



Part C3: Scope

***Employer's Scope for the
Engineering and Construction of Facilities to House Pilot Plant Equipment for the BIDF***

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1. INTRODUCTION

The Council for Scientific and Industrial Research (CSIR) (*Employer*) has taken a lead on the research and development of biorefining in South Africa intending to aid the country to develop and test this technology in a South African context. In 2016 the CSIR built a pilot-scale biorefinery in Durban to allow them to develop the technology and evaluate industrial biomass challenges.

CSIR require a *Contractor* to provide the Engineering, construction, procurement, installation and commissioning of a facility to accommodate additional equipment at the Biorefinery Industry Development Facility (BIDF) in Durban (eThekweni). This additional equipment will be supplied by the *Employer* unless expressly stated in the Works.

2. LIST OF ABBREVIATIONS

ITEM	ABBREVIATION/DEFINITION
AFC	Approved for Construction
AFP	Approved for Purchase
AIA	Authorized Inspection Authority
ANSI	American National Standard Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BEE	Black Economic Empowerment
BO	Beneficial Operation
BOM	Bill of Materials
CADD	Computer Aided Drafting and Design
CE	Compensation Event
CWP	Construction Work Package
DB	Distribution Board
DC	Direct Current
DCS	Distributed Control System / the DCS provides the requisite process control.
DEP	Detail Engineering Package
EOJ	End of Job
EPC	Engineering, Procurement and Construction
ESD	Emergency Shutdown System / the ESD implements the required 'critical' trips and
EW	Early Warning
FAT	Factory Acceptance Testing

ITEM	ABBREVIATION/DEFINITION
FEA	Finite Element Analysis
FFW	Field Fit-up Weld
FMEA	Failure Mode and Effect Analysis
FTA	Field Terminal Assembly
FW	Field Weld
GA	General Arrangement
HP	High Pressure
HVAC	Heating Ventilation and Air-Conditioning
IBL	Inside Battery Limit
IR	Industrial Relations
IS	Intrinsically Safe
ISA	Instrument Society of America
ISO	International Standards Organisation
Iso	Isometric Drawing
LP	Low Pressure
LV	Low Voltage
MAWP	Maximum Allowable Working Pressure
MFD	Mechanical Flow Diagram
MP	Medium Pressure
MT	Magnetic Particle Testing
MV	Medium Voltage
MVA	Mega Volt Amps
MW	Megawatt
NCR	Non Conformance Report
NDE	Non-Destructive Examination
NDT	Non-Destructive Testing
NEC	New Engineering Contract
NFPA	National Fire Protection Association
NOSA	National Occupational Safety Association
OBL	Outside Battery Limit

ITEM	ABBREVIATION/DEFINITION
OHS ACT	Occupational Health and Safety Act, Act Number 85 of 1993 as amended
PAS	Plant Automation System
PDA	Potential Deviation Analysis
PFD	Process Flow Diagram
PID	Process and Instrument Diagram
PLC	Programmable Logic Controller
PMI	<i>Project Manager's</i> Instruction
PSV	Pressure Safety Valve
PVP	Potential Variation From Plan
PWHT	Post Weld Heat Treatment
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
QMS	Quality Management System (of the <i>Employer</i>)
RACI	Responsibility/Accountable/Consult/Inform Matrix
RAM	Reliability, Availability and Maintainability
RFC	Ready of Commissioning
RFO	Ready for Operation
RFQ	Request for Quotation
RT	Radiographic Testing
RUI	Relied Upon Information (Detail Engineering Package)
SANS	South African Bureau of Standards
SAT	Site Acceptance Test
SDE	Semi Definitive Estimate
SHER	Safety, Health, Environment and Risk
SPIR	Spare Parts and Interchange ability Record
TSV	Temperature Safety Valve
UFD	Utility Flow Diagram
UPS	Uninterruptible Power Supply
UT	Ultrasonic Testing

ITEM	ABBREVIATION/DEFINITION
V	Volts
VAC	Volts Alternating Current
VIP's	Value Improvement Practices
VP	Variation from Plan
VSD	Variable Speed Drive
WBS	Work Breakdown Structure
WPS	Welding Procedure Specification
WRC	Welding Research Council

3. LIST OF DEFINITIONS

Term	Definition
Commissioning	Commissioning comprises those activities (potentially hazardous) necessary to prepare the <i>works</i> and facilities for the first introduction of feedstock for production purposes. Commissioning activities typically include: fitting of orifice plates; fitting and later removal of temporary strainers; tightness testing; chemical cleaning (in sections where this was not done during pre-Commissioning); furnace dry out; compressor run-in; water circulation/runs; instrument functional testing. All Commissioning work needs to be completed prior to RFO and subsequent start-up.
Construction Manager	A competent person responsible for the management of the physical construction process, the coordination, administration and management of resources on a construction site.
<i>Employer's</i> Specifications and Documents	The specifications of the <i>Employer</i> , used by the <i>Project Manager</i> , the <i>Contractor</i> , Subcontractors and Others to Provide the Works. This also includes all drawings, attachments, currently enforced industry codes and standards, including those listed in Providing the Works. Latest revisions of all relevant specifications needs to be made available by the <i>Employer</i> at the kick-off meeting.
End Of Job Documentation	Documents identified to enable the operating partner to own, operate, maintain and modify the plant within its assigned responsibilities at optimum life cycle cost.
<i>Employer's</i> Security	The <i>Employer's</i> Security officers and infrastructure around the <i>Employer's</i> Site

Term	Definition
Handover	<p>Handover constitutes change of ownership and ensures completion. It confirms that the constructed facilities are safe to commission and operate.</p> <p>Handover is therefore a process and the responsibility of the <i>Contractor</i> to manage and sell the completed facilities to the <i>Employer</i>.</p> <p>The <i>Contractor</i> completes the <i>works</i> consistent with AFC, MFD's and other engineering drawings applicable to this contract, contractual specifications and standards, and any agreed concessions, in a staged sequential manner to facilitate checkout of equipment and facilities and to best support Commissioning activities.</p>
Handover Manual	<p>The Handover Manual:</p> <ul style="list-style-type: none"> ensure easy and smooth testing, inspection and handing over of the Test Packs; define the basic handover principles such that they are suitable and specific to this project provide methods to monitor the progress of each part of the section/ sub-section to achieve Mechanical Completion (MC), Electrical Completion (EC), Instrumentation Completion (IC), Practical Completion (PC), Ready for Commissioning (RFC); define, in line with the Terms of the Contract, the split of responsibilities between the <i>Contractor</i> and the <i>Employer</i> project team in executing of the <i>works</i> assignments, as the Plant or part thereof are being completed; define the protocol forms necessary to communicate to/from Commissioning the status of completeness of each part and of the whole Plant; define the flow-chart of documents and acceptances necessary to declare the plant ready for Commissioning; facilitate the recording of any transfer of responsibility from <i>Contractor</i> to <i>Employer</i> for the care, custody and control of the <i>works</i> or part thereof;
Mechanical Completion	<p>When the construction work for the mechanical equipment and/ or piping, including specified painting and insulation within a system, unit or sub-section has been completed in accordance with the AFC, MFD's and other engineering drawings applicable to this contract, applicable specifications and all non-operating tests to ensure compliance of the specifications have been successfully carried out.</p> <p>Mechanical Completion is confirmed / signified by the <i>Project Manager</i> signing off the certificate of Acceptance of Mechanical Completion for a system, unit or sub-section.</p>
Permit to Work System	<p>The <i>Employer's</i> system which authorises work at the Site under the legal responsibility of the <i>Employer</i>.</p>
Project Management Team	<p>The <i>Employer's</i> project management group responsible for overall management of the Project</p>

Term	Definition
Pre-Commissioning	<p>Pre-Commissioning comprises those activities carried out prior to the <i>Contractor</i> submitting the <i>works</i> for handover, to prove that the <i>works</i> have been properly specified, constructed, erected and cleaned.</p> <p>The Pre-Commissioning activities are non-operational (and non-hazardous) checks and tests and typically include: quality control checks; correction of Defects; hydrostatic testing; flushing of vessels and piping; motor bump tests and uncoupled runs; alignment of rotating equipment; instrument loop-checking; lubrication of motors, pumps and gearboxes; site clean-up. These activities, amongst others, are the responsibility of the <i>Contractor</i>.</p> <p>The <i>Employer</i> may specify certain of these activities which he wishes to witness and includes:</p> <ul style="list-style-type: none"> Flushing and Blowing Vessel Internal installations Vessel Internal cleanliness inspections Vessel box-up Instrument calibration <p><i>Employer</i> checkouts of the <i>works</i> are also to be regarded as a pre-Commissioning activity. The <i>Employer</i> participates in all the checkouts. The <i>Contractor</i> is responsible for the planning and management of such check-out and subsequent correction of punch items.</p> <p>Pre-Commissioning activities can be performed pre or post MC/ IC/ EC/ PC, depending on the contractual work of the <i>Contractor</i>, but to be completed prior to RFC.</p>
Punching	<p>The process where the completed work is systematically reviewed by the <i>Employer</i> and <i>Project Manager</i> for compliance to the Approved for Construction engineering drawings including the as-built <i>work</i> and the agreed upon Specifications and Standards.</p>

Term	Definition
Ready for Commissioning	<p>When the construction work for all the <i>works</i> required for the safe Commissioning of a unit or sub-section has been completed in accordance with the AFC drawings and specifications, and all non-operational (non-hazardous) testing to ensure compliance with the specifications has been successfully carried out.</p> <p>Ready for Commissioning is confirmed / signified by the <i>Employer</i> and the <i>Employer</i> representative signing-off the Certificate of Acceptance of Ready for Commissioning for a unit or sub-section, and encapsulates the various PC, IC, EC and MC Completion forms for that unit or sub-section.</p> <p>It signifies the commencement of the potentially hazardous commissioning activities (and continuation of those which may already be in progress) necessary to prepare the unit or sub-section for start-up activities.</p> <p>At RFC if the <i>Employer</i> signs Handover then the <i>Employer</i> has full control of the sub-section and can commence with the potentially hazardous Commissioning activities (and continue with those which may already be in progress) necessary to prepare the sub-section for start-up.</p> <p>If Handover is not signed at RFC the section or sub-section remains within the <i>Contractor's</i> responsibility. The reason for not signing Handover at RFC is to give the <i>Contractor</i> more freedom in completing the construction and avoiding unwanted permit conditions. However the Commissioning activities commences at RFC and alignment then is required on what type of Commissioning activities can commence. This also caters for more flexible handover scenarios.</p> <p>All agreed EOJ documentation is available and transferred to Operations.</p>
Security	<p>The <i>Employer's</i> Security Department and personnel who controls access to the <i>Employer's</i> Site</p>
Test Pack	<p>A Test Pack is part of a System and comprises of only mechanical equipment and piping. The objective of splitting a System into test packs is to facilitate staged construction completion, <i>Employer</i> checkout (Punching), and handover and acceptance of mechanical equipment and piping. A System may comprise a variety of mechanical test packs items with different hydro test pressures.</p>
Unit, Plant or Work-pack	<p>A Unit comprises the equipment, piping and all support facilities, within defined battery limits, required to carry out a specific process from defined raw materials to produce specific products. For typical new projects, the term "Plant" may be used as a synonym. A unit can operate on its own. Work Pack may be used instead of Unit or Plant.</p>
Work permit	<p>The Permit from the <i>Employer</i> specifying the exact conditions under which the <i>Contractor</i> works under. The permit states current conditions on handover to the <i>Contractor</i> and all procedures and safety items to be adhered to while <i>Contractor</i> Provides the Works. It is stipulate work which forms part of the <i>works</i>.</p>

4. DESIGN BASIS

The design basis serves to define the project requirements and design specifications for all associated facilities.

UNITS OF MEASURE AND REFERENCE CONDITIONS

The units of measurements used during all aspects of the design should comply with the following:

- Standard International (SI) units and symbols shall be used in all documents, drawings, and specifications.
- The use of commas or points to separate groups of digits is not acceptable.
- Dimensions on drawings shall be expressed in millimetres unless indicated otherwise.
- Certain nominal sizes of commercial items manufactured to a recognised national standard shall be expressed in units of the defining standard and no conversions to SI units need be made.

The following temperatures and pressure shall be used as reference conditions:

- Standard condition refers to a temperature of 15.56 °C and pressure of 101.33 kPa(a).
- Normal condition refers to a temperature of 0 °C (273 K) and a pressure of 101.33 kPa(a).

5. SITE CLIMATE DATA

Table 5-1 summarise the site condition in Durban, KwaZulu Natal South Africa obtained from Google Earth, and Weather Spark (<https://weatherspark.com/>).

Table 5-1 Climate conditions at Durban, South Africa

Site Geology Data		
Site Location		29°52'16.63"S 30°58'41.82"E
Site Elevation	m	105 – 108
Design Ambient Condition (Site Rating)		
Design Ambient Pressure	kPa	101.8
Average Ambient Temperature	°C	13 – 27
Design Maximum temperature	°C	40
Design Minimum temperature	°C	5
Relative Humidity	%	79.1 (Annual Basis)
Maximum Relative Humidity	%	83
Design Snow Load	kg/m ²	0
Prevailing Wind Direction	-	South
Average Wind Speed	m/s	3.54 (Annual basis)
Basic wind speed (SANS-10160-3)	m/s	36
Seismic Region	MMI	N/A
Peak acceleration (SANS-10160-4)	m/s ²	<0.75

6. DESIGN DATA AND RELIED UPON DATA

PIECES OF EQUIPMENT

The plant installation scope to be implemented for the BDF expansion Project are summarised in the points below:

Installation of the following new pieces of equipment, in the new building facility as described in the Civil and structural Works scope: The listed items below is already supplied by the *Employer* and is “free issue” items for the *Contractor*, with the exception of the Marshall Fowler ES20 electric steam boiler which needs to be procured by the *Contractor*. It is the *Contractor’s* responsibility to obtain, lift and transport these items into their designated locations.

Table 6-1 Equipment specifications and recommendations.

Equipment Name	Dimensions	Utility	Value	Remarks
Parr stirred digester (19 L) – floor-standing	Length:2.5 m	Water	-	-
	Width: 2.4 m	Compressed air	6 bar(g)	
	Height: 2.4 m	Nitrogen	-	
		Electrical	220V	
Low Consistency refiner system – floor standing	Length:3.8 m	Water		Should also be provided with the option for disposing of the content and/or preventing the spillage (during a process upset)
	Width: 3.5 m	Compressed air	6 bar(g)	
	Height: 3.2 m	Electrical	380 V	
Screen – Floor standing	Length:1.9 m	Electrical	220 V	-
	Width: 1.6 m			
	Height: 1 m			
Bench-scale biochar unit – Floor standing	Length:3 m	Electrical:	Single phase & N 220V 50Hz	-
	Width: 1 m			
	Height: 2.1 m			
	Length:1.9 m	Electrical	220 V	-

Equipment Name	Dimensions	Utility	Value	Remarks
Laboratory woodchipper – Floor standing	Width: 1.3 m			
	Height: 1.6 m			
RDH digester – Floor standing	Length: 4 m	Cooling water	Max Flow 30 LPM Min Pressure 3 bar(g) Max Pressure 6 bar(g)	The pilot will release cooling water and dirty liquids – these drains can be separated by hose from pilot to collection points. Drain canals are recommended.
	Width: 2.2 m	Demin water	Max Flow 15 LPM Min Pressure 4 bar(g) Max Pressure 8 bar(g)	
	Height: 3.5 m	Compressed air	Min 6 bar(g) Max 8 bar(g)	The pilot hall will need good ventilation. Consider extra suction points near drain outlets and digester vessel, but this is not strictly required.
		Nitrogen	Low consumption Min 18 bar(g) Max 22 bar(g)	
		Electrical	3 Phase 380-480 VAC 50/60 Hz	Future expansion: Support area will also contain a washing and pulp screening unit. The recommended support area is 10 to 15 m ² .
		Steam	Max Flow 30 g/s Min Pressure 10 bar(g) Operating Pressure 12 bar(g) Max Temp 200 °C Operating Temp 200 °C	

Equipment Name	Dimensions	Utility	Value	Remarks
Flow-through digester (300 L)- Floor standing	Length:1.3 m	Water	-	Maximum operating pressure is 8 bar, and the maximum operating temperature is 180 °C. Additional height is required to allow loading and offloading digester using an overhead crane.
	Width: 1.8 m	Compressed air	6 bar(g)	
	Height: 2.14 m	Electrical	380V	
	Total height required: >5 m	Steam: Used for pre-steaming/extraction	-	
Hemp cleaner – Floor standing	Length:1.25 m	Electrical		-
	Width: 0.8 m			
	Height: 1.32 m			
Steam Generator (Boiler) – Floor standing	<i>Contractor to procure specified Unit.</i>	Electrical	Marshall Fowler ES20	Steam Generator (Boiler) to be used to supply steam to: –RDH digester (108 kg/h) –300 L flow through digester –Future expansion Estimated total steam capacity 400kg/h. Should be supported by demineralised water and condensate recovery system. Boiler to meet BDF operation and safety needs. CSIR Safety Manager and GMR 2.1, should be consulted.
Wastepaper recycling pilot – Floor standing	Length:3.1 m	Water		The pilot plant will need to be 0.5 m above the floor.
	Width: 3.4 m	Hot water		

Equipment Name	Dimensions	Utility	Value	Remarks
	Height: 2.25 m			Drain to be included. The provision of a dewatering unit should be considered.
Dewatering unit	N/A	N/A		Used with Wastepaper recycling pilot
Pilot-scale biochar unit –Floor standing (Excludes control unit).	Length:3.763 m	Cooling water	TBC	Future expansion for the wood vinegar recovery system should be considered.
	Width: 10.010 m	Electrical	3 phase & N 380 V	
	Height: 4.693 m			
Valley Beater – Floor standing	Length:1.5 m	Electrical:	TBC	-
	Width: 0.97 m			
	Height: 1.37 m			
Willey mill – Bench Mounted	Length: 1.9 m	Electrical	220 V	Shares Same bench area
Shaker - Bench Mounted	Width: 1.3 m			
Pulp Fluffwe Bench Mounted	Height: 1.6 m			
Pulp Screen , Pulp Washer	-	-	-	Support space should be allocated to support equipments.

7. SCOPE OF WORK

The Contractor Scope of Work is:

- Detail Engineering based off the basic engineering package as to be provided information i.e. not deemed relied upon information supplied by the *Employer*.
- Procurement
- Construction
- Pre-Commissioning activities including:
 - MC (Mechanical Completion)
 - IC (Instrumentation Completion)
 - EC (Electrical Completion)
 - PC (Practical Completion)
 - RFC (Ready for commissioning)
 - Commissioning, excluding introduction of product
 - RFO (Ready for Operation)
 - RFO to BO (Beneficial operation), including start-up and performance tests

DESIGN APPROACH

It is the intent of the Council for Scientific and Industrial Research (CSIR) that the works are completed with the minimum interruption to the operations ongoing on the site and in the buildings below and adjacent to the construction to be completed by the Contractor. The design life of the project is taken as 20 years. The preliminary design was done according to the South African National Standards (SANS).

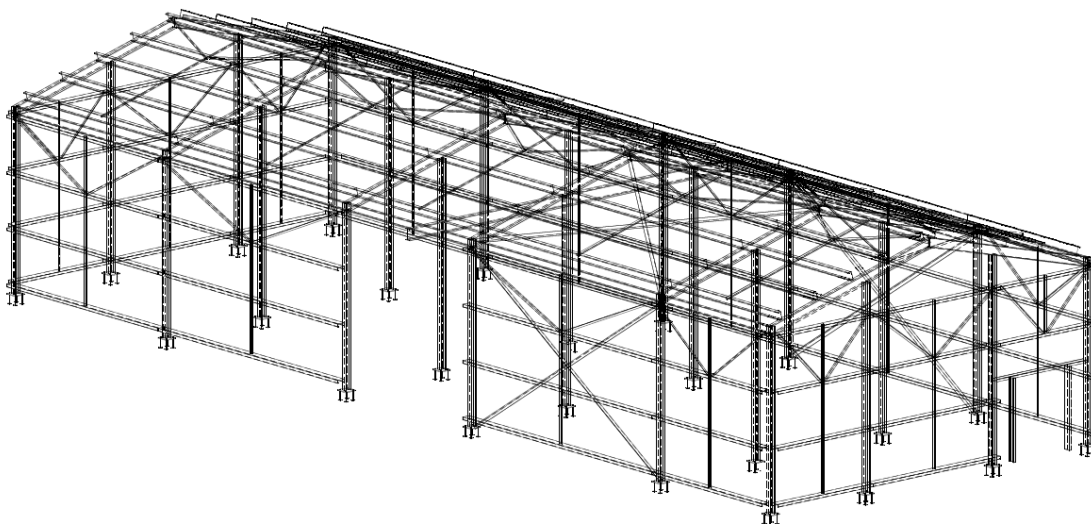


Figure 7-1 General arrangement of the light steel structure and canopy required

The Biorefinery Industry Development Facility has a concrete roof slab and is positioned as indicated in red in Figure 7-2. The roof (red) has a total space of 12 815 mm x 30 761 mm (394.2 m²) including the water gutters. From slab to slab (centre to centre) the dimension is 10 785 mm x 29 751 mm (320.9 m²).

The CSIR requires the construction of the light steel structure and canopy as indicated above to be built on top of the existing building indicated in figure 7-2 to house the BIDF pilot plant.



Figure 7-2 Aerial view of the BDF facility

The building currently hosts various lab equipment and contains most of the utility and gas lines. A new high-pressure steam line will be required.

The advantage of using the BDF area is as follows:

- Supporting utilities are available.
- Space for future expansion.

The disadvantage of using the BDF area is as follows:

- Longer construction time.
- Short period disruption of operation.

CIVIL SCOPE

The *Employer* requires a *Contractor* to construct a new light frame structural steel closed canopy above the existing concrete floor with an epoxy floor finish. This will limit additional weight on the existing structure already housing the additional equipment loading.

The additional steel structure is envisaged to have a weight of approximately 28kg/m² (purlins, sagbars and sheeting excluded), concluding to 15 ton (purlins and sagbars included). A preliminary design concluded to member sizes of:

- Columns: 152 x 152 x 30 UC
- Beams: IPE 200
- Bracing: 90 x 90 x 8 EA

All supplied and procured equipment as per table 6-1 needs to be rigged into the structure during construction. The *Contractor* is responsible for the design, supply, and fabrication of all required piping for the equipment utilities will need to be installed as per the supplied PFD's and P&ID's with all site engineering the responsibility of the *Contractor*. The *Contractor* is to submit these designs and drawings to the *Employer* for review prior to installation.

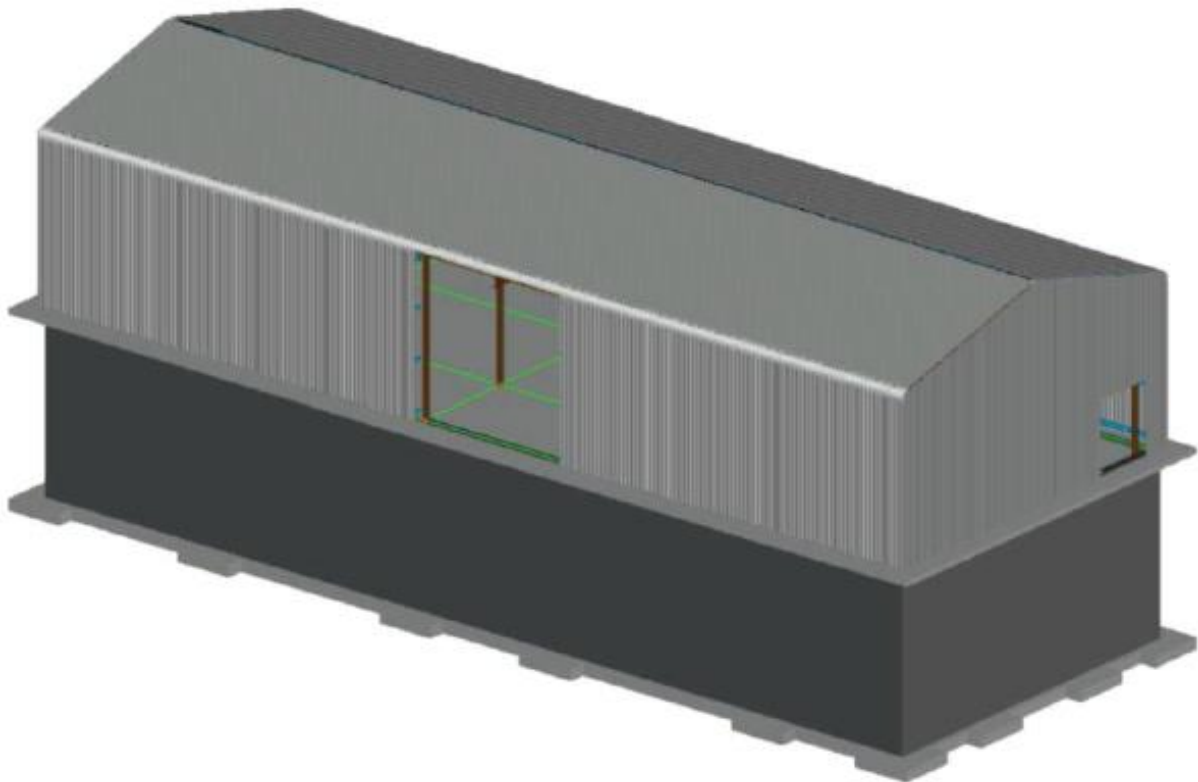


Figure 7-3 Graphical presentation of the proposed structural solution

PIPING SCOPE

Currently CSIR has two types of piping materials used for their gas and water lines. SANS 1453 – Medical Grade copper for their gas lines and SANS 460 – potable water copper tubing for their municipal and hot water lines.

The piping materials to extend these utilities to the BDF building expansion and to connect to the various equipment, was chosen to stay the same.

Some of the equipment was not designed with connections according to SANS 460 tubing standards and have therefore required the piping design and selection of ASME B31.3 compliant Stainless steel piping, to connect the utilities to equipment with matching specification.

ASME 31.3 Carbon steel piping was used to connect the steam line to the various equipment in the building.

The various piping and tubing lines are described in Table 7-1 below.

Table 7-1: Piping Material Selection

Fluid Code	Fluid	Material	Operating Temperature (°C)
CAR	Compressed Air Line	SANS 1453 Medical Cu	40

Fluid Code	Fluid	Material	Operating Temperature (°C)
NL	Nitrogen Line	SANS 1453 Medical Cu	40
MWL	Municipal Water Line	SANS 460 Cu	40
MWLB	Municipal Water Line to Biochar Cooling Water	ASTM A312 TP304	40
MWLD	Municipal Water Line to RDH Digester	ASTM A312 TP304	40
SCL	Steam and Condensate Line	ASTM SA-106	200

Piping dimensions and wall thicknesses shall be according to ASME B36.10M (Welded and Seamless Wrought Steel Pipe) for carbon steel and ASME B36.19M for stainless steel. The minimum piping size shall be 3/8".

Non-standard pipe, flanges and fittings sizes e.g., 1 1/4", 2 1/2", 3 1/2", 5", 7" & 9" (30, 60, 90, 125, 175 and 225 mm) shall not be used. If supplied equipment is fitted with non-standard nozzle sizes, a connecting piece should be fitted to immediately take the line to a standard size.

It must be noted that the SANS 1453 – Medical grade copper tube sizes are only available in imperial sizes and their wall thickness correlates to the exact same tubes as the imperial SANS 460 Class 2 copper tubes. For all extensions of the current municipal water and hot water utility lines, SANS 460 Class 2 copper tubes have been used, as the fittings for SANS 1453 and SANS 460 must meet the same standards – SANS 1067 1 and 2.

The Supplier shall secure the services of a reputable Third-Party Inspection Agency to carry out inspection and witnessing of manufacturing and testing operations in accordance with the approved Inspection and Test Plan.

All NDT shall be carried out after final heat treatment using procedures approved by the Purchaser. Dimensional tolerances shall be verified for each fitting in accordance with the specifications.

The original steel maker's certificates shall be supplied for each heat of steel used.

Test pieces, of each diameter and wall thickness are required for field welding tests

Bolting materials shall conform to ASTM A193 Grade B7 and ASTM A194 Grade 2H unless otherwise specified in the data sheet.

All gaskets shall comply with EN 1092-1/ DIN2635

Valves shall comply with ASME B16.10, ASME B16.34, ASME B31.3, API 594, API 600, API 602, API 603, API 6D or manufacturer's standard where the style of valve is not covered by an international standard and shall be as indicated on the material requisition.

INSTRUMENTATION SCOPE

Due to the intended operation of the equipment in the proposed pilot plant, no automation or control is required to open, close, or modulate any valves. The following instrumentation is however required to monitor the plant and must be supplied by the *Contractor*.

- A total of 11 additional pressure gauges are required in various locations of the plant (PG-602, PG-603A, PG-603B, PG-603C, PG-603D, PG-605, PG-606A, PG-606C, PG-607, PG-801, PG-802). These pressure gauges are used to monitor the pressure levels in the instrument air, nitrogen, and steam supply lines.
- Two additional temperature gauges are required to monitor the steam supply line for the plant (TG-801 and TG-802)
- Two additional flow meters are required (FM-504 and FM-505). The first flow meter is used to measure the amount of water used from the main water supply line and the second is used to measure the amount of hot water that is being used.

ELECTRICAL SCOPE

All power and control cables will be copper core steel wire armoured cables. All cables provided for equipment, lighting, etc. will be installed aboveground in hot-dipped galvanized cable ladders or trays. Cables installed outside shall be direct buried underground in conduits. No instrumentation or communication cables shall share cable racking with AC cables. Any cables related to fire signal or relevant electrical fire equipment shall be according to SANS 10142. See the Equipment Plot Plan and Cable Routing layout (21050-CSI-EE-DGA-001) for design detail along with the Electrical Cable Schedule (21050-CSI-EE-LST-001).

The plant lighting needs to comply with the requirements as defined in the OHS Act no.85 of 1993.

The lighting level requirements are included in the OHS Act No. 85 of 1993 GNR.2281 of 16 October 1987 with specific reference to Environmental Regulation for The Workplace, section 12 (schedule for minimum average values of maintained illuminance).

The general area lighting in accordance with the Act, as stated above, should be "safe". According to section 3, clause 4 under the Environmental Regulations for the workplace, this may be interpreted to being 0.3 lux to allow for safe movement during evacuation. However, this is raised to 20 lux (as a minimum) if any shutdown actions are required before evacuation.

The lighting design therefore includes appropriately rated light fittings for general use along with light fittings that include a battery backup for emergency situations. The Plant Lighting Design (21050-CSI-EE-LLD-001) document shows the design detail of the lighting layout.

Site Earthing and Lightning protection shall comply with SANS 10313 (2012). The new equipment for the pilot plant will be solidly earthed by connecting to the existing earthing system through the main earth bar on the ground floor. Additional earthing electrodes will be installed such that the earthing resistance of the overall building is no more than 2 Ohms. The connection to the existing earthing system is shown in the Plant Earthing Design (21050-CSI-EE-DES-001).

8. SUPPORT FUNCTIONS AND INTEGRATION

INTERFACING WITH THE OTHERS

The works needs to be executed by completing all Civil Works Contract and a Structural, Mechanical, Piping, Electrical and Instrumentation works. All work executed and or completed by Sub-Contractors will remain the responsibility of the Contractor. All damage to these services needs to be repaired at the responsible *Contractor's* own expense to the satisfaction of the *Employer*. Regular interface schedule meetings are recommended to ensure that the *Contractor* and the Sub-Contractors are aligned with each other's progress and access requirements. Site changes and rectification of these services needs to be indicated by means of the issuing of red lines and subsequent as-built drawings.

INTERFACING WITH EXISTING OPERATIONS

The items of equipment and structures needs to be constructed within the confines of an the CSIR Campus and the limited space available. All existing infrastructure is to be protected and always be required to be operational.

The *Contractor* needs to provide, with its Tender, a detailed methodology of how any work will be executed in a safe manner with minimum disturbance to the infrastructure and the operations. This methodology needs to then further be detailed post appointment of the *Contractor* and needs to be accompanied by a risk assessment for all activities around this area of the Site. All required interactions including shutdowns needs to be timeously communicated to the *Employer* and *Contractor* who provides the required permission for work to continue.

SAFE OPERATIONS

The *Contractor* provides a comprehensive qualitative risk assessment of all activities to be undertaken on site along with a safety management plan, two weeks post the placing of the order. Further to this, the *Contractor* takes all reasonable measures to ensure the safety of personnel, equipment, structures, third parties and the environment and needs to provide detailed methodologies for managing each risk in the Safety Management Plan.

SITE SECURITY

The *Contractor* is responsible for the security of all its' works on site throughout the duration of the contract period.

Any additional inclusions and exclusions are to be stated by the *Contractor* in its tender.

POLLUTION

The *Contractor* provides adequate containers with lids for the disposal of refuse. Containers be provided at the works area and at the site office. Refuse and construction waste needs to be collected and dumped by the *Contractor* at an off-site municipal refuse facility approved by the *Employer* and in accordance with the relevant *Employer* procedure. The *Contractor* ensures that his employees do not pollute any work areas with refuse.

METHOD OF CONSTRUCTION

The *Contractor* maximizes modularized erection of the structural steel to limit as far as reasonably practicable erection time on the Site.

The Works, by implication, also include for all the necessary services and tools required, based on prior experience and good judgement to perform the construction and erection of Plant and Equipment to within the parameters laid down in the documents and specifications listed herein.

PROJECT RECORDS

The *Contractor* keeps accurate, up to date records of all installed components. Quality control plans must be in place for the Works. The *Contractor* also keep a daily diary recording all events of the day, including but not limited to rainfall, areas where the Works may have been damaged by rainfall or other occurrences, complete with photos, and all security events.

THE WORKS (CONSTRUCTION)

The following form part of the temporary works included in this scope:

- Establishment and maintenance of the Site
- Parking facilities on site
- Personal protection equipment for all site personnel
- Ablutions and toilet facilities during construction for the construction crew/own workforce.
- *Contractor's* Site offices and equipment e.g. telephones, PCs, furniture, etc.
- *Contractor's* own container type storage facilities
- Securing the entire *Contractor's* Establishment and Equipment inside the *Employer's* primary security areas
- Small tools, power tools and other equipment including any cold cutting of concrete equipment
- Medical/First aid equipment
- Firefighting equipment
- Transport of site personnel to/from and on site
- Offloading of equipment for the Works

HOUSEKEEPING

- The *Contractor* must ensure that all his employees are competent, adequately trained, and experienced in their work
- The *Contractor* is responsible for the appointment of a suitably qualified full-time site safety representative
- Keeping of accurate records i.e. incident/accident logbook and reports, safety/security clearances, work permits, tests, minutes of safety meetings, etc. and furnishing these to *Employer* and *Contractor* on request
- *Employer's* site and induction needs to be attend by all *Contractor* personnel, and *Contractor's* own induction be presented to all that are required to work on site
- Daily Reports needs to be supplied to the *Employer*
- The *Contractor* attends all the site progress meetings as requested by *Employer*
- The *Contractor* is required to conduct and / or partake in Risk Assessment Studies
- Sewage removal, cleaning of offices and waste removal supplied by the *Contractor*
- Communication on site needs to be supplied by the *Contractor* for his own use

- The *Contractor*, after completion of the construction scope remove their site establishment facilities and make good the area in and around the site establishment
- Lighting
- Fuels and lubricants
- Supply of special construction tools
- Compressed air and gauges (if applicable)
- Temporary expendable or consumable construction items and supplies
- Management of ground and surface water, including dewatering equipment and disposal to the *Employer's* appropriate existing sewer system, as approved by the *Employer*. The *Contractor* employs all measures, as Accepted by the *Employer* to ensure no sediment or deleterious material transfer to the *Employer's* sewer systems as a result of the *Contractor's* Provision of the Works.
- Transportation of water for construction purposes. Construction and potable water is free issue at points near the job site as designated by the *Employer*
- Connections to, and disconnection from, water supply are to be supplied by the *Contractor*
- Maintenance of the *Contractor's* lay-down, storage and work areas, and roads within such areas
- Construction power is free issue, electric panel and distribution wiring by *Contractor*. Connections to, and connections from, the power source be by the *Contractor*. *Contractor* to advise his power supply requirements for review and approval by the *Employer* as a returnable schedule in response to the RFQ
- The excavations must be hard barricaded always (and battered/sloped back if required)
- All expendable or consumable construction items and supplies
- All Plant, Equipment, Materials and items of expense necessary to provide the Works in line with this Works Information. It's noted that the *Employer* do not record any rail fall and hence it's the *Contractors* responsibility to record these.

HOT WORK

Hot work on the Site is limited through the *Employer's* permit system and planning of the works need to be communicated timely, as far as reasonably practicable.

MECHANICAL COMPLETION

- The *Contractor* submits a prescribed Certificate of Completion, as per *Employer's* requirements.
- Completion is when the *Contractor* has: (a). Completed all works in accordance with the applicable drawings, as per the requirements as defined in this Works Information document, within the agreed project schedule. (b). Corrected notified defects which prevent the *Employer* from using the works and others from doing their work.

AS BUILT DOCUMENTATION AND DRAWINGS

Red lined drawings with all variations to construction drawings including submission to the *Employer* for review prior to update as 'As Built' and checking in to *Employer's* document management system.

HANDOVER

The *Contractor* provides the *Employer* and/or its representative(s) formal notification of witness and hold points nominated for its attendance on site or off-site. Notification must allow enough time for the *Employer* and other representatives to arrange and travel to the *Contractor* and needs to not be less than 5 working days for local inspections and 14 working days, for international inspections.

On-site inspections require a minimum of 2 working days' notice.

The *Contractor* needs to ensure access is given to the *Employer*, certifying authorities and statutory authorities to inspect the Work, review procedures and quality records at its premises, the premises or at the location of the Work, he provides the Services to achieve RFC and RFO by the prescribed dates, and handover completed works to the *Employer*.

The *Contractor* compiles and agrees with the *Employer* a commissioning plan incorporating its planned staged handover.

The handover service provided by the *Contractor* complies to and provide the following:

- Provide system definitions, followed by a test pack make up of all units or sub-sections for acceptance by *Employer*.
- Handover needs to be managed by a dedicated team from the engineering and construction team. This team needs to probably not be a separate team.
- Service needs to be provided from first PC or MC to RFC and RFO. Services after RFC needs to be the close out of the punch items.
- Execute handover according to the details in the handover manual.
- Drive Punching and Handover process up to RFO (i.e. co-ordinating and arranging with *Employer's* key personnel required for the *Employer* Punch.
- Planning updating
- Report on Progress on daily basis during punching and handover
- Provide and accepted Information Management system to track punch items and the handover progress.
- Track Punch item completion and manage back punching.
- Control Handover documentation.
- Integrate Construction, Pre-commissioning and commissioning handover requirements.
- Chair handover meetings.

THE WORKS FOR CONSTRUCTION

- Site establishment, including all Plant, Equipment site offices, storage containers, ablutions for *Contractor's* own workforce and site personnel required to complete the Works including quality, safety, material control, transport, accommodation, as well as any other items of expense necessary to execute the Works
- Project management including construction management and, and procurement for all materials
- Cleaning and housekeeping at the construction site
- HSE management plan compliant with *Employer* requirements and Occupational Health and Safety Act (No. 85 of 1993) and the regulations promulgated in terms of the Act requirements

including all resources (competent staff, equipment, tools, etc.) required to implement this plan and other associated plans.

- Risk assessments needs to be required for the construction of the various structures. Method statements, based on the outcome of the risk assessments, are to be submitted for review and approval by the *Project Manager* before construction and installation commences
- A Traffic Management Plan is to be submitted for review and approval by the *Project Manager*.
- A Personnel Management Plan is to be submitted for review and approval by the *Project Manager*.
- A Fabrication and Construction Test Pack Tracker is to be submitted for review and approval by the Project Manager and Employer
- Site surveying and verification of dimensions from the AFC drawings on Site, prior to fabrication commencing
- Shop detail of all steelwork (including all grating, hand railing and ancillaries) including submission of shop detail drawings for review to the Employer, a model of the detailed steelwork needs to be supplied simultaneously with the drawings for review
- Fabrication of structural steelwork according to the specifications listed. Note that fabrication may only commence after the approval of shop details
- Corrosion protection of steelwork according to the specifications listed.
- Fireproofing of steelwork according to the specifications listed.
- Testing of all fabricated, installed and constructed works
- Rectification of all defects, including damage to corrosion protection
- Delivery to site, offloading and temporary storage of steelwork, location of storage to be confirmed on site by the Employer
- Survey check of existing civil plinths as applicable including formal acceptance of levels
- Work noted as such needs to be completed before or during shut down
- Quality control and assurance for the construction scope
- Commissioning and hand over of the Works to the Employer including all quality Manufacturers data reports (MDR)/Datebook's. All Datebooks indexes to be agreed upon post Contract award but prior to any fabrication or construction commencing on the Site

9. PROJECT MANAGEMENT

The *Contractor* provides the works to project manage the engineering and design phase, procurement phase, fabrication phase, installation and construction phase, testing and commissioning phase, hand-over phase until the defects date of the project to meet Employer's requirements and applicable specifications.

GENERAL

The works include the following activities:

- Compiling a detailed Project Execution Plan (PEP as per *Employer's* requirements) detailing the complete project from detail design to commissioning.
- Manage all the engineering designs as well as all the interfaces;

- Manage the procurement process;
- Manage the budget and compile and keep a cost control system;
- Develop and compile the Works Information / Works (NEC4, ECC) for the various Construction Contracts;
- Compile RFQ documents for all construction activities, purchase orders for long lead items, including bid clarifications, evaluation and award of all contracts. Manage the project time deliverable and compile and keep a time schedule;
- Set the quality assurance and control plan and manage the implementation which includes approvals and handover of the project to *Employer's* requirements;
- Set the resource requirements and manage the implementation;
- Set communication procedures and manage the implementation;
- Compile project documentation (documentation control centre), manage the implementation and hand over of the required documentation to *Employer* before Completion;
- Compile risk assessments and implement corrective actions;
- Enforce safety in the work place;
- Ensure that all security requirements are adhered to;
- Ensure that all environmental requirements are met;
- Schedules progress meetings to take place monthly, or as mutually agreed upon. The *Contractor* chairs the meeting and provides the minutes of the meeting to relevant parties within three (3) working days after meeting. The *Contractor's* key personnel attend these meetings
- The communications details and format (correspondence numbering, contact details of various offices etc.) between the *Employer* and the *Contractor* is to be agreed between the two parties after contact award.

ORGANISATION AND STRUCTURE

Contractor ensures an organisational structure and personnel to efficiently and professionally execute the function of project management and to perform all work in compliance with all the provisions as stated in the core clauses of the NEC and to comply with all provisions stated in the Works of Works. The *Contractor* presents the final organisational structure for the project at the kick-off meeting between the *Employer* and the *Contractor*.

The *Project Manager* approves any changes to the organisational structure of the *Contractor*.

COST MANAGEMENT

The *Contractor* manages all costs applicable to this Project. All changes or issues resulting in changes to the prices of the various contracts.

The *Contractor* is responsible for the following:

- Update control base budget with accepted compensation events.
- Update the cash flow monthly, three monthly and yearly and report on deviations.
- Measure and report on projected final project cost.
- Report on all possible and accepted compensation events

- Compile and manage compensation event/early warning registering
- Maintain proper EW, PVP, VP, PMI, & CE registers and included in monthly reporting by contractor.

The *Contractor* submits Pro-forma invoices to the *Project Manager* by the 20th of each month for approval. Once pro-forma is approved, the *Contractor* creates an Invoice on native format. The pro-forma invoices comply with the project schedule in terms of rate of each activity and description. Invoice assessment to be done according to the latest updated schedule.

RISK

The *Contractor* ensures that all risks are managed to enable the successful execution of the project. Any risk that occurs or develops during any phase of the project is brought to the *Project Manager's* attention in writing immediately or at the latest within 3 days

A general risk analyses is performed prior to starting with the construction work.

MEETINGS

- The *Contractor* co-ordinates and chairs the first “kick-off” meeting to take place at *Employer's* premises at a date mutually agreed upon.
- Thereafter, the *Contractor* schedules progress meetings to take place bi-weekly or as mutually agreed upon. The *Contractor* chairs the meeting and provides the minutes of the meeting to relevant parties within three (3) working days after meeting. The *Contractor's* key personnel attend these meetings.
- The *Project Manager* attends the Site/Construction meetings on a regular basis.
- The *Contractor* invites the *Project Manager* to all procurement, manufacturing and testing meetings to be held with the various suppliers. Notification of the above meetings should take place at least five (5) days in advance for suppliers in South Africa and at least four (4) weeks in advance for suppliers overseas.
- The *Contractor* to attend potential deviation analysis (PDA) meetings during the course of the *works* as agreed with the *Employer* in the project kick-off meeting.

10. PLANNING AND PROGRESS REPORTING

ACCEPTED PROGRAMME REQUIREMENTS

GENERAL

In addition to the requirements given in clause 31.2, the *Contractor* complies with the following requirements on each programme submitted for acceptance:

- The *Contractor* develops his programme using Primavera or *Project Manager* accepted alternative;
- Submission of the programme is in native electronic format which can be read by the *Employer*, in line with the accepted planning system, namely: MS Projects *.msp, not pdf file format;
- The *Contractor* submits the programme developed to a level 4 detail at the start of contract. Refer to paragraph “Programme Levels” below for definitions of level.

- The *Contractor* submits a level 4 resource loaded programme with associated programme basis document, updated with any comments arising during contract award, for acceptance within 4 weeks of Contract Date.

The *Contractor* submits a programme basis document (called Basis of Schedule) with the programme when submitted for acceptance See below for requirements

The following columns need to be represented as a minimum requirement for all programme submissions:

- Activity ID
- Activity name
- Original duration
- % complete (Based on rules of credit)
- Planned start (As per latest Accepted Programme)
- Planned finish (As per latest Accepted Programme)
- Forecast / Actual Start
- Forecast / Actual Finish
- Total Float

The *Employer's* activities within the programme are clearly defined, unambiguous and are either discrete activities or bulk type activities, the progress of which can be demonstrated through a weighted progress tracking mechanism. The operations are clearly related to the method statements provided.

The programme contains the *Contractor's* full work from the Contract Date to Completion Date, including amongst others tasks associated with permits that allow for an 8 hour productive work day, safety reviews, testing, punching (within accepted notification and response periods), punch rectification, documentation review and handover.

ADDITIONAL PLANNING REQUIREMENTS

The *Contractor* submits the following planning documents aligned with the operations indicated on the programme

- Two week task look ahead plans
- Weekly & Daily Activity lists
- Tracking / production documents for actual progress achieved

CRITICAL PATH AND NEAR-CRITICAL PATH ACTIVITIES

Critical activities are defined as all activities with zero total float and the construction path through these activities is the critical path.

Near-critical activities for the purposes of this project is defined as all activities with 10 days or less total float (working days)

The *Contractor* submits a critical path analysis clearly indicating the critical path and near critical paths of his programme with each updated programme issued for Acceptance. The risks and key mitigating actions for the critical path are clearly indicated.

BASIS OF PROGRAMME DOCUMENT

The *Contractor* submits a Basis of Programme Document with his first programme, and updates and re-issues the Programme Basis Document with any subsequent programme issued for acceptance, indicating any key aspects of his program that have been altered. The typical items which the *Contractor* includes in his Programme Basis Document are listed below:

- Sections of work
- Sequence of work
- WBS
- Summary table of contractual dates
- Calendars
- Activity Codes
- Critical Path analysis
- Float Management
- Risks & Constraints
- Assumptions, Exclusions and Exceptions
- Changes since the previous programme submission

Additional detail for the basis of programme headings:

Assumptions

The *Contractor* lists all assumptions he has made in developing his programme.

These may include;

- Dates on which he requires access to Site, drawings or materials where such dates are not provided elsewhere. The *Contractor* provides this information in tabular format with a clear description of the required site, drawing, material etc.
- Durations for receipt of permits, PDAs, scaffold erection and other activities where such durations are not otherwise defined.
- Durations for Punching, *Employer* inspections etc.
- Provisions for storage of material, tools and plant on site.
- Time spent on toolbox talks, safety stand downs and other safety related matters.
- Handover and end of job documentation covering all aspects of the *works*.

Calendar

The *Contractor* clearly explains his calendar(s) and takes due cognizance of public holidays, and non-working days which typically arise around the Easter and Christmas holiday periods as indicated in Works Information.

Working Hours

The *Contractor* provides intended working hours per week or fortnight as applicable and staggered rotation cycle as indicated in Returnable Schedules. NDE activities are planned as per designed time frame windows indicated in this Works Information.

Incllement Weather Allowances

The *Contractor* includes the allowance for inclement weather in his level 4 programme.

11. REPORTING

UPDATING AND REPORTING

The updating and reporting of the programme is the *Contractor's* responsibility and he ensures that he has adequate resources to perform this function until the last RFC handover has been achieved

Actual start and Completion Dates is reported;

Progress "S-curves"

Breakdown of activities to be executed are included in the *Contractor's* programme are at least at a level 3 detail.

The Bar Chart programme submitted shows separate activities for each section of work. The *Contractor* provides a programme, which includes delivery, installation and Commissioning, satisfying the project as a whole.

Procurement schedule as extracted from the Accepted Programme, for the procurement and receipt of Plant and Materials and subcontracted *works* by the *Contractor* and a monthly status report of all such Plant and Materials.

The *Contractor* prepares and submits a monthly progress report for the *Employer*. The report reaches the *Employer* by the date as agreed in the kick-off meeting. Refer to "Planning, scheduling and reporting procedure" in Volume II for detailed progress measurement guidelines. The report is structured with the following headings in electronic format:

- Executive summary
- Main activities this past period, in progress and next period per discipline
- Areas of concerns
- Project risks
- Areas of opportunity
- Progress curves
- Procurement
- Cost Control
 - ◆ Cash-flow (forecast, actual and variances)
 - EPC contract
 - ◆ Purchase order register
- Compensation event (CE) register and status thereof
- Safety
- Updated programme

Detail content and format of the headings to be agreed by the *Employer*.

Contractor submits a fortnightly short report in a format and on the dates to be agreed with the *Employer*.

12. QUALITY MANAGEMENT

QUALITY CONTROL REQUIREMENTS

The *Contractor's* appointed QC Manager submits a Quality Assurance plan for the fabrication of his Plant and Materials to the *Project Manager* for acceptance, before work commences, but not more than 14 days after the Contract Date.

The *Contractor* records Defects, with the following information included:

- A reference number for each Defect
- A basis to reference each Defect
- The name of the person who identified the Defect
- The category of the Defect
- The sign off of the corrected Defect by the *Contractor* and the *Employer*

Plant and Materials are subject to inspection and/or test by a representative of the *Employer* who is to be granted access to any and all parts of the *Contractor's* or Subcontractor's premises engaged in the manufacture or processing of this Contract.

Where Third Party Authority Inspection is required for Equipment, Plant and Material associated with this contract. The Third Party Authority is appointed by and at the expense of the *Employer*.

Resolution of engineering problems directly with the Third Party Authority is prohibited. All engineering problems are to be addressed, along with proposed solutions, to the *Project Manager* for resolution. Component parts pertaining to pressure envelopes are to be inspected at source of manufacture by the Third Party Authority.

The *Contractor* implements a Quality Management System (QMS) that, as a minimum, meets the requirements of ISO 9001, throughout the Contract.

The *Contractor* provides, during the bidding cycle, details of the established ISO-9001 (or similar) accredited *Contractor* quality management systems in order to demonstrate to the *Employer* how the system complies with the quality requirements of this Works Information. It addresses QA/QC actions and deliverables during design, procurement, manufacture, inspection, certification and equipment delivery, as well as during the equipment preservation cycle and specifically address the aspects of modular facility design and construction. The *Contractor* highlights any internal QA/QC system customizations it intends undertaking to execute this Works Information and demonstrates how subcontracted (if any) deliverables are to be handled from a QA/QC perspective.

The *Contractor* ensures that a consistent standard of engineering document quality is maintained throughout engineering design, procurement and construction activities, through the use of checklists or similar mechanisms. The *Employer* aims to undertake ongoing assessments of the training provided to new *Contractor*-employees on the use and application of such mechanisms.

The *Contractor* appoints a project QA/QC manager, who is responsible for all QA/QC activities on the project. The appointment and function, proven via the comprehensive project organogram, is such that the QA/QC manager/function is an authoritative appointment independent of production, reporting directly back to the *Contractor's* QA/QC department manager

13. APPROVED INSPECTION AUTHORITY

The *Contractor* presents the technical works(s) of work for inspection authorities to the *Employer* for review.

After appointment of the inspection authorities by the *Employer*, the *Contractor* arranges a technical alignment session between the *Employer*, *Contractor* and the appointed inspection companies.

The *Contractor* manages and coordinates all the activities between the inspection authorities, the *Contractor*, the *Employer* and Others.

The *Contractor* ensures that all inspection activities required per Regulation 11 of the Pressure Equipment Regulations (GNR. 734 of 15 July 2009) are undertaken and completed.

Radiographs are viewed and interpreted by the AIA. It is not acceptable that radiographs are subjected to interpretation by contracted NDE companies alone.

14. PROCUREMENT, FABRICATION AND DELIVERY

CONTRACTING & PROCUREMENT

The *Employer's* objective is to have the Plant and Material and *Contractor's works* supplied using sound business practices, from sources which provide maximum value for each expenditure, taking into consideration quality, price, delivery and reliability.

The *Contractor* complies with the agreed and approved bidder's list in all transactions. The *Contractor* ensures that all contractors and suppliers comply with the applicable *Employer* Specifications and approved vendor list.

The *Contractor* submits a detail list of all engineering *Contractors*, construction contractors to *Employer* for acceptance.

The *Employer* stresses the importance of the *Contractors* understanding the requirements of working in the *Employer's* Working Areas.

Contractor handles all Suppliers/contractor's contractual communications, technical and commercial queries and negotiate any change orders and/or claims which may arise during the course of the execution of this contract and purchase orders or within the guarantee period set out in this contract or purchase orders.

Contractor provides a detailed Procurement Schedule in a format agreed with the *Employer* and updated monthly.

PROTECTION AND CONTROL OF EQUIPMENT

The *Contractor* at all times provides protection for all Plant and Materials from damage or loss resulting from adverse weather conditions, fire, theft or any other unforeseeable cause.

The *Contractor* at all times protects all Plant and Materials and Equipment, paving, structures and any and all items on the Site on Site belonging to the *Employer* or others from damage caused by the *Contractor* in performance of the *works*.

15. CONSTRUCTION MANAGEMENT

WORKS INFORMATION

The execution of the construction phase of the project as well as the commissioning phase (up to RFO) is the direct responsibility of the *Contractor*. The *Contractor* is responsible for overall construction safety, quality control, field supervision, field engineering, document control, project controls and reporting, and testing and turnover within their module. The *Contractor* is responsible for developing a detailed contracting plan for its Works. This contracting plan considers the use of local and regional contractors, specialty contractors and BEE's.

WORKS

The *Contractor*:

Manages his access to the Site.

Manages his activities on Site to ensure that no interference takes place between his work and that of the *Employer* and Others.

Maintains and promotes labour harmony on the Site and the working environment in general.

Immediately reports any potential labour disharmony to the *Project Manager*.

Does not recruit or employ any personnel from the *Employer*, Subcontractors and Others, without prior acceptance of the *Project Manager*.

The *Contractor* performs the management and supervision of all construction activities by Construction Subcontractors and includes overseeing Construction Subcontractors' daily activities.

Ensure that the Construction Subcontractor employs appropriate skilled personnel and sufficient level of staffing which enables Construction Subcontractor to achieve the necessary progress and which complies with the technical requirements to meet the progress milestones dates set out in this Contract.

Perform spot-checking of Construction Subcontractors' deliverables to ensure the Construction Subcontractors fulfil project quality requirements.

Identify problems in the execution of Construction Subcontractors' work and liaises with Construction Subcontractors to resolve issues, which may impact quality, technical integrity and/or schedule requirements.

Manage the establishment of the *Contractor's* construction management field office. This includes supplying all necessary office equipment, e.g. telephones, computers and applicable software, printers and all appliances for *Contractor's* staff as required, including personnel safety equipment.

Ensure that the Construction Subcontractor obtains all necessary security and hot and cold work permits required to perform construction activities.

Receipt, inspection and issuing of all Material procured by *Contractor* and Others in accordance with the procedure outlined in the Materials Management section 9 of the Project Execution Plan, included in Volume II.

Monitor and manage safety on Site in accordance with the requirements outlined in the SHE section 13 of the of the Project Execution Procedure, included in Volume II and the requirements of the Occupational Health and Safety ACT (Act no. 85 of 1993).

Prepare Construction Subcontractors' closeout and acceptance documents and reconcile/close-out contracts.

Ensure that construction facilities (including amongst others construction power) are available for contractors. Obtain construction utilities requirements, including quantities and timing of such utilities, from Construction Subcontractors and liaise with *Employer* and Others regarding the provision of these utilities.

The *Contractor* liaises with Others, where required to ensure a smooth, uninterrupted execution of the construction work.

The *Contractor* maintains work diaries, drawing register and other records as required.

The *Contractor* maintains site progress records and photographs. Photographic equipment may only be brought onto Site with the necessary permission from the *Employer*.

The *Contractor* provides the necessary hand-over documentation to the *Employer* in accordance with requirements outlined in the project Checkout, Hand-over, Acceptance, Commissioning and Start-up procedure section 14 of the of the Project Procedure Manual, included in Volume II.

"APPROVED FOR CONSTRUCTION" DRAWINGS AND SPECIFICATIONS

The *Contractor* Provides the *works* using only drawings and specifications marked or stamped "APPROVED FOR CONSTRUCTION" by the *Employer*

In order to maintain the Accepted Programme, the *Contractor* performs only that portion of the *works* outside the areas marked "HOLD" on the "APPROVED FOR CONSTRUCTION" drawings and specifications until revised "APPROVED FOR CONSTRUCTION" drawings and specifications are received with the "HOLD" markings deleted.

REFERENCES AND STANDARDS

All relevant *Employer* standards needs to be adhered to with regards to the Construction works for this project.

In the event a subject is not addressed by the Employer standards, the *Contractor's* practices and procedures have been used.

EMPLOYER INTERFACE

The Construction discipline interfaces with the *Employer* representatives in the review and approval of the following documents:

- HSSE requirements
- RFQ Packages
- TBA's
- Temporary Facilities requirements
- Quality Systems requirements
- Installation works of work
- Definition of Construction Work Areas (CWAs) & Construction Work Packages (CWPs)
- Work Permit requirements
- Turnover Systems and requirements

CONSTRUCTION CONTRACTS

The *Contractor* is responsible for the following Construction Contracting activities:

Developing a detailed construction contracting plan

Developing and issuing all construction contracts necessary to complete the construction work

Management and administration of the Construction Contracts

16. SAFETY, HEALTH AND ENVIRONMENTAL (SHE) REQUIREMENTS

LEGAL APPOINTMENTS

This agreement serves to exclude the presumption in terms of the OHS Act Section 37(1) and serves to meet the requirements of Section 37(2) of the Act.

The *Contractor* warrants that his people all have the professional and technical expertise, the qualifications, competencies and skills and the appropriate equipment, tools, resources, facilities, licenses and permits to perform its obligations.

The *Contractor* ensures that the Construction Health and Safety Manager and Officer are registered with the South African Construction and Project Management Professions (SACPCMP) and he / she has the necessary competencies.

APPLICATION FOR A CONSTRUCTION WORK PERMIT / NOTIFICATION OF CONSTRUCTION WORK

The *Contractor* participates with the *Employer* in the provision of the necessary documentation in compliances with the requirement for application for a permit to do construction work when applicable.

SHE MONTHLY REPORTING

The *Contractor* indicates how SHE performance indicators are captured and managed. This includes trend analysis, the reporting and communication thereof. A monthly SHE report is submitted in the form of an official report to the *Employer* on the 1st of each month. The report is signed by the SHE Manager and approved by the *Project Manager* prior to submission. The format of the monthly SHE report is determined by the *Employer*, and is issued to the *Contractor* after contract award.

REPORTING OF INCIDENTS

The *Contractor* immediately telephonically reports the following incidents mentioned below to the *Employer*:

- Near misses;
- Any incident/accident or injury that may have a significant impact on the project or adjacent plants;
- Any occupational injuries and illnesses on site (fatal cases, lost work day cases, restricted work cases, medical treatment cases, first-aid cases and section 24 incidents);
- All visits from Department of Labour, any condition that may endanger the adjacent and surrounding plants and any condition that may endanger the construction activities;
- All reportable incidents as required by legislation (flying or falling objects, machinery out of control, failure of safety or alarm systems, dangerous substance spilled or uncontrolled release of substance under pressure);
- Any occupational health or hygiene incidents other than illnesses; and
- Any damage caused to the property or environment.

The *Contractor* complies with the *Employer's* requirements with regards to incident management. The requirements are set out in the incident management toolkit, and is issued to the *Contractor* after contract award.

Only injuries which are classified as project related is accepted and recorded for statistical purposes.

PERMITS (RSA)

The *Contractor* is not allowed to conduct site visits, perform any work without authorization and the necessary official work permit or task risk assessment document, as issued by the *Employer*.

Daily work permits provisions need to be made to ensure that all employees who are required to sign on work permits have received the necessary training in accordance with the permit to work RSA procedure.

17. COMMISSIONING AND TAKE-OVER

The Pre-Commissioning as well as the commissioning phase is the direct responsibility of the *Contractor* up to RFO and thereafter they assist with start-up up to BO on a reimbursable basis. The *Contractor* is responsible for overall safety, quality control, field supervision, field engineering, document control, project controls, reporting, testing and turnover within their module.

PRE-COMMISSIONING

The *Contractor*:

Take full responsibility for all Pre-commissioning activities up to RFC and Commissioning activities up to RFO. Typical Pre-Commissioning activities included is:

- Quality control checks,
- Correction of construction Defects
- Hydrostatic testing
- Cleaning of equipment and piping
- Motor bump tests and uncoupled runs
- Alignment of rotating equipment
- Instrument loop checking
- Lubrication of motors, pumps and gearboxes
- Site clean-up,

Develop all cleaning and drying procedures (flushing, blowing, chemical cleaning, mechanical cleaning and drying) and get approval from the *Employer*.

Ensure that the *Employer* witness and sign off all cleaning activities.

Develop with the approval of the *Employer* all preservation procedures up to RFO. The *Contractor* delivers a plant at RFO that is clean, dry and ready for Start-up.

HANDOVER PROCEDURE

Contractor Provides the Services in order to achieve RFC and RFO by the prescribed date (s) and hand over completed *works* to *Employer* in accordance with the handover procedure specified in the Works Information. The *Contractor* compiles and agrees with the *Employer* a commissioning plan

incorporating its planned staged handover and completion of the Service to support *Contractor's* required commissioning sequence for units and/or systems.

The Handover Service provided by the *Contractor* complies to and provide the following:

- Provide system definitions, followed by test pack make up of all units or sub sections for acceptance by the *Project Manager*.
- Handover is managed by a dedicated and separate team from the engineering and construction management team.
- Service is provided from First PC or MC to RFO.
- Develop and agree a complete project and plant specific handover manual, 6 months prior to the first MC.
- Execute handover according to the details specified in the handover manual.
- Drive Punching and Handover process up to RFO i.e. co-ordinating and arranging with *Employer's* key personnel required for the *Employer Punch*.
- Punching Data Management.
- Punch Pack Quality and Completeness Verification.
- Punching Scheduling.
- Planning updating.
- Provide and Manage Hand over Management Room up to RFO.
- Report on Progress on daily basis during punching and handover.
- Provide an accepted Information Management system to track punch item and the handover progress.
- Track Punch item completion and manage back Punching.
- Control Handover Documentation.
- Integrate Construction, Pre-commissioning and Commissioning Handover Requirements
- Chair Handover Meetings up to RFO
- Follow-up and monitor completion of Additional Punch Items and registered Start-up Modifications
- *Contractor* develops unique QCP's for start-up modifications for review by the *Employer*
- Minimum of 3 audits is done on handover, each comprising of
 - ❖ A System Audit
 - ❖ Punching Quality Audit

COMMISSIONING MANAGEMENT

The *Contractor*:

Manages his access to the Site.

Manages his activities on Site to ensure that no interference takes place between his work and that of the *Employer* and Others.

Maintains and promotes labour harmony on the Site and the working environment in general.

Immediately reports any potential labour disharmony to the *Project Manager*.

Does not recruit or employ any personnel from the *Employer*, Subcontractors and Others, without prior acceptance by the *Employer*.

ENGINEERING SUPPORT FOR COMMISSIONING

The *Contractor* is responsible for the following engineering support activities:

Performing all home office commissioning activities

Providing *Contractor* field-engineering support to Commissioning *Contractors*.

Development of an approved commissioning plan and schedule.

Implementing a commissioning program/ plan up to RFO.

COMMISSIONING CONTRACTS

The *Contractor* is responsible for the following Commissioning Contracting activities:

Developing a detailed commissioning contracting plan

Developing and issuing all commissioning contracts necessary to complete the commissioning work

Management and administration of the Commissioning Contracts

Managing interface with other module Commissioning *Contractors*

This contracting plan considers the use of local and regional contractors, specialty contractors and BEE's.

18. FINANCIAL MANAGEMENT

FORECAST RATES OF INVOICING

At each assessment interval, the *Contractor* submits to the *Employer* a forecast rate of invoicing that includes all the expected payments to be made by the *Employer* to the *Contractor* on a month by month basis.

INVOICES

The invoices from the Contractor contain the following information:

- the registered name of the company
- the VAT registration number of the company (where applicable)
- The *Employer's* contact or purchase order number
- the invoice sequence number
- the original contract or purchase order value
- the amount paid to date
- the value of the invoice split into the payments as indicated on the *activity schedule*
- any retention monies deducted from the invoice
- any interest payable
- the price adjustment for inflation

FINANCIAL RECORDS AND ACCOUNTS

- *Contractor* receives payment by bank transfer the *Contractor* ensures that the *Employer* has his correct banking information to make the transfer. The *Contractor* assumes the risk of incorrect bank transfers arising from changes to the *Contractor's* banking information.
- Bank charges in respect of telegraphic transfers levied by the *Contractor's* bank are for the *Contractor's* account. Bank charges in respect of telegraphic that are levied by *Employer's* bank, is for the *Employer's* account.
- All payments made for and on behalf of the *Employer* are subject to audit.
- The *Contractor* preserves its records for such a period as the Department of Internal Revenue may require. Should different periods be prescribed, the longest period applies, but in any event, records are retained for not less than five years.
- The *Employer* may deduct any amount owed by the *Contractor* to the *Employer* from any amount owed by the *Employer* to the *Contractor*.
- The *Contractor* submits original invoices complying with the Value Added Tax Act and containing the detail specified to:
 - Attention: CSIR Accounts Payable Office
 - PO Box 395
 - Pretoria, Gauteng, 0001

19. COMPLETION

DEFINITION

- The status of Completion is defined in the core clauses.
- The *Contractor* completes all of the *works* by the Completion Date as indicated on the Accepted Program. Completion of detail engineering is the Completion Date as defined in the core clause.

HANDOVER PROCEDURE

The *Contractor* needs to develop a handover procedure and submit to the *Employer* for approval. The handover procedure provided by the *Contractor* need to address the following:

- Handover need to be managed by a dedicated and separate team form the engineering and construction management team
- Punching and the handover process up to the last RFO
- Punching data management
- Punch pack quality and completeness verification
- Punching scheduling
- Planning updating
- Handover room management up to RFO
- Daily progress reporting during punching and handover
- IM system to track punch items and handover progress
- System to track punch item completion and manage back punching
- Control handover documentation

EOJ DOCUMENTATION

The *Contractor* needs to provide 2 (two) hard copy and 2 (two) electronic copies of all EOJ documentation. One electronic copy is provided in native format and one in pdf format.

The *Contractor* obtains EOJ documentation from Others and ensures that it is in the correct format to issue with the final EOJ documentation.

All Operating Manuals are required at the completion of detail engineering. All Maintenance Manuals are required at the completion of detail engineering.

20. GUARANTEES

As per Contract data, i.e. AFC approved deliverables.

Contractor provides:

- Mechanical equipment warrantees and guarantees
- Hydraulic guarantees.

21. COMMUNICATION

- One subject per communication is maintained at all times.
- All correspondence regarding the works is between *Contractor* and the *Project Manager*.
- All correspondence is in electric format, correspondence not in electronic format is simultaneously copied in electronic format (signature documents)
- All electronic formats is finalised at the contract kick-of meeting.
 - Letters, e-mails, faxes memos, minutes, data sheets MS office
 - Transmittals, signature documents PDF format
 - Schedules MS Project
 - Calculation, simulations, etc. Various
 - Drawings AutoCAD, Revit, Smartplant, Navisworks (to be agreed)
- Telephone communication are not regarded as official communication
- All communications and invoicing pursuant to or in connection with this project is identified by the *Employer's* Contract Number and is quoted in accordance with the correspondence procedure to be agreed at the kick-off meeting.

22. ATTACHMENTS FOR FURTHER INFORMATION

Annexure A – CSIR BoQ Rev 0

Annexure B – Equipment Supplied by the Client

Annexure C – Equipment Layout

Annexure D – Equipment information

Annexure E - 21050-CSIR-CE-DGA-001 Rev B

Annexure F - 21050-CSI-EE-LLD-001 – Lighting Layout Rev A

Annexure H - 21050-CSI-IC-DAS-001 (Pressure Indicators) Rev A

Annexure I - 21050-CSI-IC-DAS-002 (Temperature Indicators) Rev A

Annexure J - 21050-CSI-ME-DAS-001 Steam Boiler

Annexure K - 21050-CSI-PR-LST-001 Tie in List (Rev 1)

Annexure L - 21050-CSI-ME-DAS 006 - Globe Valves Data Sheet

Annexure M - 21050-CSI-ME-DAS-002 Valves Data Sheet

Annexure N - 21050-CSI-ME-DAS-001 Line Connections Rev A

Annexure O - 21050-CSI-ME-DAS-003-Data Sheet – Strainers

Annexure P - 21050-CSI-ME-DAS-004 - Data Sheet - Steam Line Air Vent

Annexure Q - 21050-CSI-ME-DAS-005 - Data Sheet - Thermodynamic Steam Trap