering) and/or a detailed explanation of the processes including ramp rates, hold times and temperatures.
- (g) Details or records of surface finish and corrosion protection applied.
- (h) All concession correspondence if applicable.

CONTROLLED DISCLOSURE

4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Andrew Downes	Chief Metallurgist
Bhavesh Naran	Chief Engineer
Teboho Molokwane	Senior Engineer (Metallurgy)
Nellan Govender	Chief Engineer
Morris Maroga	Corporate Specialist (Materials & Welding) & Senior Manager (Acting) - PEI—Materials, Welding, NDT & RBI

5. REVISIONS

Date	Rev.	Compiler	Remarks
August 2019	0.1	P. Dlamini	Original draft version prepared for review
August 2019	0.2	P. Dlamini	Final draft after review process
August 2019	1	P. Dlamini	Final document for authorisation and publication

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Prince Dlamini

7. ACKNOWLEDGEMENTS

- Not applicable.

CONTROLLED DISCLOSURE