EMPLOYERS REQUIREMENTS

1. Scope of Work

This document defines the employers requirements as per FIDIC Yellow Book (2017 edition) to design, construct, supply and erect a replacement of the compromised boiler stack at Illovo's Sezela Sugar Mill. The stack has reached the end of its life and needs to be demolished. The new stack that is to be designed and constructed must comply with a specification as set out in these requirements.

Existing Boiler Stack to be replaced

All work to be performed as set out in this requirement must be clearly defined to avoid any change orders or schedule delays later. The appointed contractor is responsible for furnishing and erecting all materials (if applicable), and for providing the supervision, labor, tools, and transportation required for the work specified.

The existing brick stack is to remain in operation whilst the replacement stack is to be constructed. The contractor shall make provision for tie - ing into the existing ducts during the course of the operational crushing season that shall be from April - December 2023.

The figure below indicates the position of the new stack relative to the existing stack that will remain in operation up to the completion of the new stack.

Proposed position of new stack shown in blue

2. Site Requirements

2.1 Location

The site will be Illovo Sugar's Sezela Sugar Milling Operation

2.2 Construction Parking

Construction-parking areas shall be identified to provide sufficient parking for all construction personnel. Construction-parking areas may need to be maintained throughout the construction process and restored to the original condition after construction.

2.3 Access Roads

Vehicular access will be as per the general factory site access. The contractor shall ensure that all activities associated with the scope of works requirements shall be adequate to ensure the sole use of this access point.

Google Earth Imagery of the Plant in Sezela with the location of the existing stack in red

2.4 Laydown Areas

The contractor shall advise within his offering requirements for a suitable laydown area. The consideration shall consider (but not limited to) the following requirements

- Adequate area for construction-material storage
- Provisions for substantial, weather-tight enclosures (if necessary for storage of materials)
- Control of temperature and humidity according to manufacturers' recommendations
- Platforms, blocks, or skids to protect materials from soiling or staining
- Provisions for fabrication areas and/or enclosures if substantial on-site prefabrication/assembly activities are planned.

2.5 Safety Barrier

The contractor is required to comply with all the requirements of the Occupational Health & Safety Act (Act 85 of 1993) and its associated regulations as well as the relevant Illovo Sugar Safety Stipulations as required and advised.

The contractor in this regard, shall provide for a safety barrier around the base of the chimney, which would protect personnel working below from falling objects. The barrier shall demarcate a 20 m wide safety zone around the base of the boiler stack during its construction and erection.

Due consideration needs to be given to a debris net on the outside of the chimney shell to catch falling objects during construction and erection.

2.6 Temporary Facilities

The contractor shall furnish, install, and maintain temporary utilities required for construction, safety, and security in addition to those offered by site should he/she deem it necessary. These shall in include (but not limited to)

- water distribution, drainage, dewatering equipment
- enclosure of work, heat, ventilation
- electrical power distribution
- lighting
- hoisting facilities

3 Design and Construction Requirements

3.1 General

The employer's requirements call for a new/stack system to be designed, supplied and erected to replace the existing boiler stack. This section of the bid specifications includes minimum standards for design, materials, and construction. The contractor shall be responsible for the detailed thermo - hydraulic and structural design of the stack and associated sub assemblies.

The stack shall be free standing, multi - flue, uninsulated steel fabricated type with suitable liner.

The stack will be required to accommodate the flue gas from dual fired bagasse boilers that feed the stack individually. The multi - flue nature of the stack is to accommodate the two boilers and minimize the effect of combustion disturbances that one may have over the other in a common stack type design.

The thermo - hydraulic design shall aim to limit the potential for stack liquid discharge (SLD). The stack shall be designed using materials that are acceptable for the wet corrosive environment; shall incorporate design characteristics that minimize the potential for droplet re-entrainment back into the gas flow; and can be designed to operate within the range of gas velocities recommended for the stack-liner material use. Although the processes controlling the design of an effective stack system are well understood, much of the re-entrainment potential for a particular unit is site-specific, and a physical-flow-model study for each installation is highly recommended. Such a study will evaluate liquid re-entrainment and liquid collection in the ductwork and liner, based on the design of the actual unit and anticipated gas velocities**.**

3.2 Flue Gas Composition

The flue gasses liberated during wet bagasse combustion in addition to the oxygen that is contained in the excess air on a mass basis is indicated in the table table below (for typical values). The total amount of flue gasses that liberated during wet bagasse combustion is 4.22 kg/kg of bagasse

Nr.	Composition	Percentage (kg/kg)	Products	Mass of flue gasses (kg)
1	Carbon (C)	0.225	CO_2	0.825
2	Hydrogen (H_2)	0.03	H_2O	0.27
3	Oxygen (O_2)	0.23	O_2	0.23
4	Nitrogen (N_2)	-	N_2	2.4
5	Moisture (H_2O)	0.5	H_2O	0.5
6	Ash(A)	0.015	A	-
7	Total			4.225

Flue gas analysis of wet bagasse

The contractor shall be responsible for confirming the site specific flue gas temperature, composition and flow rates to complete his / her design.

3.3 Stack Dimensions

The steel stack shall approximate a cylindrical shape. The stack should be at least 5 meters taller than the surrounding area within a 150 meter radius. The diameter of the stack shall be selected so that the exit velocity never exceeds 30 m/s. The optimum range of velocity may be taken as between 15-20 m/s.

The height of the stack must also be selected such that it complies with the *National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004).*

3.4 Thermal Expansion

The stack will be subjected to differential expansion between its various elements. The design of the stack needs to address the following areas via suitable expansion joints (but not limited to) to limit the damaging effects of differential expansion:

- The joint between the external and internal shell of a dual wall associated with a multi - flue stack
- All platform, catwalk and ladder attachments brackets
- At the stack top and truncated cone
- Any or all connections that involve the use of dissimilar materials (and associated differential expansion coefficients)

3.5 Structural Design

3.5.1 Loadings

The associated loadings for the design of the stack shall be based upon the requirements of *SANS 10160*:

- Part 1 - Basis of structural design
- Part 2 - Self weight and imposed loads
- Part 3 - Wind actions
- Part 6 - Actions induced by cranes and machinery
- Part 7 - Thermal actions
- Part 8 - Actions during execution

The dead load shall consist of the weight of steel stack, coatings, internal liner, insulation, and cladding, and all permanent accessories such as ladders, platforms,

and gas sampling equipment. The applied weight of the refractory material shall be used to calculate dead load stresses

3.5.2 Shell Design

The design of the shell shall conform to *SANS 10162*. The design shall shall be of the welded construction.

3.5.3 Shell Material Consideration

The structural steel shell of the stack shall be fabricated from material conforming to *SANS 1431*, e.g. 350WA steel plate. The materials are to be sized to accomodate a minimum corrosion allowance of 6 mm.

3.5.4 Bolts, nuts and washers

All nuts, bolts and washers shall conform to the requirements of *SANS 1700 & SANS 10094* unless otherwise stated.

3.5.5 Wind excited oscillations suppression

Boiler stacks are subject to vibrations due to wind induced flow fields around the stack that cause periodic vortex shedding (Von Karman vortices). These oscillations can reduce the life of the stack due to the fatigue loading.

Various suppression devices exist which are designed to alter the flow field around the cylinder to prevent periodic vortex shedding. These include helical strakes, shrouds, and variation of structural parameters such as wall thickness and diameter.

Preference shall be for a helical strake to be fitted to the stack as indicated in the figure The helical strake shall consist of a three-start set of curved-plates attached to the outer surface of the stack. These strakes shall be 120^{o} apart with the strake plate approximately perpendicular to the stack surface at all points. The pitch of the helix should be five times the diameter of the stack. The helical strake is to be aerodynamically continuous. The presence of helical strakes significantly increases the drag forces which shall be incorporated in the loading analysis. Segments of flat vertical strakes at helical locations are not acceptable methods for disrupting vortices

Boiler stack with helical strakes to limit vibration associated with wind induced periodic vortex shedding

4 Access Doors & openings

Access doors are usually specified for the chimney liner at floor level or in the stack inlet ductwork for cleanout and maintenance. Access shall be required in the stack shell for annular platform and test-port access.

Openings shall be provided in the stack to allow for isokinetic sampling as per the *National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004).*

Any opening associated with providing access to the stack enclosure shall be reinforced. Reinforcement stiffeners shall be placed normal to the shell and concentrated along the edge of the openings and shall be sized and fabricated as per *SANS 10162*.

5 Platforms & Ladders

Platforms and associated ladders are required for general inspection of the stack and to gain access to specified test ports.

The general arrangement and position of these platforms and ladders shall comply with the *Occupational Health & Safety Act (Act 85 of 1993)*.

6. Stack Liner

Linings for the interior of the steel stack may be required to provide resistance to corrosive gasses, vapors, or condensates; to provide resistance to heat; and to maintain stack surface temperatures for the prevention of condensate corrosion.

The stack-liner diameter should be based on the recommended gas velocities to accommodate the liquid downflow on the liners.

Preference shall be given to a castable refractory type liner material conforming to the requirements *ASTM F1097-17(2022) - Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting).* Alternative liner materials and liner designs shall be considered provided it exceeds the existing requirement in terms of life cycle costing.

The design of the stack shall be cognisant of the stresses induced via the differential expansion of the liner material and the stack shell and shall make specific allowance in the design to cater for these expansions.

7. Mechanical

Provision shall be made for all pipes, fittings, hangers, supports, and accessories required to complete any stack drain-piping systems. These pipes shall be tied into the existing facilities that provide for this duty.

8. Electrical

8.1 General

The electrical scope includes provisions to furnish and install all electric equipment, wiring (including plant-interface wiring),grounding, and lighting necessary associated with the new stack.

8.2 Obstruction Lighting

Provision shall be made installing obstruction lighting including temporary obstruction lighting during construction as per the requirements of the *South African Civil Aviation Authority (SACAA).*

9.2 Lightning Protection System

Provision shall be made to supply and install a complete stack lightning-protection system, including a below grade, stack-ground system as per the requirements of *SANS 10313.*

10. Civils

The reinforced concrete foundation for the stack shall be designed for all cases of loading, any foundation movement or rotation will cause partial or total collapse. The connection of the shell to the concrete foundation or to the supporting structure should resist the overturning moment, normal force and shear force developed at the shell base and transmitted to the foundation.

The foundation design shall conform to the requirements of SANS 10100 1 -2, SANS 1200 & SANS SANS 10400-H.

11 Terminal Points

The terminal points for the project will be as follow:

Ducting:	Flanges that currently connects the existing stack to the boiler
Piping:	Flanges of all existing piping to be tied into.

11 Warranties and Guarantees

The warranties shall be as per the requirements of *FIDIC Yellow Book (2017)* whilst performance guarantees shall be as per the requirements of *BS EN 13084-1:2007 Free-standing chimneys. General requirements.*

12 Documentation

Documentation that confirms the adequacy of the design shall be provided during project handover and completion. The calculations confirm that the design was performed in accordance with the codes, standards, and specification requirements specified. These shall include.

Stack Foundation

- Foundation layout and size

- Foundation loads
- Soil-bearing pressure load or pile loading
- Factor of safety against overturning
- Radial and tangential design moments
- Radial and tangential reinforcing-steel requirements
- Shearing-stress calculations
- Drawings detailing the foundation layout

Stack Shell

- Wind analysis and resulting loads
- Dynamic seismic analysis and resulting loads
- Column geometry, including diameters and wall thicknesses
- Column deflections
- Thermal stresses
- Structural design
- Drawings detailing its construction and layout

Stack Liner

- Liner geometry, including diameters and wall thicknesses
- Joint/weld specifications