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SANSA

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Document prepared by:

Zutari South Africa
Reg No 1977/003711/07
1 Century Drive, Waterford Precinct
Century City, Cape Town
PO Box 74381

T +27 (0)21 526 9400
F +27 (0)21 526 9500
E connect@zutari.com

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Author signature		Approver signature	
Name	Mohammed Rawat	Name	Wynand Venter
Title	Pr.Mechanical Engineer	Title	Pr.Mechanical Engineer

Contents

Figures

No table of figures entries found.

Tables

No table of figures entries found.

Executive summary

This electronic BMS specification document relates to the SANSA PRECINCT in Hermanus. This document forms part of the electronic services relating to the project and shall be read in conjunction with all project documentation and drawings.

This specification document addresses the following item(s):

- Building management system
- Digital Twin for BMS integration

This document is a technical specification and does not define contractual matters.

1 Introduction

1.1.1 This specification document outlines the minimum performance specifications and requirements of the electronic BMS system required for the new complex.

1.1.2 The building BMS services scope of work shall be for the design, supply, installation, programming, commissioning and maintenance of the required systems as outlined in this document.

1.2 Scope of work

1.2.1 The building BMS services scope of work shall include:

- Headend equipment and software
- Field devices
- GUI and report development

1.2.2 The contractor shall be available to assist the end-user in the commissioning and configuration of these systems during the project commissioning stage to ensure his installed system functions as intended.

2 General

2.1 Site conditions

2.1.1 The contractor shall familiarise themselves with the site conditions prior to undertaking or providing cost estimates for any work. Specific conditions to be observed include, but are not limited to, the main contractor's site access and entry requirements, OHS requirements, qualification and identification of personnel.

2.2 Advice

2.2.1 The contractor shall advise the main contractor and gain approval before undertaking any work that may or will result in voice, data, security or other ICT network service disruption or network downtime. Any work that may result in network down time will require scheduling with the client's ICT representatives.

2.3 Time elapsed

2.3.1 Due to the time elapsing between the release of this specification and the installation and construction works, it is anticipated that some of the equipment proposed will be superseded by later models by construction time. The contractor is to review products and confirm the models of all equipment and products proposed with the engineer one month prior to the procurement and installation of the equipment, interfaces to the other equipment and systems.

2.4 System design

2.4.1 In addition to section specific requirements the following general system design requirements shall be adhered to.

2.4.2 The scope of work shall be for the design, supply, installation, programming, testing, commissioning and maintenance of the system as detailed in this specification. Ancillary works to be carried out by the contractor shall include, but not be limited to.

- Project management of the scope of work.
- Project coordination with other services trades to ensure timely and successful completion of the scope of work including on-site and off-site project meetings as required.
- Project documentation.
- User training
- Maintenance during the Defects Liability Period

2.4.3 The supply, construction, programming, testing, commissioning and maintenance of the installation shall comply with all relevant Statutory Regulations, and the latest editions (current at the time of Tender) of all applicable standards as listed in the specification.

2.4.4 The contractor shall operate an auditable quality assurance procedure covering the supply, construction, inspection and testing of the installation.

2.4.5 The contractor shall provide all materials and equipment not explicitly mentioned in this specification but which is obviously needed for the completion of the scope of work. This is not limited to the system only, but also includes all tools, equipment for testing, safety equipment, working platforms, scaffolding, ancillary materials, etc., needed to complete the design, supply, installation, programming, commissioning and maintenance of the system

2.4.6 The operation of the system shall be configurable per the client’s requirements.

2.5 System requirements

2.5.1 The various system requirements shall be as detailed for each service required.

2.5.2 All equipment installed under this contract shall comply with the requirements of IEC 61000 Parts 1 to 6 ELECTROMAGNETIC COMPATIBILITY (EMC).

2.5.3 Any equipment found producing Electromagnetic interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any cost to the Employer.

2.6 Components and equipment

2.6.1 In addition to section specific requirements the following general component and equipment requirements shall be adhered to.

2.6.2 All materials, equipment and components shall be new, of good quality and fit for purpose. The contractor shall not provide without written approval products that are obsolete, discontinued or about to be discontinued.

2.6.3 The contractor shall provide equipment and associated accessories which are the products of established manufacturers regularly engaged in the manufacture of such equipment applicable to the system.

2.6.4 All equipment and materials used in these works shall be standard components that are regularly manufactured and utilised in the manufacturers' system.

2.6.5 Attic stock of the main components of the installed system shall be required. The final quantities and items shall be agreed with the engineer during construction.

2.6.6 All system components shall operate reliably within the range of -10 degrees to +55 degrees and 98% non-condensing humidity.

2.6.7 To ensure the long-term dependability of the system, the contractor shall provide all system components with appropriate environmental protections including (as appropriate);

- Protective enclosures.
- Seals.
- Insulation.
- Water proofing.
- Rust proofing.
- UV protection.

2.6.8 Any modifications to equipment to meet the intent of this specification shall be performed in a way that does not alter the manufacturers' warranty.

2.7 Interfacing with other systems

2.7.1 System interfacing requirements shall be as detailed for each service required.

2.8 Installation of components and equipment

2.8.1 In addition to section specific requirements the following general installation of components and equipment requirements shall be adhered to.

2.8.2 The contractor shall be responsible for coordination with the main contractor and with other works and trades including civil, building, electrical, mechanical and security where work is dependent upon or carried out in conjunction with these works. This includes but is not restricted to:

- Use of site and facilities
- Closure of restriction of access to site and facilities
- Scheduling of works and resources
- Segregation of services
- Site reinstatement

2.8.3 Major items requiring coordination are listed as follows:

- Coordinate with other trades to ensure that no conflict occurs between proposed cable, cable tray and ducting routes, pipe runs and air conditioning ductwork, hydraulics pipework and the like.
- Ensure staging of works is to the requirements of the Construction Program

2.8.4 The location of all outlets, switches and equipment indicated in the drawings is indicative only and may be relocated within a 3000mm radius to suit coordination with other services, finishes, architectural preference and to meet code requirements. The exact locations are to be determined by reference to architectural plans, sections and details and are to be confirmed with the engineer prior to installation. Clinical architectural room data sheets and room layouts sheets shall also be adhered to.

2.8.5 The installation and mounting of all equipment shall ensure that the components remain operational and connected to the structure and to their foundations (if applicable) throughout a seismic event by means of proper installation of all anchors and mounting hardware. The contractor shall issue a seismic compliance certificate at completion

2.8.6 Seismic requirements

- Seismic ratings and definitions shall be as per ASCE 7-10.

- The spectral response acceleration parameters (the maximum acceleration experienced by the building during an earthquake) are as follows.

Design Spectral Acceleration Parameters	Period [Seconds]	Spectral Response Acceleration [%g]
-	0	0.18
SDS	0.2	0.45
SD1	1	0.13

2.8.7 Seismic Design Categories:

- Based on the building risk category and the spectral response acceleration parameters, the seismic design categories are as follows:

Period [Seconds]	Seismic Design Category
0.2	D
1	C

2.8.8 All equipment shall be securely mounted using proprietary fixtures and fittings.

2.8.9 The method of equipment installation shall not adversely affect the function or structural integrity of the structure to which the equipment is attached.

2.8.10 The method of equipment installation shall not compromise the IP rating of the equipment.

2.8.11 Framework and brackets

- Site-fabricated framework and brackets shall not be used.
- Framework and brackets shall be positioned so as not compromise the removal and replacement of equipment.
- Where it is necessary to modify on site any pre-fabricated galvanised mild steel framework, the cut edges shall be dressed and treated immediately with an approved cold galvanising paint to prevent corrosion.
- Fasteners securing equipment to framework and brackets shall be independent of those securing framework and brackets to walls and floors.

2.8.12 Positioning of Equipment

- Final positions of equipment shall be agreed on site, prior to installation.
- Equipment shall be positioned with due regard to the aesthetics of the installation

2.8.13 All surface mounted equipment shall be solidly fixed to walls or soffits by means of their back plates.

2.8.14 Cables

- Dedicated metal wire trunking for the system shall be provided by the electrical contractor as per the layout drawings.
- The cable installation shall comply with the requirements of BS 7671.
- Cables shall, as far as possible, run parallel with the lines of building construction.

- Cables and their support systems shall not be fixed to protective barriers, guards or direct to guard-rails.
- Cables shall be installed strictly per the manufacturers' requirements pertaining to:
  - Maximum tensile or compressive stresses (e.g. due to pinching or squashing).
  - Minimum bending radius.
  - Temperature of installation.
  - Operating environment.
- Cable installation in conduit shall conform to BS 7671.
- Conduit shall be debugged and swabbed prior to cables being pulled in.
- The entire conduit system shall be complete prior to installing cables.
- No joints shall be allowed in the cables without the prior approval of the engineer.
- The use of PVC insulation tape shall not be accepted – heat shrink or approved equivalent method shall be used.
- The contractor shall take utmost care whilst pulling conductors through conduit to ensure that the conductors are not kinked, twisted or strained in any manner. Damaged cables shall be replaced in its entirety.
- Care shall furthermore be taken to ensure that conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the insulation and durability of the conductor.
- Conductors installed in vertical wire ways shall be secured at intervals not exceeding 400mm to support the weight of the conductors.
- Proprietary or approved clamps shall be supplied and installed in suitable draw-boxes for this purpose.
- The contractor shall allow for the installation of the "last mile" conduit connection/link from the containment infrastructure installed by the electrical contractor, i.e. from trunking/cable basket to device location.

2.8.15 Method of Cable Support

- Fixing of cables to containment shall be via appropriate cable metallic straps, clamps and clips.
- No cable ties shall be used in the installation.
- Cables should be strapped to cable containment or supports every 500mm.
- The methods of cable support should be non-combustible and their installation should not in any way compromise the integrity of the circuit. The cable support material should be of a material that can withstand a similar temperature and duration to that of the fire rated cable whiles maintaining adequate support.

2.8.16 Terminations

- Connectors recommended by the manufacturer of the cable being terminated shall be used. Terminating equipment must be designed for the connection type and be used in the manner intended by the manufacturer. Connections must be of compression crimp type or similar, such that it is not possible to easily disconnect equipment simply through applying cable tension. All connections

must be located in accessible locations and protected against tampering and environmental risks.

- Spare electrical/optical cores shall be terminated into spare terminals for future connections and proper insulation.

2.8.17 Identification

- All system components shall be suitably identified with labels. Labels shall be located so that they are easily seen from normal access adjacent to the item being marked. Labels shall not be installed on components normally removed or replaced.
- General labels:
  - Stencil with black or white lettering contrasting with background.
  - For indoor applications only, engraved two-colour laminated plastic, black lettering on white background.
  - Engraved and black filled lettering on stainless steel or brass, minimum thickness 1mm.
- Warning labels and markings:
  - Danger and warning labels, fire and safety equipment labels: White lettering on red background.
- Pipes, conduits and ducts
  - Identification of the contents of pipes, conduits and ducts.
- Wiring and terminal strips
  - Identify wiring with numbered ferrules at both ends.
  - Number each terminal of terminal strips.
  - Numbering system: To match electrical and control shop drawings.
- Equipment identification
  - Identify each item by name and identification number.
  - Contents: Match terminology and numbering system of the contract documents. Number multiple items individually.
- Minimum lettering heights:
  - Equipment nameplates: 40mm
  - Danger, warning and caution notices: 10mm for heading 5mm for text.
  - Warning notices: 7mm.
  - Minor lettering: 3mm
- Lettering style:
  - Helvetica medium.

2.9 Samples, drawings and documentation

2.9.1 In addition to section specific requirements the following general samples, drawings and documentation requirements shall be adhered to.

2.9.2 All drawings, information, and documentation shall be in English, and each item shall be identified with the client's name and project / scheme / contract reference title and numbers, the Employer's representative's name and reference numbers, and the Manufacturer's works / contract / order references

2.9.3 Shop drawings, samples, product data submission and connection diagrams of the system configurations shall be provided by the contractor for approval by the engineer prior to equipment ordering.

2.9.4 Factory acceptance testing (FAT)

- Allowance for factory acceptance testing as per BOQ allowance.

2.9.5 Shop drawings

- Shop drawings shall be submitted by the contractor for approval by the engineer prior to any equipment ordering or installation.
- The tender drawings are schematic and do not show the exact dimensions or positions of equipment. Contractors must satisfy themselves that the equipment offered by them will fit in the available space and can be positioned so that access for maintenance, repair or removal is not encumbered.
- Not later than the time stated in the contract document (typically 1 week) after access to site or receiving verbal instruction, the successful contractor shall submit to the engineer, two copies of the detailed working drawings showing the required conduits, conduit boxes, position of equipment, cable trays, ducts etc., should extras be required. It must also be ensured that the complete installation is according to the specification and standards.
- Approval by the engineer of these drawings submitted by the contractor shall not relieve him of his liability to carry out the work in accordance with the requirements of the contract documents.
- NOTE: Final dimensions must be taken on site before any equipment or materials is either purchased or manufactured.

2.9.6 Sample submissions

- The contractor shall submit one sample of each designated item with copies of its supporting documentation.
- The contractor shall submit a range of samples if choice of colour or finish is required.
- The contractor shall also reselect and resubmit samples which are not approved
- The contractor shall keep the approved samples in good condition on site, until practical completion. The approved samples shall be checked against the installed products at Practical Completion and will not be returned.

2.9.7 Product data submissions

- The contractor shall submit manufacturer's data for all equipment, materials components and systems to be provided including the following as applicable:

- Technical specifications and datasheets
- Evidence of compliance with specified product certification schemes
- Drawings, showing size, arrangement, operating and maintenance clearances
- Schematic layout, piping, wiring and control drawings
- Operating weight and support loadings
- Lifting points
- Control details
- Recommendations for installation and maintenance

2.9.8 Submissions Schedule

- The contractor shall maintain and submit a monthly schedule of submissions to identify all proposed submissions designated with the following information:
  - Submission number, description, date and revision number
  - Status
  - Accepted
  - Submitted awaiting acceptance
  - Not yet submitted
  - To be corrected and re-submitted

2.9.9 All documentation shall be detailed and be written to enable any supplier or maintenance organization to maintain the system.

2.9.10 As-built drawings shall be provided by the contractor for the completed installation.

- "As-built" drawings shall be computer generated through a recognised CAD software package. Drawings submitted for acceptance shall be provided on A3 paper size.
- Final "As-built" drawings shall be submitted in A0 paper format, PDF and CAD format, on CD. Paper copies are to be neatly folded and placed in a perspex cover sleeve.
- The contractor shall supply laminated A3 layouts of the "As-built" drawings for the main control room.
- The detailed "As-built" drawings shall be provided by the Contractor showing positions of the following.
  - Equipment
  - Wire ways
  - Cable Routes.

2.9.11 Comprehensive operating and maintenance manuals (hard and soft copy) shall be provided by the Contractor prior to the commissioning stage. This shall include all duly completed certificates.

2.9.12 A draft copy shall be provided to the engineer for approval prior to final handover.

2.9.13 The operating and maintenance manuals shall include at least the following:

- A schedule of all components in the installations with the following information provided:
  - Manufacturers name and contact details
  - Function
- Full description and details of design capacity and design criteria for each item of equipment and each product.
- Detailed description of the function of all operator controls.
- Operator training manuals and operation procedures:
  - Safety procedures for protection against electrical, mechanical, and any other hazards.
  - Clear instructions for setting up and configuring the system.
  - Complete software configuration and physical connection information.
  - Safe starting up, operating and shutting down procedures for the systems.
  - Drawings and technical data as necessary for the efficient operation and maintenance of the systems.
- Project-specific Administrator's Guide that must detail all the functions available to the Administrator. It must also provide a detailed record of all the system configuration and programming settings for all programmable parameters. It must also contain all the administrator passwords that have been programmed into the system
- Procedures for fault finding.
- Maintenance instructions for all components, including frequency, repair, overhaul, change-out and installation procedures. Including:
  - Emergency maintenance procedures, including telephone numbers for emergency services and after hour's contacts for suppliers and contractors.
  - Detailed recommendations for preventative maintenance procedures, which should be adopted to ensure the most efficient operation of the systems installed.
  - Inspection, testing and maintenance programme in tabular form showing frequency and level of routine checks for each item.
  - Trouble shooting checklists and simple diagnostic analysis.
  - Schedule of normal consumable items, local sources of supply, and expected replacement intervals.
  - Schedule of recommended spare parts
- Commissioning procedures.
- "As-built" drawings.

- Copies of Software Licenses
- Manufacturer's Manuals, Warranties and Certificates

2.10 End-user training

2.10.1 In addition to section specific requirements the following general end-user training requirements shall be adhered to.

2.10.2 The contractor shall provide training to two separate groups of users, namely System Administrators and System Operators. In general, the training shall include presentations, informal discussions, demonstrations and hand-on activities on the actual system.

2.10.3 Training for System Operators shall cover all the functions and activities that the operators need to carry out on a daily basis.

2.10.4 The training for the System Administrations shall include that provided for the System Operators and additional training specific to system administration. Further, the System Administrators training shall also include training on how to teach other staff members by way of a 'train the trainers' approach.

2.10.5 The System Administrators' training shall be provided for up to 10 personnel. The training shall be carried out up to 2 sessions with 1 or more personnel per session.

2.10.6 The System Operators training shall be provided for up to 10 personnel. The training shall be carried out up to 2 sessions with 2 or more personnel per session.

2.10.7 Refresher training shall be provided after client occupation – typically 3 to 6 months following completion

2.10.8 The timing of the training shall be agreed between the contractor and the users, but must be completed prior to the handing over of the live system to the user. The contractor shall make provision for training of users on multiple work shifts.

2.10.9 Training Plan and Course Materials

- Training plan and course materials shall be submitted to the engineer at least two weeks prior to the commencement of the training for approval. The contractor shall provide all course materials, all support equipment (e.g. computer, projector, whiteboard, flipchart, etc.). The venue for the training shall be on the project site.
- A training feedback form shall also be provided for all trainees to fill out at the conclusion of every training session to evaluate the effectiveness of the training and for future improvement.

2.10.10 Training Records and Certificates

- The contractor shall maintain a complete record of the training. The record shall include:
  - Date and time of training session.
  - Name of trainer.
  - Name of all trainees.
  - Names of trainees issued with a completion certificate.
  - Training feedback forms.
- All trainees who have successfully completed the training shall be issued with a certificate signed by the trainer.

2.11 Testing and commissioning

2.11.1 In addition to section specific requirements the following general testing and commissioning requirements shall be adhered to.

2.11.2 Comprehensive testing and commissioning of the system shall be required. The contractor shall provide qualified personnel for the supervision of all inspection and testing activities.

2.11.3 A test plan and programme shall be submitted for approval by the engineer before any tests are conducted

2.11.4 The test plans shall be developed to unambiguously demonstrate the correct operation of the installed equipment. The contractor shall identify any testing that may impact on critical operations and seek direction from the engineer.

2.11.5 At minimum, the test plan shall include the following

- Details of the equipment to be tested.
- Configuration (e.g. memory, I/O cards, power supplies) of equipment to be tested.
- Software and/or firmware versions of equipment to be tested.
- Major software configuration parameters.
- System diagram showing how equipment is logically arranged.
- Details of any interfaces to third party equipment, both high level and low level.
- Cause and effect matrix detailing all input/output relationships/results.
- Pass or fail criteria to be specified within test documentation.

2.11.6 The test programme shall be developed providing the sequence of testing to be conducted. As a minimum, the test programme shall indicate the relative start and finish dates for the following:

- System Commissioning Tests
- System Acceptance Tests

2.11.7 System Commissioning Tests

- Upon receiving approval for the test plan and programme from the engineer, the contractor shall conduct unsupervised System Commissioning Tests in accordance with the test plan and within the dates defined in the programme.
- Any defects shall be rectified immediately by the contractor and the system re-tested. Tests shall be repeated until the contractor is able to complete all approved tests successfully without any defects. Upon successful completion, the contractor shall formally advise the engineer in writing of such, and that they are ready for the System Acceptance Tests.
- The engineer is not required to witness the system commissioning tests but may choose to do so.

2.11.8 System Acceptance Tests

- The contractor shall demonstrate the functionality of the system using the approved test plan. System Acceptance Tests shall be witnessed and signed off by the engineer or his representatives. The contractor shall provide two-way radio communications and all equipment required for the testing.
- If the System Commissioning Tests have been properly carried out, the systems acceptance tests should be straight forward and no defects should arise. In any case, should there still be defects; the systems acceptance tests shall be repeated. The contractor shall bear all costs incurred by the engineer or his/her representatives in attending system acceptance re-testing.
- Report of all the test event transactions shall be provided in both soft and hardcopy. Softcopy shall be in in the Microsoft Office Excel format for easy analysis.

2.11.9 The Contractor shall provide all necessary safety equipment and test instruments. All test instruments shall be covered by a current test and calibration certificate.

2.11.10 All inspection and test results shall be recorded using proforma documentation (test certificates and schedules) complying with applicable standard (e.g. BS 5839) – all test results shall be included in the handover documentation.

2.11.11 All certificates to be issued once final commissioning has been completed shall be submitted to the engineer for approval before being issued.

2.11.12 The Contractor shall make provision for all inspection and testing activities to be witnessed by the engineer. Unless otherwise specified, the period of notice for witness testing shall be 10 working days.

2.11.13 Unless otherwise agreed by the engineer, no part of the installation shall be commissioned until all defects or omissions revealed by inspection and testing have been rectified. Where a defect or omission renders all or part of the installation unsafe for use, the contractor shall take approved precautions to ensure that no part of the installation can be commissioned.

2.11.14 Before testing and commissioning, inspections shall be performed to verify:

- All equipment and material is of the correct type and complies with applicable BS standards.

- All parts of the installation are correctly installed.
- No part of the installation is visibly damaged or otherwise defective.
- The installation is suitable for the environmental conditions.
- The installation complies with this Specification.

2.11.15 On satisfactory completion of the inspections the following tests shall be performed in the sequence listed:

- A power failure shall be simulated to test the standby power supply.
- If required by the applicable standard, or requested by the engineer, cables and wiring shall be insulation tested at 500V after they are installed. The insulation resistance to earth and between conductors shall comply with the requirements of BS 7671. Because 500V can damage electrical and electronic equipment, the insulation test shall be carried out before equipment is connected to the cables or wire. The completed installation shall be tested at a lower voltage, as recommended by the manufacturer.
- Earth continuity should be tested in accordance to BS 7671.
- Each system component dynamically tested to ensure that they work satisfactorily, and that the correct indications and responses are given by the fire control panel.
- Annunciating devices shall be tested to ensure that the correct sound levels are achieved throughout the building.
- All signals from the system to ancillary systems shall be checked to ensure that the correct actions or responses are achieved.
- After individually testing the components and equipment, system simulation tests shall be done to commission the system and to indicate that the system is working.

2.12 Maintenance during defects liability period

2.12.1 In addition to section specific requirements the following general maintenance requirements shall be adhered to.

2.12.2 Comprehensive maintenance shall be provided during the twelve months Defects Liability Period. The defect period shall commence upon successful completion of system acceptance testing and the issue of the certificate of completion.

2.12.3 Comprehensive maintenance shall comprise of:

- Half-yearly preventative maintenance for all installed items.
- Ad-hoc corrective maintenance for reported faults.
- Keeping a maintenance register.

2.12.4 Half-yearly preventative maintenance

- The maintenance to be carried shall include but not be limited to the following activities:

- Consultation with user on any problems encountered and adjustment required (e.g. adjustment of programming of system behaviour, etc.).
- Check the operation of all system components for correct operation
- Check for correct system reporting of faults, alarms and errors.
- Check the operation of all annunciators
- Check and confirm interfacing with other connected systems
- Check operation of user interfaces (GUI, workstations, etc.)
- Check the physical conditions of the installation including mechanical fixing, evidence of corrosion to any part, signs of overheating, abrasion or physical damage.
- Check all data, control signal and power connections and terminations.
- Check the conditions of all batteries connected to the system. Clean batteries; recoat terminal posts with an approved coating.
- Check all labels and signage.
- Install software updates and upgrades including patches, firmware, updates and upgrades.
- Check time and date on system clock.

2.12.5 Ad-hoc Corrective Maintenance

- Ad-hoc maintenance shall be carried upon the user reporting a fault.

2.12.6 Maintenance Register

- A comprehensive maintenance register shall be kept by the maintenance service provider. The maintenance register shall include the following minimum information:
  - Name of person reporting or discovering fault.
  - Date and time of fault reported or discovered.
  - Nature of fault.
  - Date and time technician arrived on site.
  - Name of technician attended to fault.
  - Date and time fault is resolved.
  - Details of the action taken to resolve the issue including any parts being replaced.
- The maintenance register shall be an electronic register such a Microsoft Office Excel or Access database file. The electronic maintenance register shall be the property of the user and shall be handed over to the user at the end of the maintenance contract. Hard copy reports shall be updated and submitted to the user following any changes to the register.

2.12.7 Quality of service

- Quality of service shall be based on the key performance indicators below.

Service/Fault Description	Minimum Standard

Fault Reporting Help desk	Calls answered within 30 seconds during business hours. Return calls within 8 hours during weekends, public holidays and non-business hours.
Critical fault that impact on safe operation.	Technician on site within 24 hours of fault being lodged and fault resolved within 48 hours.
Urgent fault that impact on efficient operation.	Technician on site the next business day of the fault being lodged and fault resolved within 3 business days.
Minor fault that inconvenience the operation.	Technician on site within 2 business day of the fault being lodged and fault resolved within 5 business days.
Maintenance register	Every maintenance activity is accurately recorded in the register at the conclusion of the service activity. The maintenance register must be made available for inspection by the user following a 24 hours' notice.

3 BMS Installation

3.1 System design

3.1.1 Refer to section 2.4 for additional system design requirements

3.1.2 The building BMS system shall be provided to monitor and control some technical systems, such as power supplies, generators, UPS, HLI to HVAC control system (fixed IP address), water usage, pumps, clinical systems, etc as per the point schedule and layout drawings. The BMS shall be network-based and it shall be possible to log into the BMS system from any computer linked to the security network (provided by security contractor).

3.1.3 The goal is to implement an open architecture system that uses open protocol such as BACnet, Modbus or LonWorks that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.

3.1.4 The BMS system designs shown on the indicative schematics are based around the Schneider Electric SmartStruxure system. Alternate solutions may be proposed for consideration provided they achieve and exceed that of the documented design.

3.1.5 The following systems, including but not limited to the following, shall be connected to the BMS system.

- HVAC control system (Chiller plants, AHUs and Humidifiers, Fresh air and extract air fan systems)
- Water, booster, fire pump and tanks
- Smoke extract fan systems
- Lifts

- Substation switchgear (MV SCADA system)
- Automatic transfer switches
- Generator control panels
- UPS
- Water metering
- Electrical metering

3.1.6 The HVAC systems shall have its own dedicated control systems that links to the building BMS system via HLI interface to provide monitoring functions and alarm duplication on the BMS system. The HVAC BMS does not form part of the building BMS system, however the integration, interface testing and commissioning is deemed included.

3.1.7 The MV electrical network shall employ its own dedicated SCADA control system which shall output to the BMS system for selected function, status reporting and control via HLI interface as per the specification.

3.1.8 The BMS point schedule applicable to this specification is appended to this document.

3.1.9 The BMS system shall operate on the security ICT network. All ICT network points shall be provided by the structured cabling system contractor. Active network equipment shall be supplied and configured by the clients' ICT representative, including VLANs, VPN, etc. The BMS contractor shall liaise with the ICT trade contractors to ensure his requirements are met. Details on the ICT network are contained in the ICT specifications and associated drawings and not included in this specification.

3.1.10 The BMS contractor shall be the lead coordinating contractor to coordinate all interfaces between the BMS and all other systems.

3.1.11 The various trade contractors shall provide and assist the BMS contractor as follows

- Confirmation of the BMS software representation of system and system variables. This shall include providing comment of the screen layouts, graphic layouts, reports and trends as prepared by the BMS contractor
- Provide interface equipment, terminals or sockets to connect to the BMS system. Preference shall be given to a TCP/IP connection and an open protocol such as BACnet, Modbus or LonWorks. The BMS contractor shall be responsible for the connection of the output of the installed interface to the BMS system.
- Confirmation, at the time of tender, of the type of connection and protocol options associated with each item in the point schedule that is to be connected to the BMS system.
- Commissioning and testing of the BMS system

3.1.12 The functional descriptions provided in this document provide the design intent and the BMS contractor shall actively participate in the development of the final functional descriptions for the BMS.

3.1.13 The BMS contractor shall produce documentation to support the delivery, installation, testing and commissioning of the BMS in conjunction with affected parties.

3.1.14 The client shall be the named license holder, or shall nominate the name to be used, of all software associated with any and all incremental work on the project.

3.2 System requirements

3.2.1 Refer to section 2.5 for additional system requirements

3.2.2 The BMS shall primarily be a monitoring system, however a selected number of critical systems shall be controllable via the building management system frontend, including the main distribution board change over circuit breakers and substation switchgear.

3.2.3 The entire BMS shall comprise a network of interoperable, stand-alone digital controllers communicating via LonWorks, Modbus and/or BACnet communication protocols to Network Interface Controllers (NICs). To provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of standard communication protocols at controller level and Ethernet TCP/IP communication technologies at Server and Terminals level at minimum. High level interfaces are to use BACnet protocol where possible.

3.2.4 The new building management system shall perform the following functions:

- Overall system status monitoring
- Control of connected systems as detailed in the point schedule
- Energy monitoring
- System scheduling
- System reporting
- Alarm reporting
- Email & SMS (via SMS server) capabilities

3.2.5 The BMS contractor shall provide the hardware and software necessary to implement the functions shown or implied in the contract documents.

3.2.6 The Human Machine Interface shall be based on the Microsoft Windows Environment, allowing the user to make full use of the features provided with these operating systems. The system shall support standard LAN communication on Ethernet® or fibre optics TCP/IP and standard network equipment.

3.2.7 The features of the system shall include dynamic graphical user interfaces, data acquisition and logging alarm and system exception handling.

3.2.8 The system response times are shown below. The times are maximum overall elapsed times after initial event (non-cumulative).

Function		System response time
Alarm category 1 or 2	Outstation detection	4 seconds
	Workstation alarm	10 seconds
	Event initiated action	10 seconds
Alarm category 3, 4 or 5	Outstation detection	10 seconds
	Workstation alarm	30 seconds
	Event initiated action	30 seconds
Priority global command (fire, safety)	Outstation action	15 seconds
Normal global command	Outstation action	60 seconds
Graphic Display Delays:	Refresh of values displayed on graphics at the operator's workstations	30 seconds
	Generation of a graphic following transfer from another graphic:	5 seconds
	Time from operator login to viewing graphics:	60 seconds

3.2.9 The BMS software package shall provide the following tools for network analysis and monitoring:

- Protocol analyser tool;
- Traffic analysis tool; and
- Network diagnostic tool.

3.2.10 The BMS software shall provide alarm recognition, storage, routing, management and analysis. The server software shall be able to route any alarm to any defined user location whether connected the local network or remote via dial-up, telephone connection, or wide-area network.

3.2.11 Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

- To alarm
- Return to normal
- To fault

3.2.12 The system shall provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e. security, HVAC, fire.

3.2.13 The system shall provide alarm generation from “runtime” and / or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

3.2.14 Control equipment and network failures shall be treated as alarms and annunciated. Alarms shall be annunciated in any of the following manners as defined by the user:

- Screen message text
- E-mail of the complete alarm message to multiple recipients

3.2.15 The BMS server shall provide the following functions at minimum.

- Calendar
- Scheduling
- Trending of ALL parameters, including SQL database (Historian function)
- Alarm monitoring & routing
- Time synchronization
- Time zone handling
- Integration of multiple communication protocol-based controller data
- Object linking and embedding for process control (OPC Unified Architecture) for connectivity to third party OPC complaint software/devices
- Colour graphic display
- On-line plots
- Use Microsoft-based security
- System documentation and graphs generation
- Dynamic data exchange (DDE)
- Dispatch of a single time schedule to all programmable nodes
- Tune control loops through the adjustment of control loop parameters (if required)
- Enable or disable systems

- Generate text file reports to a networked printer
- Select points to be alarmable and define the alarm state
- Configure alarms to be send to Microsoft windows mail client
- Select points to be trended over a period of time and initiate the recording of values automatically
- Provide different levels of security to every object in the server database
- Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords.

3.2.16 The server shall have multiple graphics with flashing alarm object(s) with printed messages, routed directly to a designated alarm printer (when selected) and audio messages.

3.2.17 The following shall be recorded by the server software for each alarm (at a minimum):

- Time and date (ISO 8601 format)
- Location (building, floor, zone, office number, etc.)
- Equipment (label, access way, etc.)
- Acknowledge time, date and user who issued acknowledgement.
- Number of occurrences

3.2.18 Alarm actions may be initiated by user defined programmable objects created for that purpose. Defined users shall be given the proper access to acknowledge any alarm, or specific types of classes of alarms defined by the user. A log of all alarms shall be maintained by the server and shall be available for review by the user, attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by the user.

3.2.19 Repeat/nuisance must have the feature to be disabled, and a feature for monitoring disabled alarms.

3.2.20 An alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. The dedicated alarm window shall provide user selectable colours for each different priority alarm.

3.2.21 The system shall have the ability to collect data for any property of any object and store this data for future use. The data collection shall be performed by objects, resident in the node and server, shall have at a minimum, the following configurable properties:

- For interval logs, the object shall be configured for time of day, day of week and the sample collection interval
- For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object

- For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis
- Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action
- All log data shall be stored in a database in the server and the data shall be accessed from a server or a standard Web Browser

3.2.22 The system shall provide the ability to configure the following archiving properties, at a minimum:

- Archive on time of day
- Archive on user-defined number of data stores in the log (buffer size)
- Archive when log has reached its user-defined capacity of data stores
- Provide ability to clear logs once archived

3.2.23 The system shall provide and maintain an Audit Log that tracks all activities performed on the system. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to the server or remote storage device. For each log entry, provide the following data:

- Time and date
- User ID
- Change or activity: i.e. change set point, add or delete objects, commands, etc.

3.2.24 The server shall have the ability to, and be supplied with, automatic backup its SQL database (Historian function). The database shall be backed-up based on a user-defined time interval.

3.2.25 Copies of the current database and, at the most recently saved database shall be stored on the server. The age of the most recently saved database is dependent on the user-defined database save interval.

3.2.26 Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.

3.2.27 System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected for a period of time.

3.2.28 All system security data shall be stored in an encrypted format. Each object in the system database must be able to have a security policy applied to it.

3.2.29 The system software shall be able to seamlessly interact with Microsoft Office Products, including Excel, with no additional programming.

3.3 Components and equipment

3.3.1 Refer to section 2.6 for additional component requirements

3.3.2 The BMS head-end equipment shall be installed in the main server room on ground floor in the SC1 tower in a 19" rack cabinet supplied by the Structured cabling contractor. The head-end equipment and software shall consist of the following components at minimum.

- Client Server Software and license
- HMI Programming, Trends, Logs & Logics including licensing
- Client Workstation Software and license
- Programmable logical controllers incl. power supply module
- Historian SQL database

3.3.3 Field hardware and system interfacing

- Field hardware and system interfacing shall be done via field controllers or outstations, or combination of both as per the contractor's final shop drawings.
- Field controllers shall be smaller microprocessor based digital controllers with resident control software dedicated to the controlling a single item of plant. Normally <15 I/O points.

- Outstations shall be larger programmable microprocessor based digital controllers with resident control software, adaptable and expandable for controlling a number of items.

3.3.4 The system, shall at a minimum, support the following graphical features and functions

- Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to a graphic background, the SERVER shall support the use of scanned pictures.
- Graphic screens shall contain objects for text, real-time values, animation, colour spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens
- Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner
- Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered
- Adjustments to analogue objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value
- The SERVER shall be able to support multiple graphic objects at the same time. If tiled, then each graphical object shall be fully scalable or aspect locked.
- Trend Displays (variable versus time) - A trend display shall show the values of points plotted versus time. The SERVER software shall provide real-time and historical trending (for data which had been logged).
- This may be achieved by colour graphic page display.
- Real-Time Trends shall contain real-time data.
- A historical trend log display present data stored on the computer's hard disk.
- X-Y Plots (variable versus variable) - An x-y plot shall dynamically represent the real-time or historical relationship one variable plotted against another variable.
- The server software shall provide dialog boxes and menu picks for configuring trends and plots
- Any analogue or binary data may be trended or plotted
- The software shall store pre-configured presentation of trends to facilitate operator call-up of trend log displays. It shall be possible to call up a trend log with preassigned data

3.3.5 The server software shall provide a graphics builder. The graphics builder shall provide show, simulate, review, and document animation functions to allow the user to identify, diagnose, change, and document animation points on each display. The graphics builder shall include but not be limited to the following.

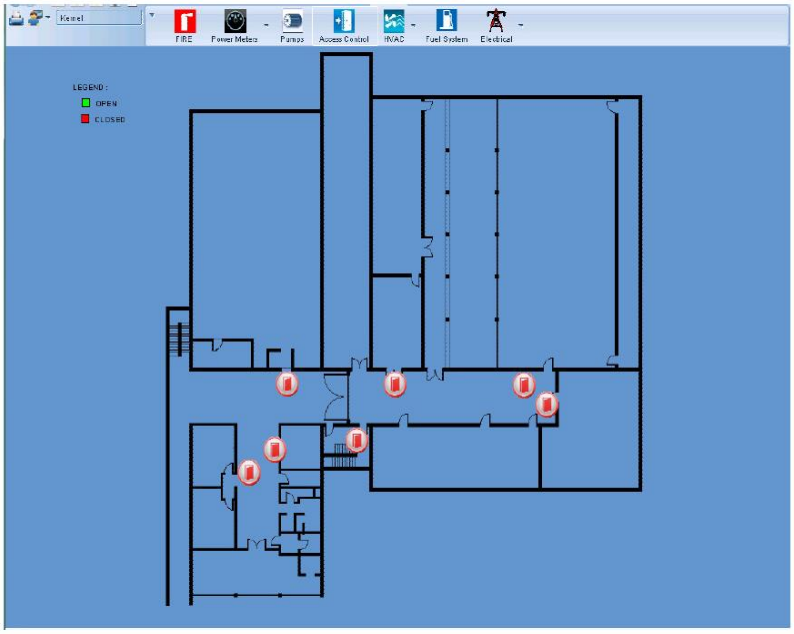
- A library of vendor-supplied objects will be included. These objects, widgets, and symbols must be continuously scalable. These items shall be editable by the user.
- A library of animated graphic objects shall be included. The Graphics Builder will animate process graphics with real-time data from field devices. Multi-State colour animation shall be provided to change a graphic object's colour from a palette of colours. Colour animation for normal, alarm, and alarm acknowledged

states for both analogue and binary point tags shall be provided. The user shall define the foreground and background colours for each state. Objects and text data shall blink based on alarm state and acknowledged state.

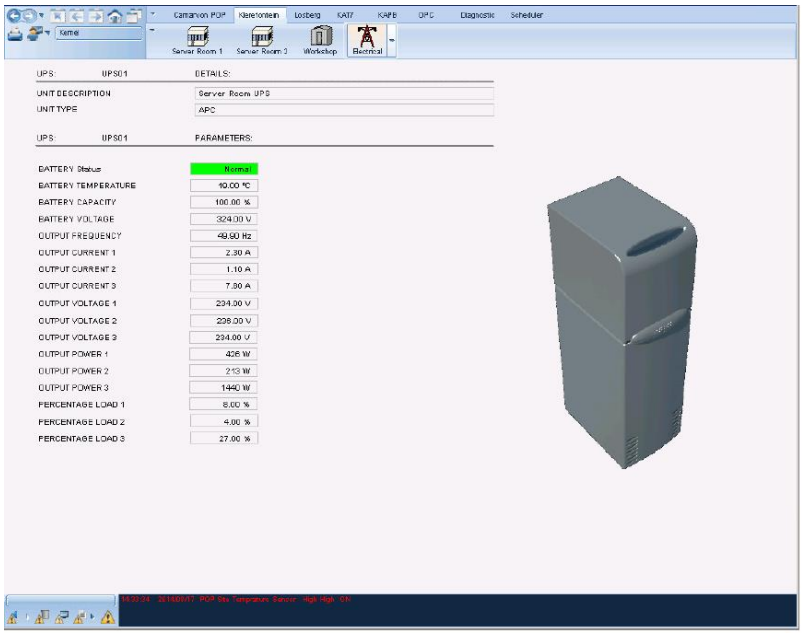
- The software shall display the numeric value of an analogue point, text of a text point, and the descriptors of a binary point. The software shall provide a display linking function. Clicking the object associated with the link changes the display to a new user-defined display.
- The software shall enable active points to be selected with the mouse and accessed. It shall be possible to make a point non-pickable: the dynamic information shall be displayed, but the operator will not be able to access a detail display, change the value, etc. based on security settings of the software.
- The server, shall at a minimum, support the following graphical features and functions
  - Open external executable files from button click.
  - Ability to open HTML web pages from button click
  - Ability to view Microsoft Excel files from button click

3.3.6 The BMS system graphics shall be configured as follows.

- A general overview layout screen indicating main status, alerts and alarm notifications shall be provided.
- BMS screens shall be available in the following configurations for all connected systems.
  - Site overview
  - Per building
  - Per floor
  - Detailed view of system
- The above shall be available at site, floor and schematic layout level for each system connected to the BMS. A typical system overview screen example is shown below (access control system).



- Technical equipment screens for all connected equipment indicting a detailed breakdown of monitored parameters for equipment in question. A typical technical equipment screen is shown in the figure below (UPS system).



- The BMS contractor shall develop and present the overview and equipment screens for the system for approval by the engineer prior to initial commissioning.
- The following main system screens shall be provided at minimum – also refer to integration matrix and point schedule for connected systems
  - Medium voltage distribution (switchgear and transformers
  - Distribution boards, energy meters and change overs
  - Power conditioning equipment
  - Emergency standby generators
  - Diesel storage
  - Fire detection system (Gas fire suppression system)
  - Wet services (pumps and tanks)
  - Fire protection (pumps and tanks)
  - HVAC HLI
  - Vertical transport

3.3.7 On-Line Help function shall be provided which shall include a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.

3.3.8 A system diagnostics shall be provided which shall enable the system to automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciated to the operator.

3.4 Interfacing with other systems

3.4.1 The BMS system shall interface to all systems as per the appended point schedule.

3.4.2 The BMS contractor shall liaise with all trade contractors to ensure the integration of the required services onto the BMS system.

3.4.3 Medium voltage electrical (11kV) installation

- The MV electrical contractor shall supply and install energy meters and MV switchgear in the MV substations. The BMS system shall communicate via HLI to the MV system via Ethernet Modbus TCP/IP over the Converged ICT network or via BMS controller as per contractor's final workshop drawings.

3.4.4 Electrical installation

- The electrical contractor shall supply and install energy meters in distribution boards. The BMS system shall communicate to the BMS via Ethernet Modbus TCP/IP over the Converged ICT network or via BMS controller as per contractor's final workshop drawings.
- The electrical contractor shall supply and install the Isolated power supplies. The BMS contractor shall connect the BMS system to the voltage free alarm contracts.
- The electrical contractor shall supply and install the surge protection in the distribution boards. The BMS contractor shall connect the BMS system to the voltage free alarm contracts
- The electrical contractor shall supply and install the façade lighting contactors in the distribution boards. The BMS contractor shall connect the BMS system to the coil contracts for scheduling and switching of the Façade lighting contactors.
- The electrical contractor shall provide 230 VAC power outlets in close proximity to the equipment. The contractor shall coordinate the final location and number of points required.
- The BMS contractor shall reticulate all power requirements for the system from the point provided by the electrical contractor onward.
- The BMS contractor shall perform all power reticulation from the power outlet to all required BMS equipment

3.4.5 UPS installation

- The electrical contractor shall supply and install UPS power supplies. The BMS system shall communicate to the UPS systems via Ethernet Modbus TCP/IP over the Converged ICT network or via BMS controller as per contractor's final workshop drawings.

3.4.6 Standby diesel generation

- The electrical contractor shall supply and install standby diesel generators. The BMS system shall communicate to the Generator control system via Ethernet Modbus TCP/IP over the Converged ICT network or via BMS controller as per contractor's final workshop drawings.

3.4.7 Domestic water

- The domestic water contractor shall install the meters, pumps and tank level sensors, etc. as part of their scope of work. The BMS contractor shall connect the BMS system to the sensors

3.4.8 Fire water and fire protection

- The BMS contractor shall connect the BMS system to the mimic panel provided by the fire water and protection contractor.

3.4.9 Fire detection system

- The BMS contractor shall connect the BMS system to the main fire alarm control panel's BMS output relays or high-level interface Modbus TCP/IP as per the contractor's shop drawings for alarm and fault monitoring.

3.4.10 Vertical transport (lifts)

- The BMS contractor shall supply and install the BMS lift interface panels with volt free contacts for the lift contractor to terminate wiring in the lift shaft (top)

3.4.11 HVAC system

- The HVAC control system shall provide high level BACnet interfaces to the BMS system. Selected critical alarm shall be duplicated directly on the BMS system (e.g. Operating theatre AHUs) for alarm and monitoring purposes.

3.4.12 ICT services

- The structured cabling contractor shall provide data outlets adjacent to each BMS panel to enable the BMS to utilize the Converged ICT Network. The BMS contractor shall liaise with the structured cabling contractor to determine the final position and number required
- The BMS head-end shall be housed in shared security racks shall be provided by the structured cabling contractor in the main equipment server room for the installation of the BMS servers by the BMS contractor

3.5 Installation of components and equipment

3.5.1 Refer to section 2.8 for additional installation requirements.

3.5.2 Specialist cables

- All extra-low voltage BMS cables shall be run in Mylar screened twisted pair cables or as recommended by the Manufacturer
- All cables shall be affixed to containment wire-ways / trays, drawn into conduit or trunking and protected as agreed with the engineer to suit the various environmental, social and mechanical locations.
- No joints shall be allowed in cables, where these are unavoidable, the cables shall be joined using an approved housing, securely fixed and having cable securing clamps. Any such connecting boxes shall be shown on the as-built drawings.
- Where cables are connected to sensors measuring extreme heat, the necessary thermal breaks, local connecting cables shall be supplied by the BMS contractor.

- No BMS data cable shall be installed in the same conduit as any power cable nor affixed within 25mm if surface/tray mounted. Where cables are run in trunking or with other services, clipped to trays of a similar type, the BMS cables shall be identified either by colour or permanent labels every 2m.
- Special care shall be taken to ensure that the manufacturer's recommendations with respect to earthing data cables and outstations are obeyed.
- All BMS cables shall be suitably identified with sleeves at the terminations. These shall be recorded on the installation diagrams and wiring schedules and included in the as-built drawings.
- Network cables shall be supplied with at least two spare pairs to allow for future system expansion.

3.5.3 Field devices

- Each BMS field device shall be identified (internally on space temperature and humidity sensors) with a common code used on points and wiring schedules, parts lists, control strategy, and installation diagrams/drawings.
- Sensors, actuators, switches and all field devices shall be mounted according to the manufacturer’s instructions. All devices shall be installed with clearance to allow for servicing, and the conduit connected by methods to allow easy replacement.
- Where outstations switch circuits having potentially different mains voltage supply feeds, extra low voltage relay circuits shall be employed. A notice shall be fixed inside the outstation detailing how all mains feeds into it shall be isolated.
- Each outstation shall be provided with a schedule identifying the points connected to the I/O terminals inside the panel door.

3.6 Samples, drawings and documentation

3.6.1 Refer to section 2.9 for samples, drawings and documentation requirements

3.6.2 Pre-construction submissions

The contractor shall submit the following prior to construction;

- Functional controls description including full points list and sample graphics of each system proposed. The functional control description is to be fully developed in conjunction with the engineer and shall be progressively submitted in stages to enable progressive feedback to be obtained from all stakeholders.
- Schedule of points connected to each controller.
- UPS electrical power demand calculations

3.6.3 Workshop drawings

Workshop drawings shall consist of the following minimum information;

- Schematic drawings of the control system.
- Floor plans indicating all BMS panels, plant controlled/monitored by the BMS, and BMS sensors including all wall mounted sensors, duct mounted sensors, in-ceiling actuators (including VAV boxes and mixing boxes), and interfacing points (eg VAV diffusers).

- Drawings to be 1:100 scale to project drawing setouts. Refer project drawing plan for drawing layouts.
- Detailed written description of control strategies including setpoints, dead bands, limits, alarms and alarm suppression. Do not re-iterate this specification.

3.6.4 The BMS contractor shall ensure the following are completed at hand-over:

- Any snagging to be documented and agreed date determined for clearance
- All passwords/PIN numbers, levels and operators recorded
- Disk copies of all system and data files supplied
- Proprietary software manuals & disks
- Consumables, printer ribbons, printer paper at agreed levels
- All equipment access keys handed over
- Complete sets of Operation & Maintenance manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.
- Training of engineers and operators to be checked complete or program for completion agreed

3.6.5 Multiple soft and hard copies, as defined in the schedule of quantities, of all final operating and maintenance manuals shall be supplied within the contact defined period of hand-over in A4 binders. Preliminary copies shall be available to the client during this time. All system documentation shall be in accordance with standard templates as developed by the BMS contractor and approved by the engineer.

3.6.6 Operating Manuals shall comprise instructions on equipment safety checks, start-up and close-down procedures, daily operation and full descriptions of operating features. These shall match and comply fully with the software supplied, provide examples of operation with supporting flow/strategy diagrams. Diagrams shall show the full diagrammatical (network structures, outstations and peripherals) and physical layout of the system and components.

3.6.7 Maintenance Manuals shall comprise full descriptive and maintenance details on each and every item of equipment supplied. Suppliers and spare parts references, contacts, telephone numbers, and addresses shall be supplied where relevant.

3.6.8 Data sheets and maintenance instructions shall be provided for each item of equipment.

3.6.9 Wiring schedules shall show the connection of each item of equipment to the field equipment. Diagrams showing the configuration of all control and monitoring schemes, identifying the modules used, their interconnections and setting parameters, copy print-outs showing the individual outstation module configurations and sequences.

3.6.10 As-built record drawings of the BMS installation shall be prepared and supplied by the BMS contractor in a recognised CAD software package. All drawings relating to the BMS shall be supplied A1/A0 sizes bound into A4 ring binders. These shall include system, outstation and user terminal configuration diagrams, listings and flow charts.

3.6.11 Back-up copies of all system configuration files and master software disks shall be supplied in an appropriate lockable storage facility. All system and data files shall be current as at the hand-over date, disks to be suitably identified and directories and files cross-referenced in the maintenance manuals. The storage unit and key shall be handed to the client's engineer at hand-over.

3.7 End-user training

3.7.1 Refer to section 2.10 for additional end-user training requirement

3.7.2 The BMS contractor shall supply the following training for the client's engineering/maintenance staff:

- On or off-site prior to hand-over at manufacturers works; non-specific system structure, components and applications. Operation of user terminals, keyboards, use of displays, overrides, passwords etc.
- On-site specific system structure, outstations locations, control strategy overviews. Operation of user terminals, adjustments, graphs and alarm handling. Other networked components.

3.7.3 Engineering and selected operator staff

- On or off-site prior to hand-over complete training courses at the manufacturers works, instruction in the following; all as above but also including, configuration of outstation and user terminals software, Windows file structures, password and engineering utilities, fault-finding, tuning and maintenance.
- On-site; while the clients engineer shall attend the acceptance demonstrations, the BMS specialist shall instruct him in the specific application of the system, the structure and the control strategies adopted to meet the specification

3.8 Testing and commissioning

3.8.1 Refer to section 2.11 for additional testing and commissioning requirements

3.8.2 The BMS contractor shall be responsible for the full commissioning of his system and any other control equipment supplied by him.

3.8.3 It is critical that the functionality of the BMS be verified after the installation and this will be accomplished using an approach similar to the following. The installation contractor needs to update and confirm the final verification procedures suitable for the specific system:

- Confirm that the correct hardware and software is installed and running correctly and that the relevant firmware has been upgraded on all devices including field devices. The supplier should confirm that the hardware, software and firmware are compatible with each other.
- Screen layouts, graphic layouts, reports and trends shall be inspected and reviewed by the engineer to confirm that suitable information is displayed and that the layouts are easy to understand and use.
- Confirm that each IP address corresponds with the client supplied IP addresses of all devices including filed devices.
- Confirm error free communication between the BMS servers, work station and field devices. The software should give any errors or warnings.
- Confirm that the tags, labelling and naming of each device is according the latest approved labels and names. Confirm that the same tags, labels and names are used on all screens, manuals, drawings, documentation, devices, etc. (software representation vs real-world presentation)

- Demonstrate and confirm the addresses and tags for all the data or control points. This shall be done in collaboration with the installer of the relevant system. Procedures shall be established to confirm beyond any doubt that the correct data point is read or controlled. This can be done by creating or simulating a change in device data and witnessing that same change is displayed and recorded on the BMS.
- Confirm that the data types of each data point are correct and that the BMS display and record the data according to the correct precision and range.
- Do similar demonstrations to confirm the correct and error free communication between the BMS and external parties.

3.8.4 A pre-completion test demonstrating the functionality of controllers and operator workstations to demonstrate system operation shall be required. The test shall include but not be limited to the following.

- Scaling (Calibration certificates shall be provided as required)
- Control algorithms
- Operation of graphic screens
- Provide means of simulating inputs and outputs to and from the system.
- Witnessing: Give notice of factory tests.

3.8.5 All safety interlocks, overrides and fail-safe conditions are to be operational prior to starting the system.

3.8.6 Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective once BMS control mode is selected. Sensors shall be checked to ascertain accuracy within limits, pressure switches checked for switch points and hysteresis. Humidity sensors shall be checked for accuracy using a wet/dry bulb thermometer. All the necessary test equipment and materials used in commissioning shall be supplied by the BMS contractor. All test equipment shall have valid test certificates.

3.8.7 Graphs shall be provided to demonstrate the stable control of the plant. Simulated inputs shall be employed to check stability over the design environmental range.

3.8.8 The BMS contractor shall allow additional time on site by his commissioning engineer to revisit the system at a later date (after hand-over) as per the schedule of quantities. He shall check and adjust operational parameters, and re-tune any control as maybe required by change in the control system load conditions or bedding-in of the plant.

3.8.9 Commissioning documentation and schedules shall be submitted for approval during the design phase showing each plant, point, interlock and control algorithms, and the stages of checks and commissioning required. Each cleared item to have date and engineer reference. Completed copies shall be available to the engineer prior to acceptance testing. A complete set of the commissioning documentation is to form part of the system documentation.

3.8.10 Once any item of plant is commissioned and left running to the dictates of the BMS, documentation showing the overrides, control and software configuration shall be available on site at all times. All system documentation shall be in accordance with standard templates as developed by the BMS contractor and approved by the engineer.

3.8.11 A comprehensive acceptance demonstration of the BMS system shall be required prior to final handover. The BMS contractor shall give notice, as per the contract defined notice period, to the engineer of his intention to provide the acceptance demonstrations once the initial commissioning is complete. The operation of all safety interlocks shall be tested and ten per cent of all points shall be selected by the engineer and demonstrated for operation/accuracy. Should more than 1% fail performance test, a further ten per cent may be selected. If above 1% fail, the engineer may at his discretion demand 100% demonstration. The BMS contractor shall supply sufficient man-power/test equipment, consumable items and two-way radios to conduct the demonstration efficiently. Testing shall also incorporate an audit of the wiring and hardware installation, demonstration of safety interlocks, start of system from power-down and review of time schedules and alarm levels, grouping and selected control parameters.

3.9 Maintenance during defects liability period

3.9.1 Refer to section 2.12 for additional maintenance during defects liability period requirements

3.9.2 The contractor shall advise the client’s ICT department during commissioning and handover if remote access to the BMS system will be required during the maintenance period.

4 Digital Twin integration

4.1 Terms of Reference

4.1.1 There is a requirement to fully digitise the SANSA Hermanus site with accurate and reliable information to provide the BMS system with the as-built three dimensional information for the site. This would further support SANSA with its planning and design, projects, maintenance & operations, occupational health and safety and environment sustainability requirements in line with National Key Point requirements

4.1.2 The list below illustrates the inventory of buildings. Note this list is not exhaustive and other buildings may be added to the Terms of Reference depending on priority. The assignment will be undertaken in tranches and prioritised in terms of importance, relevance and budget, with each tranche representing a work order ring-fenced for specific locations.

4.1.3 Buildings for 3D Scanning

#	Campus	Building
1	SANSA - Hermanus	New Building
2	SANSA - Hermanus	New Accommodation
3	SANSA - Hermanus	Student Accommodation
4	SANSA - Hermanus	Falmouth Building
5	SANSA - Hermanus	Admin Block
6	SANSA - Hermanus	Generator Block
7	SANSA - Hermanus	Existing 1
8	SANSA - Hermanus	Existing 2
9	SANSA - Hermanus	Existing 3
10	SANSA - Hermanus	Existing 4

4.2 Reality Capture

4.2.1 Purpose

The Contractor is required to provide all relevant, existing site information for integration into a descriptive Digital Twin. This shall include all geometric and non-geometric information required to build an effective Digital Twin which will enable facility-wide 3D and 2D viewing, management of documentation and files, asset management, and the management of design information.

This reality capture section provides guidance for the capture of geometric information of existing infrastructure, buildings and equipment, the BIM process, quality processes and final deliverables. The data collection process described below is the Engineer's guidance, and the final method of capture will be based on the Tender offer i.e., the **Contractor's Method Statement for Reality Capture and** Modelling which must be submitted as part of the tender response.

All Clauses referencing data accuracy, quality and data integration are technical specifications which shall be adhered to and forms contractual obligations.

4.2.2 Survey control

The site will be measured and captured by using a combination of technologies to capture the buildings in their current condition, shape, and composition. These technologies may include 3D laser scanners, drones, geotagged imagery for above-ground features and Ground Penetrating radar for detection of underground services as the need arises.

These sets of information shall "fit together" to form a single integrated reference from which the model will be generated. This shall be accomplished by using survey control points to reference each dataset into the correct place.

Surveyed control points and targets shall be established throughout the site and inside the buildings prior to commencement of drone, scan or GPR based measurements. This shall ensure that the data is referenced reliably in the 3D model environment. These points shall be high visibility targets that will be used to reference the data into the correct 3D position.

4.2.3 Data collection

Drone photogrammetry will ideally be used for capturing of building façades, any rooftop equipment and precinct layout and topography. The drone will capture high-resolution images of the building and facilities from overhead. The images are processed into a 3D point cloud, a 3D mesh, and a composite aerial photo of the site. These outputs will be referenced to the survey benchmarks. The cost for all licence applications, Client approvals, regulatory approvals shall be included in the Tender rates.

3D Simultaneous Localisation and Mapping (SLAM) scans may be done throughout the building and the precinct grounds to capture all indoor and outdoor ground level spaces. The SLAM scanner is a hand-held scanner that takes continuous measurements while the operator carries it at walking speed through the facility. The SLAM scan data is processed to create a 3D point cloud. The SLAM output will be referenced to the survey benchmarks.

High detail areas like plant rooms should be scanned using a **static 3D laser scanner** that captures a higher density of points than the SLAM scanner. The high-density 3D point clouds that are achievable from the static scanner facilitates the modelling of more complex and congested 3D environments. The static scans will be referenced to the survey benchmarks.

Indoor building services that are situated **above the ceiling** will be located by using a combination of visual inspection, markup on layouts and 3D scanning. 3D scanning is reliant upon line-of-sight to measure objects. Celling panels must be removed to expose the ceiling void and make the services visible. It may be challenging to capture utilities above ceilings due to the limited line-of-sight. Visual inspection is thus essential to verify that the 3D scans are interpreted correctly by the modelling team.

360 photographic reference of the building including details of any problematic aspects shall be supplied.

Sub-surface scan of external areas adjoining and/or inter-leading between adjoining buildings/erven to locate utilities and services is required for a comprehensive model to be completed. The Contractor will need to obtain all wayleaves and permits required to survey/detect services which is located within municipal road reserves or council property.

Ground Penetrating surveys using equipment to locate and mark all underground services may be required as the need arises and included in the Tender offer. Items required to be included with the GIS information package shall include water, sewage stormwater, electrical, telecommunications and IT, gas and any other pipes, valves, underground structures e.g., manhole and meters components and systems. There shall be modelled in Civil 3D and coordinated with the building model using Navisworks.

4.2.4 Data assembly

The point clouds that were generated from the drone, SLAM and static scans shall be assembled into a single point cloud that will be the basis of 3D modelling.

4.2.5 3D modelling

The building model/s shall be created in Revit using an approved BIM methodology. This methodology shall be approved by the Engineer following review and acceptance of the Contractor's **BIM Execution Plan**. The BIM Execution Plan shall include the following as a minimum:

- Level of development/detail/information required
- Drawing/modelling templates
- Classification systems
- Naming and numbering systems
- Quality Control procedures
- Model issuing and exchange protocols
- Filing structure
- Coordination and clash detection protocols
- File export formats
- COBie data strategy

The assembled scan data shall be traced by the 3D modellers to create the 3D components that make up the digital model. Each component shall be classified into categories that are defined to suit the Client's operational and information requirements.

- Dimensional accuracy of architecture of +/- 5cm and pipe sizes, ducts, etc
- Dim accuracy of 10mm or better, and

- Location of underground services 50cm or better.
- Utilities in ceilings must be modelled at 50cm or better

The display properties, symbology, colours, and component classification system shall be applied to the components as they are modelled. The Client's requirements for these parameters must be discussed and agreed upon prior to commencing modelling.
A ground surface representing the external areas around the site shall be generated in the form of a 3D mesh. The mesh must be created from the combination of ground level points that are generated from the drone photogrammetry and supplementary scan points that were collected under trees and canopies where the drone may not have had a clear line of sight. The 3D mesh will provide a general shape of the ground to enable the contextual placement of possible drainage structures.

The ground level and underground components of the stormwater system shall be modelled in AutoCAD Civil 3D and imported into the Revit model. The ground level features shall include manhole covers and grid inlets. These will be modelled into the 3D ground surface mesh.

The overall 3D model will thus comprise all existing buildings, equipment.

4.2.6 Level of Development and information

The visual representation of the infrastructure, buildings and equipment shall be representative of the actual elements on site and modelled to LOD 300, as defined by the Level of Development (LOD) Specification for Building Information Models, December 2021 edition.

The information associated with each maintainable element shall be captured in COBie format and sufficient to allow the following:

- Locating the element via the 3D viewer
- Tag identification
- Manufacturer, model and serial numbers
- Service interval
- Next service date

All point cloud densities shall be suitable to allow for an efficient modelling workflow and for modelling to LOD 300. The level of acceptance for point cloud densities and devices used shall be approved by the Enginer prior to commencement of the works.

4.2.7 Modelling and storage

Model quality assurance (QA) shall be achieved by inspection on site, using a mobile device to view the model while inspecting the facility. Discrepancies, errors, and omissions shall be identified and marked directly on the model using the mobile interface, by the Engineer. Changes shall be tracked and completed by the modelling team.

BIM USE	**DISCIPLINE (if applicable)**	**SOFTWARE**	**VERSION**
Design authoring	Architecture	REVIT	2019 (minimum)
Design authoring	Structural	Revit Structure	2019 (minimum
Design authoring	MEPF	Revit MEP	2019 (minimum
Design authoring	Civil	Autodesk Civil 3D	2019 (minimum

Design authoring	Mapping	Autodesk Map 3D	2019 (minimum
Design authoring	Mapping	ESRI ArcGIS	10.8 (minimum)
Co-ordination	All	Navisworks	2019 (minimum
Design authoring	Civils	Civil 3D	2010 (minimum)

4.2.8 Measurement and coordinate systems

All measurement shall be in metric units.

GIS file exchange formats shall conform to the following:

Data Type	**Extension**	**File Type**
Vector GIS File Formats	Esri Shapefile	.SHP,
		.DBF,
		.SHX
	Geographic JavaScript Object Notation (GeoJSON)	.GEOJSON
		.JSON
	Geography Markup Language (GML)	.GML
	Google Keyhole Markup Language (KML/KMZ)	.KML
		.KMZ
	GPS eXchange Format (GPX)	.GPX
Raster GIS File Formats	ERDAS Imagine (IMG)	.IMG
	American Standard Code for Information Interchange ASCII Grid	.ASC
	GeoTIFF	.TIF
		.TIFF
		.OVR
	IDRISI Raster	.RST
		.RDC
	Envi RAW Raster	.BIL
		.BIP
		.BSQ
Compressed Raster File Formats	ER Mapper Enhanced Compression Wavelet	.ECW
	Joint Photographic Experts Group JPEG2000	.JP2

	LizardTech Multiresolution Seamless Image Database MrSID	.SID
		.SDW
Geographic Database File Formats	Esri File Geodatabase	.GDB
	Esri Personal Geodatabase	.MDB
LiDAR File Formats	ASPRS LiDAR Data Exchange Format	.LAS,
		.LASD,
		.LAZ
	Point Cloud XYZ	.XYZ
Elevation File Formats	USGS DEM, Canadian CDED	.DEM
	Digital Terrain Elevation Data (DTED)	.DT0
		.DT1
		.DT2

4.2.9 QA and site verification

Model quality assurance (QA) shall be achieved by inspection on site, using a mobile device to view the model while inspecting the facility. Discrepancies, errors, and omissions shall be identified and marked directly on the model using the mobile interface, by the Engineer. Changes shall be tracked and completed by the modelling team.

The QA process shall include visual checks, clash detection, checks against standards and validation against actual site information. The process, frequency, hold points and reporting associated with the QA process shall be documented in the BIM Execution Plan for the project.

4.2.10 Deliverables

The following deliverables shall be supplied:

- Drone photogrammetry point clouds
- Scan point clouds including all generated 360 photographs
- 3D Revit Model capable of being viewed on various platforms incl. Navisworks, elements modelled as generic objects/place holders
- IFC files of the above 3D Revit Model for import into the Digital Twin, Common Data Environmet
- COBie data file for import into the Digital Twin, Common Data Environment
- Digital Twin 3D Model with Common Data Environment and integrated with BMS and GIS.

4.2.11 Deliverables with tender

The following deliverables shall be supplied as part of the Tender response

- Comprehensive reality capture method statement
- BIM execution plan

Figure 1 - SANSA Hermanus Site Map

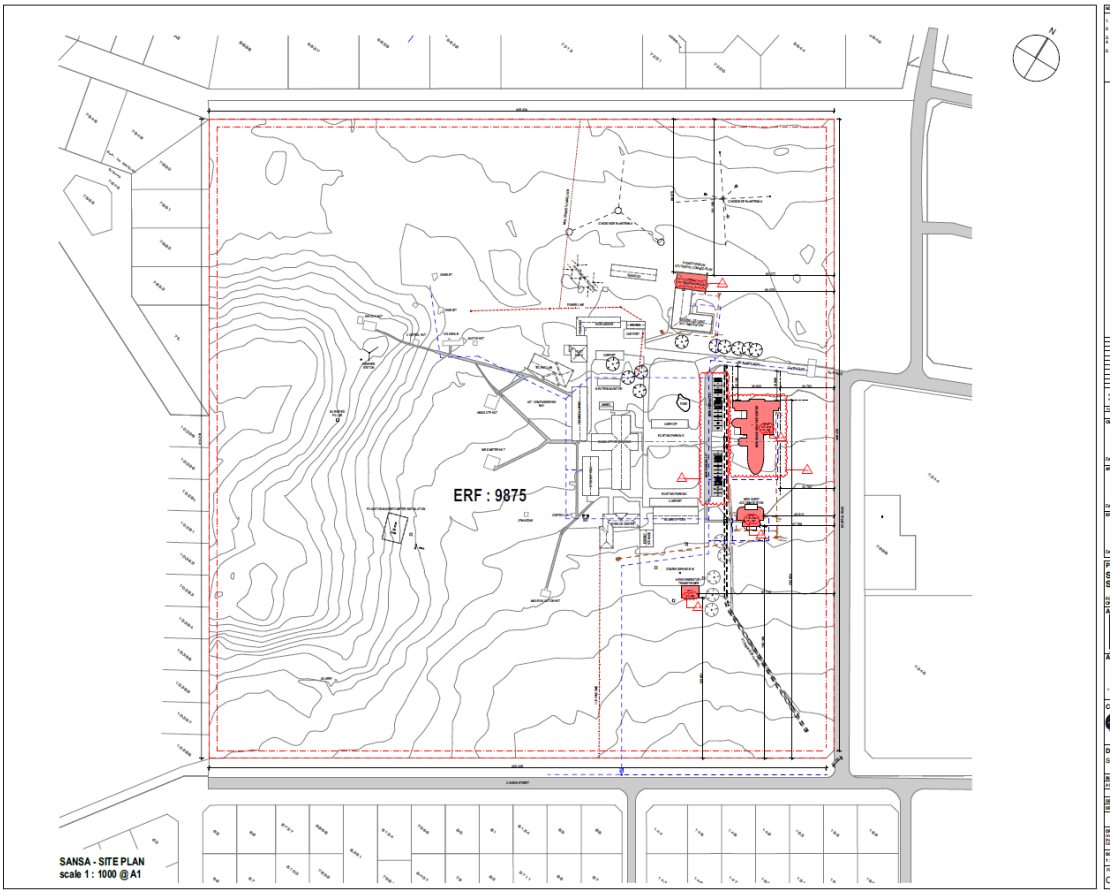


Figure 2 - Site Map (incl new buildings)

4.3 Scan to BIM

4.4 Digital Twin - BIM to FM Integration

The following information is provided regarding Client's anticipated requirements for Products and Services. Client offers this information as basis for this quote only and does not guarantee the accuracy of this information or the level of projected business that may be accomplished under any contract awarded as a result of this solicitation.

4.4.1 Project Scope

This section will detail the key outcomes sought from the Lifecycle BIM management solution, which should be considered when responding to the tender.

One-Stop Solution for Lifecycle BIM for Different Users

a) The overall objective for the Lifecycle BIM management solution is for it to be a 'one stop solution' for design, construction and maintenance projects, providing a one source of truth that can be easily accessed and referred to.

b) The solution is to be easily accessible for all approved users. It should be installed on a central internally hosted (or a cloud) server [specified by the tenderer] and accessed through a web browser.

c) It is vital that the solution can be accessed by employees and external partners on site. The Client does not want to be reliant upon a solution provider when making changes or adding to the solution. This would have to be done without having to write scripts to make changes.

d) The Client is currently going through the process of creating a 3D model of the building and site, this again will have to be constantly updated and as such the solution will have to allow for constant geometric changes from the model, whilst maintaining links to databases.

e) The Client will hold all licenses for the solution.

f) The target date for the Lifecycle BIM management solution to be operational is _____.

Key Requirements for Tender Response

The list below is a high-level breakdown of all the key requirements of the solution that the tenderers will have to respond to.

List of Key Requirements for the Lifecycle BIM Solution:

4.4.2 Viewer

a) 3D Viewer should be able to work in the Cloud and on-premises (without connection to public internet).

b) 3D Viewer should work in major browsers (Firefox, Chrome, Edge) without plugins.

c) 3D Model Viewer should allow:

    a. hide/show selected objects
    b. allow changing navigation speed
    c. load models by layers (i.e. hide architectural and show electrical objects)
    d. allow sectioning
    e. change object selection colors
    f. adjust field of view
    g. provide ability to measure distances within 3D
    h. show 2D layers / floorplans in the same window as 3D
    i. show 2D sheets published from Revit

j. show room name and number for 2D floorplans
k. show objects selected in 2D within 3D view and vice-versa
l. provide ability to navigate in 3D by selecting rooms in 2D
m. show the number of issues / work orders assigned to the object in 3D
n. provide ability to show real-time sensors' data in 3D
o. change transparency (opaqueness) of elements by various degrees
p. provide high-resolution rendering as an option
q. support point clouds and parametric 3D in the same window
r. set different colors for 3D objects based on various criteria
s. allow selecting/viewing one or more systems at the same time

d) Ability to search for assets, systems, and locations within the 3D Viewer and view their details.

e) Ability to view documents associated with assets/locations within the 3D model.

f) Ability to view & create work orders (issues) associated with assets/locations within the 3D model.

g) Ability to create 3D markups and attach them to issues.

h) Ability to view which objects affect the selected object, and which objects are affected by the selected object within the 3D model.

i) Specify module for creating and editing model views (viewpoints) within the solution, including automatic viewpoints generation, and storing viewpoints by folders.

j) The solution should be able to link existing asset information to 3D objects.

k) Demonstrate ability to group elements in 3D and assign to a space or a system.

l) Demonstrate ability to use visual (3D) analytics based on the existing data, for example, select objects based on some criteria in 3D.

m) Provide the ability to color objects based on some criteria and apply multiple criteria for the same view in 3D.

n) Demonstrate how point cloud viewer allows for redline / markups linked to issues / work orders.

o) Demonstrate how 3D Viewer objects are linked to historical data from BMS/BAS/SCADA systems.

p) Provide the ability to build 2D diagrams (i.e. electrical riser diagram) in the browser, and link diagram elements to BIM objects.

4.4.3 Asset Data Management

a) The solution should allow editing asset metadata (attributes for types, components, spaces, systems, zones, floors, facilities).

b) Allow searching and filtering asset data in grids (types, components, spaces, systems, zones, floors, facilities) and view individual asset's profile page and related information.

c) Provide the means to customize which fields (columns) are displayed on asset data grids.

d) Provide the ability to export asset grids data to Excel.

e) Allow tracking and differentiating maintainable assets (as defined by COBie) and non-maintainable assets (i.e. valves and pipe segments).

f) Asset profile pages should be able to include classification-specific attributes.

g) Support BIM attribute types (i.e. length, volume, etc.).

h) Provide the ability to batch update an attribute for a group of assets via a web interface.

i) Provide the ability to set up barcode templates and generate barcodes/QR codes for a group of assets.

j) Demonstrate the ability to create assemblies (group of components).

k) Demonstrate the ability to navigate through systems and subsystems (i.e. electrical circuits and panelboards).

l) Provide the ability to easily assign and un-assign components to/from a system.

m) Show how the solution provides the list of assets located within a space (Room Data Sheet).

n) Show how a user can view the selected asset or space in 3D BIM viewer.

o) Provide the ability to build relationships (upstream/downstream impacts) for a group of assets and spaces.

p) Enable Preventative Maintenance (PM) Jobs to be entered during the project stage:

    a. Specify Job steps / tasks per COBie standard.
    b. Define end date or number of occurrences for Job.
    c. Link Resources to Job (per COBie standard).

4.4.4 Files Management

a) The solution should be able to link existing technical documentation to the model's elements (types, components, spaces, systems, etc).

b) Demonstrate ability to customize list of document categories.

c) Demonstrate ability to filter files and documents using tags or metadata.

d) Provide ability to create folders and subfolders and place the files in them.

e) Provide ability to set up access to folders by user roles.

f) Show how to create tags and edit document metadata (container) using the web interface.

g) Demonstrate versioning of files.

h) Provide ability to assign more than one document to the same container (i.e. same named files with different file extensions).

i) Demonstrate Check-in / Check-out functionality for files.

j) Demonstrate auto-naming files on upload.

k) Demonstrate workflow editing for files' status management.

l) Provide ability to view 2D drawings (DWG, DGN) and PDF, JPG, PNG files, create redline markups and attach them to issues.

m) Provide report / counts of documents in folder by status.

n) Provide ability to create issues for files (documents).

4.4.5 Quality Control

a) Provide ability to create dynamic reports and/or filters (saved queries) for asset data.

b) Provide ability to create custom forms online, and fill out forms using web interface and mobile devices (iPad).

c) Provide ability to schedule inspections, link forms to be filled out, assign users.

d) Specify processes and features for managing quality control of information:

    a. Show which fields are not populated.
    b. Show which fields do not match pre-established criteria (range, selection list, pre-defined value, etc.)

c. Show which documents are not uploaded / assigned to BIM objects
d. Enable in-grid editing of data.
e. Enable batch update of data.

4.4.6 Use of Handheld / Mobile Device

a) The solution must provide access to BIM on a handheld device (Android smartphones, iPhone, iPad) as a native application (not via browser).

b) Demonstrate ability to use barcoding on handheld devices.

c) The solution must be able to work both online and offline (when Internet is not available).

d) Demonstrate ability to create issues (punch list, snagging, work orders) on mobile devices using 3D interface.

4.4.7 User Access

a) Demonstrate how user roles and permissions allow limiting access to information.

b) Demonstrate how users access and edit information filtered by discipline (i.e. electrical, HVAC, plumbing, etc.).

4.4.8 Support for Open Standards

a) The Solution must support open standards: COBie import and export, the solution must be certified by buildingSmart (via COBie Challenge).

b) Specify filtering of data (by organization, by asset maintainability, by attribute templates) during exporting COBie data. The client does not want to receive data not specified as required.

c) Provide support for BCF files import and export.

d) Provide support for import of IFC files.

e) Provide support for import of CityGML files.

f) Provide a specification / solution or details regarding linking live BAS/BMS/SCADA data and support for OPC, BACnet, Modbus standards.

g) Demonstrate how the Solution supports open standards for objects classification, e.g. OmniClass, Uniclass, Uniformat, MasterFormat.

4.4.9 Interfaces to BIM Authoring Tools

a) Specify direct integration with the BIM authoring applications (i.e. Autodesk Revit) using APIs for the respective products.

b) Demonstrate the ability to publish 2D sheets and 3D views from Revit into CDE.

c) Explain how the solution checks BIM (i.e. Revit) files for space/rooms consistency, how it allows dealing with equipment-to-space linking.

d) Provide ability to map fields from imported BIM objects to custom and default fields in CDE.

e) Describe the protocol for updating 3D models, maintaining a single version of data (no duplication of assets in several CAD/BIM files).

4.4.10 Integration with External Systems

a) Provide API / SDK module and demonstrate how it supports web services.

b) Specify GIS integration capabilities (i.e. ArcGIS, Mapbox, Google Maps).

c) Demonstrate integrations with CMMS / CAFM applications.

d) Demonstrate integrations with Project Management software and options to reduce data collection challenges for handover.

e) The solution should provide links to engineering and maintenance documentation stored in external systems. It should provide a solution for linking those documents to BIM objects (Types, Components, Systems, Spaces, Floors, Zones, Facilities), so that the Client can add and link these documents to the model over time.

f) The Lifecycle BIM management solution need to be able to link BIM objects to the Building Automation System(s) (BAS) data points.

g) The BAS connection settings (i.e. frequency of saving data point value, IP address, etc.) shall be managed via a browser interface.

h) Ability to build 2D diagrams (i.e. P&IDs) in the browser, and link diagram elements to the BAS data points.

4.4.11 Templates, Processes and Specifications

a) Specify ability to reuse information (templates, saved queries, etc.)

b) Demonstrate how end users can create hierarchies of objects using web interface (disciplines, categories, types, etc.).

c) Provide a built-in business workflow engine (how end user actions trigger other activities).

4.4.12 Proof of Capability (References)

Appendix: Returnable schedules

The returnable schedules shall be completed by the tenderer in full, failure to complete the schedules and submit the required information could result in the disqualification of the submission.

The following documents must accompany the submission:

DOCUMENT	INCLUDED ✓ / ✖
Cover letter	
Tender Document	
Completed Schedule of Quantities	
Form A: Signing Authority	
Form B: Schedule of Work Carried Out by The Tenderer	
Form C: Amendments or Qualifications by The Tenderer	
Form D: Schedule of Construction Plant	
Form E: Schedule of Proposed Subcontractors	
Form F: Technical Data Schedule Completed Schedule of Returnable Documents and Information (complete with data sheets/product information submissions)	
Project references (similar to project Scope of Work)	
Company profile and proof of registration	
Proof of Contractors membership (e.g. Fire Detection Installers Association, Private Security Industry Regulatory Authority, etc.)	
Proof of Contractors accreditation on proposed systems (approved installer, maintainer, etc.)	
List at least 5 projects with paying referenceable clients that utilised the tenderer's BIM+FM software/services.	
Tenderer must show examples (or case studies) of use cases of BIM to FM projects done.	

FORM A: SIGNING AUTHORITY

State in cases where the Tenderer is a company, corporation or firm, by what authority the person signing does so, whether by Articles of Association, Resolution, Power of Attorney or otherwise.

I, the undersigned .....

(Full names in block letters) am authorised to enter into the contract on behalf of:

.....

.....

By virtue of .....

Dated .....

SIGNATURE: .....

DATE : .....

AS WITNESSES:

1. .....

2. .....

FORM B: SCHEDULE OF WORK CARRIED OUT BY THE TENDERER

The Tenderer must insert in the spaces provided below a complete list of the last ten engineering contracts awarded to him. This information shall be deemed to be material to the award of the contract.

EMPLOYER (NAME, TEL NO, TELEFAX NO AND TELEX NO)	CONSULTING ENGINEER (NAME, TEL NO, TELEFAX NO AND TELEX NO)	NATURE OF WORK	VALUE OF WORK	YEAR COMPLETED

SIGNED ON BEHALF OF TENDERER: .....

DATE : .....

FORM C: AMENDMENTS OR QUALIFICATIONS BY THE TENDERER

PAGE	DESCRIPTION

SIGNED ON BEHALF OF TENDERER: .....

DATE : .....

FORM D : SCHEDULE OF CONSTRUCTION PLANT

The tenderer must state below what construction plant will be available for the work should he be awarded the contract.

DESCRIPTION, SIZE, CAPACITY	NUMBER

NB:

After the award of the contract, the contractor must satisfy the engineer that all the above constructional plant or equivalent plant will be on the site at all times when required. The contractor shall maintain all constructional plant in a good working order for the duration of the contract.

The contractor also undertakes to bring onto the site, without additional costs to the employer, any additional constructional plant which, in the opinion of the engineer, is necessary for completing the contract within the tendered contract period.

SIGNED ON BEHALF OF TENDERER: .....

DATE : .....

FORM E: SCHEDULE OF PROPOSED SUBCONTRACTORS

The tenderer shall list below any subcontractors he wishes to employ to carry out part(s) of the work.

The acceptance of this tender shall not be construed as being approval of all or any of the listed subcontractors. Should any or all of the subcontractors not be approved subsequent to the acceptance of the tender, it shall in no way invalidate this tender, and the tendered unit rates for the various items of work shall remain final and binding even in the event of a subcontractor not listed below being approved by the employer.

PART OR TYPE OF WORK	PROPOSED SUBCONTRACTOR	WORK RECENTLY EXECUTED BY SUBCONTRACTOR

SIGNED ON BEHALF OF TENDERER: .....

DATE : .....

FORM F: TECHNICAL DATA SCHEDULE

This information schedule must be fully completed by the Tenderer to allow the Engineer to evaluate compliance with the specification.

Failing to complete the schedule will result in disqualification.

This information shall not be treated as qualifications or deviation from the specification.

The Engineer reserve the right to ask the Tenderer to submit alternative offers for equipment and materials found to be not compliant to the specifications.

The schedule shall not be completed by using answers such as “refer to” and “see attached”

All technical brochures and technical sheets shall be provided separately form this document

1.	**BMS system**	
1.1.	Manufacturer	
1.1.1.	Software package name	
1.1.2.	Historian package name plus SQL version	
1.1.3.	Graphics package	
1.2.	Server ICT requirements (list all requirements including software, databases etc.)	
1.3.	Report server requirements (list all)	
1.3.1.	Workstation requirements (list all)	
1.4.	Automation server make and model	
1.4.1.	Automation server I/O make and model	
1.5.	Automation server PSU make and model	
1.6.	Communication cable make and model	

1.7.	Enclosure make and model	
1.8.	Lead time	

SIGNED ON BEHALF OF TENDERER: .....

DATE : .....

Appendix: Schedule of quantities.

PREAMBLE TO THE SCHEDULE OF QUANTITIES

(a) For the purpose of this schedule of quantities the following words shall have the meanings hereby assigned to them:

Payment Item	:	This number refers to the relevant clause in the specification that describes the item
Item No	:	This number is for reference only
Description	:	The description clarifies what the item is for
Unit	:	The unit of measurement for each item of work as defined in the standard specifications or the special provisions of contract
Quantity	:	The number of units of work for each item
Rate	:	Payment per unit of work or material at which tenders offer to do the work or supply material
Amount	:	The product of quantity and rate
Lump sum	:	A price tendered for an item, the extent of which is described in the schedule of quantities, the specifications or elsewhere but of which the quantity of work is not measured in any units

(b) This schedule of quantities forms part of the contract and shall be read in conjunction with all the other documents comprising the contract documents.

(c) The quantities set out in the schedule of quantities are approximate only and the quantities of work finally accepted and certified for payment, and not the quantities given in the schedule of quantities, shall be used for determining payments to the Contractor.

(d) The validity of the contract shall in no way be affected by differences between the quantities in the schedule of quantities and the quantities finally certified for payment. Work shall be valued at the rate or lump sum prices tendered, subject only to the provisions of the general conditions of contract and the provisions of paragraphs (k) and (l) of this preamble.

Rates and lump sum prices shall include full compensation for overheads, profits, incidentals, etc, and for the completed items of work as specified. Full compensation for completing, and maintaining during the maintenance period, all the work shown on the drawings and specified in the project specifications and for all the risks, obligations and responsibilities specified in the tender rules, general conditions of contract, special conditions of contract and project specifications shall be considered as provided for collectively in the items of payment given in the schedule of quantities, except in so far as the quantities given in the schedule of quantities are only approximate.

(e) The Tenderer must fill in a rate or lump sum to each item where provision is made for it, even where no quantities are given. Items against which no rate or lump sum has been entered in the tender will not be paid for when executed, as payment for such work will be regarded as covered by other rates or lump sums in the schedule of quantities.

The Tenderer must fill in a rate opposite all items where the words "rate only" appears in the "Price" column. The intention is that although no work is foreseen under such an item, and no quantities are accordingly given in the "Quantity" column, the tendered rate shall apply in the event of work under this item being actually required. The attention of the Tenderers is directed to the provisions of paragraph (l) of this preamble.

If the Tenderer should group a number of items together and tender one lump sum for such group of items the single tendered lump sum shall apply to that group of items and not to each individual item, or should he indicate against any item that full compensation for such item has been included in another item, the rate for the item included in another item shall be deemed to be nil.

The tendered lump sums and rates shall be valid irrespective of any change in the quantities during the execution of the contract.

(f) The works as executed will be measured for payment in accordance with the methods described in the contract documents under the various payment items, notwithstanding any custom to the contrary. Except where otherwise specified, the net measurements or mass of

the finished work in place shall be taken for payment but excluding any volume or mass of work in excess of that ordered.

(g) The quantities of work or material stated in the schedule of quantities shall not be considered as restricting or extending the amount of work to be done or quantity of material to be supplied by the Contractor.

(h) The quantities of material or work stated in the schedule of quantities shall not be regarded as authorisation for the Contractor to order material or to execute work. The Contractor shall obtain the Engineer's detailed instructions for all work before ordering any materials for or executing work or making arrangements in this regard. Material shall be ordered according to the construction drawing routing, and measurements taken on site.

(i) The short descriptions given of payment items in the schedule of quantities are only for the purposes of identifying the items and providing specific details. Reference shall be made, inter alia, to the drawings, project specifications, general conditions of contract and special conditions of contract for more detailed information regarding the extent of the work entailed under each item.

(j) Reference shall be made to the general conditions of contract regarding provisional sums.

(k) Subject to the conditions stated in paragraph (l) below, the rates and lump sums filled in by the Tenderer in the schedule of quantities shall be final and binding and may not be adjusted should there be mistakes in the extensions thereof. Should there be any discrepancies between the correctly extended and totalled schedule of quantities and the tender sum, the Employer shall have the right to make such adjustments to the tender sum as he may deem necessary in order to reconcile the total of the schedule of quantities with the tender sum. In their own interest Tenderers should make doubly sure of the correctness of their tendered rates, the extensions and the tender sum.

(l) A tender may be rejected if the unit rates or prices for some of the items in the schedule of quantities are, in the opinion of the Employer, unreasonable or out of proportion, and the Tenderer fails, within a period of seven (7) days after having been notified in writing by the Employer to adjust the unit rates or prices of such items, to make such adjustments.

(m) The units of measurement indicated in the schedule of quantities are metric units. Abbreviations used in the schedule of quantities are as follows:

mm	=	millimetre
m	=	metre
km	=	kilometre
m^2	=	square metre
m^3	=	cubic metre
No	=	number
P.C. sum	=	Prime cost sum
Prov. sum	=	Provisional sum

(n) The Tenderer's rates shall not include VAT.

VAT shall be added to the total value of the contract in the item specifically allowed for VAT in the calculation of the tender sum.

Note: The main offer must be as per specification; i.e. without qualification. If Tenderers offer alternatives, these can be included in an “alternative bid” under a separate covering letter.

(o) The “submission” column indicates what tender and pre-installation criteria will be adhered to by the contractor.

Abbreviations used in the schedule of quantities are as follows:

Datasht	=	product or equipment datasheet
Sample	=	Sample of product/equipment required prior to installation
FAT	=	Factory acceptance testing.

		To occur after manufacturing, before delivery to site.
Calc	=	Contractor calculation proof required

Where no guidance is offered in the column, datasheets of the equipment shall be provided at minimum. The engineer reserves the right to request additional equipment information as may be required from the contactor.

The contractor shall prepare an approval tracker spreadsheet as per the specification document listing all systems and the approval status thereof. The spreadsheet shall also be used to track expected delivery dates and actual delivery dates to site

In diversity there is beauty and there is strength.

MAYA ANGELOU

Document prepared by:
Zutari (Pty)Ltd
Registration number
1 Century City Drive,
Century City, Cape Town
7000

T 021 526 9400
F 021 526 9500
E mep@zutari.com

ZUTARI
IMPACT. ENGINEERED.