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Title: User Requirement Specification for Refractory Lining Monitoring system to be used to monitor and measure refractory lining thickness of 2*4ton Induction Furnaces and 125kg Test Smelter Induction Furnace	

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Revisions

This document has been revised according to the following schedule:

Revision	Date Approved	Nature of Revision	Prepared by
00	See title page	First Issue	T Munyai

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1.0 PURPOSE

The purpose of this user requirements specification document (URS) is to prescribe the requirements of Refractory Lining Monitoring system that is required to measure and monitor refractory lining thickness of 2-off *4ton induction furnaces and a 125kg test smelter induction furnace at the Smelter Facility of Necsa. This is to eliminate the need to manually measure the furnace refractory lining. The system will allow a safer and more informed decisions to be made regarding the furnace refractory lining management. The end-user will need to gain confidence in plant safety through an integrated, automatic monitoring system.

2.0 SCOPE

The Smelter plant requires a refractory lining monitoring system that will measure and monitor the refractory lining thickness during the melting operation of 2-off*4 tons induction furnaces. The coil grout diameter is 1040mm with a furnace coil height of 1400mm. Attached is Annexure A showing the 4-ton Main Smelter Induction Furnace cross section & refractory arrangement and Annexure B showing the 125 kg Test Smelter Induction Furnace cross-section for ease of reference.

3.0 REFERENCES

The following documents are referenced in this document:

- | | | |
|-----|-------------------------------------|--|
| [1] | NLM-URT-21/002 | User Requirement Specification for Refractory Lining Monitoring system to be used to monitor refractory lining thickness of 4tons Induction Furnace |
| [2] | Smelter Public Information Document | Smelter Public Information Document |

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS:

- **Refractory lining monitoring system/solution**

A system which will continuously monitors and provides data of the lining during the operation of coreless induction furnace(s). A system which will provides continuous measurement of refractory wall thickness during operation and convey the readings/measurement to the control room's SCADA/HMI system and store the data for future references.

4.2 ABBREVIATIONS:

NLM:	Nuclear Liabilities Management
Necsa:	South African Nuclear Energy Corporation Ltd Pty
URS:	User Requirement Specification
DS:	Decontamination Services
SCADA:	Supervisory Control and Data Acquisition
HMI:	Human Machine Interface

5.0 BACKGROUND

Approximately 14 000 tons of ferrous and non-ferrous uranium contaminated and potentially contaminated metals are stored on the Pelindaba site. These metals cannot be effectively decontaminated by conventional means nor can it be sufficiently proven that the contamination levels are within the clearance criteria [2].

As part of Necsa waste management programme a project proposal has been made to construct and operate a smelting facility in Area 26 on the Pelindaba East site. The aim of the Smelter is to decontaminate metals and reduce the volumes by clearing the metals for reuse and recycling purposes.

The melting facility consists of two 4 ton induction furnaces which will need to be lined by refractory material to protect the coils from high temperatures generated inside the furnaces. This refractory linings wear during the operation of the furnaces due to high temperatures and the reactions of charge material inside the furnace and becomes very difficult to monitor the wearing of lining manually. It is for this reasons that a refractory monitoring system is required to be installed to monitor the wearing of refractory linings inside the furnace avoid unexpected explosion that may occur which may be caused by water penetrating into refractory lining cracks.

5.1 TYPES OF SCRAPS/MATERIAL TO BE MELTED IN THE INDUCTION FURNACES

5.1.1 *The following ferrous alloys will be melted:*

- Cast Iron
- Stainless Steel
- Carbon Steel
- Mild Steel
- Other ferrous alloys/metals that are available

5.1.2 *The following non-ferrous alloys will be melted:*

- Brass
- Bronze
- Nickel
- Aluminium
- Copper
- Zinc
- Tin
- Other non-ferrous alloys/metals available

5.2 FLUXES TO BE ADDED DURING THE MELTING OPERATION.

The fluxes will be added during the melting process at a certain intervals to facilitate the melting and decontamination of molten metals

5.2.1 For the ferrous melting furnace, fluxes added into the furnace while melting will typically be combination of the following:

- Bunt lime (CaO)
- Aluminium Oxide (Al₂O₃)
- Silica (SiO₂)

5.2.2 For the non-ferrous melting furnace, fluxes added into the crucible while melting will typically be a combination of the following:

- Calcium Fluoride (CaF₂)
- Potassium Chloride (KCl)
- Barium Chloride (BaCl₂)
- Lithium Fluoride (LiF)

5.3 TYPES OF REFRACTORY LINING TO BE INSTALLED IN THE FURNACE TO MELT FERROUS SCRAPS

The refractories to be considered for lining the Induction Furnace crucible are composite refractories of alumina (Al₂O₃) and spinel of Mg(Al,Cr)₂O₄^[1]

6.0 REFRACTORY MONITORING SYSTEM USER REQUIREMENT

The system should be able to achieve the following on the 125 kg Pilot Plant Induction Furnace and 2-off 4 ton Induction Furnaces:

- Provide continuous monitoring
- Provide refractory thickness measurements and anomalies detection
- Display, control and view measurements from the SCADA/HMI
- Protect the water-cooled copper coil from liquid metal penetration through the monolithic refractory lining in the sidewall to prevent metal run-outs and furnace explosions.
- Monitor the refractory sidewall lining wear over the full height of the water cooled copper coil.
- Monitor the refractory sidewall lining wear in segments.
- Provide calibration conditions for different liquid metal grades/alloys
- Provide protection against potential bridge formation.
- Provide protection against furnace cooling water leaks.
- Interface with the furnace control system to trip the furnaces under selected alarm conditions.
- Maximize service life of refractory material without any risk (monitor refractory performance).
- Provide accurate predictions of the refractory campaign life wear during operating conditions.
- Provide a user-friendly user interface for the operational and management staff in control room or furnace decks.
- Provide an early alarm warning light system on furnace decks for the benefit of furnace operational personnel.
- To monitor any hotspots and display lining thickness measurement on the SCADA
- Provide historical trends (automatic storage of long term trending data) for advanced monitoring, analyses and reporting purposes.
- Provide remote support and after-hours services
- Provide end-user and maintenance training for operational and maintenance personnel, as well as management personnel
- Provide system replacement parts for a minimum of 10 years to be procured by the end-user.
- System warranties to be provided by the supplier
- A system/solution that uses sensors (or related) to measure remaining refractory lining thickness inside the furnace.

- Provide adjustment capability of alarm conditions, periodic inspections and emergency inspections.
- Provide flexibility to expand the system in future including software application updates.
- Provide historical and current operational references of the lining monitoring application on other coreless induction furnaces locally and/or international.

7.0 INSTALLATION OF THE SYSTEM

A successful preferred supplier in the tender bid of supplying and installing of the furnace refractory lining monitoring system will work in collaboration and cooperatively with the supplier installing refractory lining of the furnaces and the end-user.

8.0 TRAINING

- The costs of training for operational and maintenance staff should be included in the quotation or binding proposal prepared for to the end-user.
- Formal training shall be provided about the equipment/system for four (4) personnel at the supplier premises for both local and abroad. The personnel will be sourced from different department (Electrical, Maintenance, Instrumentation and Production).The training which will take place during installation, functional testing and commissioning of the system will include all Operating staff of the Smelter plant.
- Certificates of training shall be provided for each person completing the training program.
- Provide advanced user and maintenance training for operational and maintenance

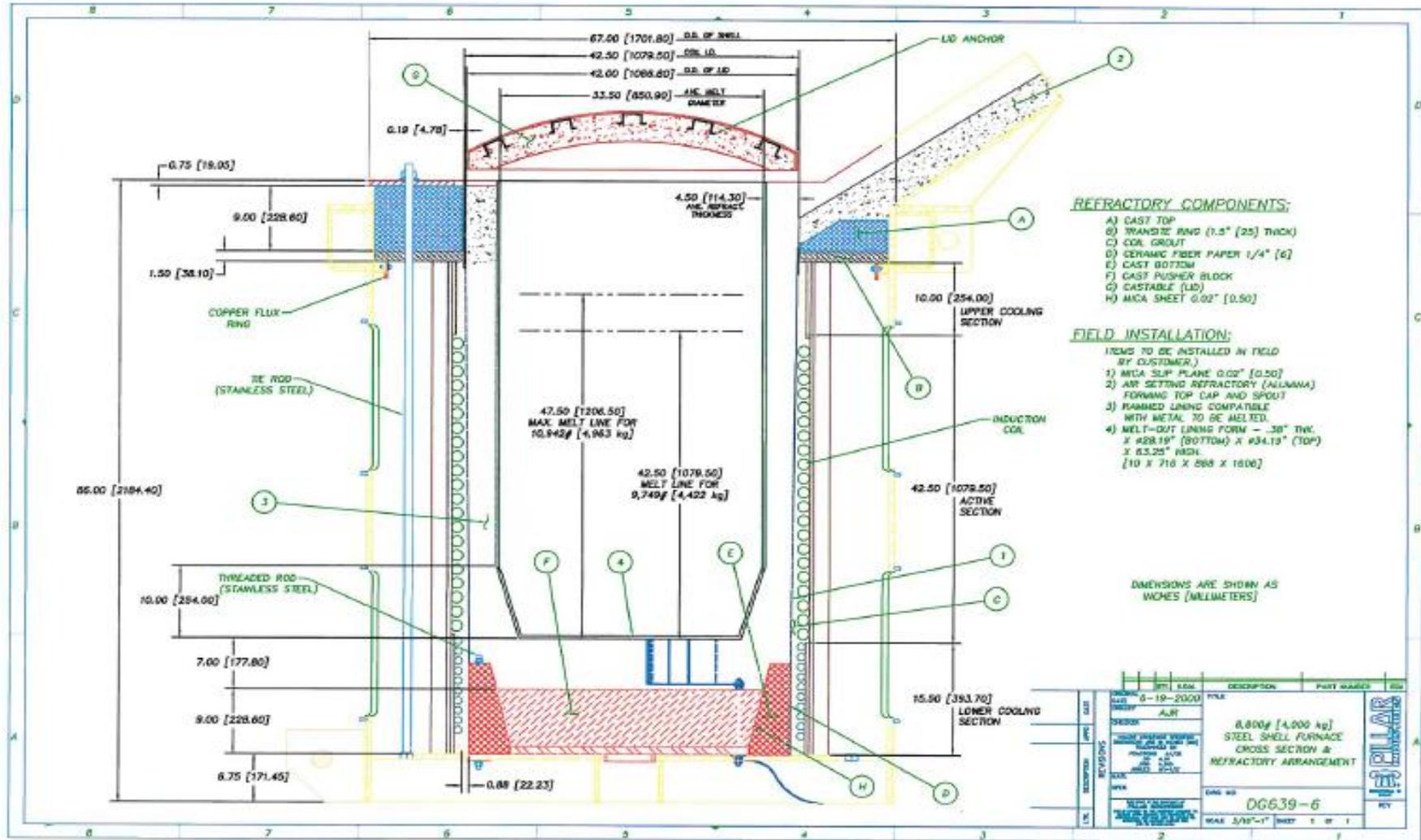
9.0 SUPPORT

- On-site Start-up Support services for first two (2) weeks and remote daily dial up support for the first two (2) months should be provided by the supplier on the user's site.
- Maintenance support of the system to be provided by the supplier as per the supplier's normal required schedules.
- The Supplier shall notify the User of preventative maintenance system improvement availability.

10.0 TECHNICAL SUPPORT

- Technical support shall be available via telephone for a period agreed between the supplier and end-user following the procurement of the system/equipment.
- A recommended replacement parts/spare parts list including all long lead items shall be provided.

ANNEXURE A



REFRACTORY COMPONENTS:

- A) CAST TOP
- B) TRANSFER RING (1.5" [25] THICK)
- C) COIL CRUIT
- D) CERAMIC FIBER PAPER 1/4" [6]
- E) CAST BOTTOM
- F) CAST PUSHER BLOCK
- G) CASTABLE (LD)
- H) MCA SHEET 0.02" [0.50]

FIELD INSTALLATION:

- ITEMS TO BE INSTALLED IN FIELD BY CUSTOMER:
- 1) METAL SLIP PLANE 0.02" [0.50]
- 2) AIR SETTING REFRACTORY (ALUMINA) FORMING TOP CAP AND SPOUT
- 3) RAMMED LINING COMPATIBLE WITH METAL TO BE MELTED.
- 4) MELT-OUT LINING FORM - .38" THK. X #28.19" (BOTTOM) X #34.19" (TOP) X 83.25" HIGH [10 X 716 X 268 X 1600]

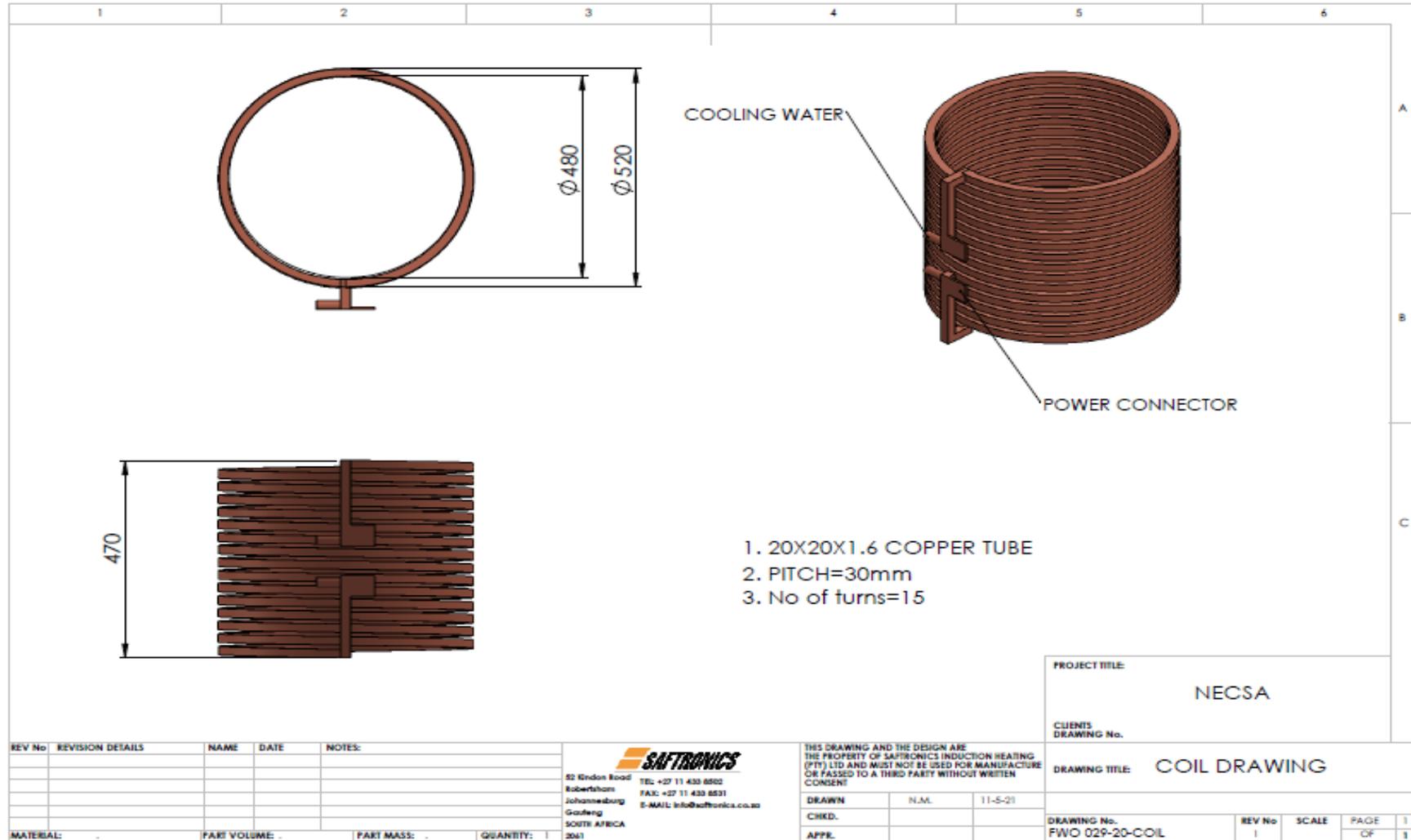
DIMENSIONS ARE SHOWN AS INCHES (MILLIMETERS)

REV.	DESCRIPTION	DATE	BY	CHECKED
1	ISSUED FOR CONSTRUCTION	08-19-2020		
2	REVISION			
3	REVISION			
4	REVISION			
5	REVISION			

DATE	08-19-2020	FILE	
DESIGN	AJR		
DESCRIPTION	8,800g [4,000 kg] STEEL SHELL FURNACE CROSS SECTION & REFRACTORY ARRANGEMENT		
DATE		DWG NO.	06639-6
SCALE	3/16"=1"	SHEET	1 OF 1

ANNEXURE B

a) Drawing 1:



b) Drawing 2:

