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APPENDIX 1 – AUTOMATION AND CONTROL SYSTEMS – SCHEDULE OF CHANGES – VERSION 6.1

As a guide only, attention is drawn to changes that have been made in the following clauses since the last revision

Clause	**Date**
General revision	
No changes	August 2004
Major rewrite (Version 4.1)	July 2005
General revision (Version 4.2)	September 2013
Major rewrite (Version 5)	July 2015
General Revision (Version 5.1)	April 2016
General Revision (Version 5.2)	March 2017
Major rewrite (Version 6)	March 2018
Critical Alarm Section Updated (Version 6.1)	April 2019

1 ACRONYMS & TERMS OF REFERENCE

BACnet	BMS communication protocol
BMS	Building Management System
BTL	BACnet Testing Laboratories
CBACS	Campus Building Automation and Control System
CAMS	Critical Alarm Management System
CPI	Critical Plant and Infrastructure
CUE	Critical User Equipment – School or Faculty Fridges/Freezers/Incubators
EM Engineering	UNSW Estate Management Engineering
FAT	Factory Acceptance Test
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HLI	High Level Interface
HMI	Human Machine Interface
I/O	Input / Output – Field monitoring and control devices
IST	Integrated System Test
LLI	Low Level Interface
LSS	Life Safety System and Gas Detection
Modbus	Industry communication protocol
MS/TP	Master Slave / Token Pass – BACnet communication protocol
MTTR	Mean Time To Repair
NAS	Network Attached Storage
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance Manual
PLC	Programmable Logic Controller
SAT	Site Acceptance Test
SIF	Safety Instrument Function
VLAN	Virtual Local Area Network

2 BUILDING MANAGEMENT SYSTEMS

2.1 General

The works shall include design, supply, installation, and commissioning of nominated control systems to achieve the performance specified in the following clauses hereafter referred to as BMS. All BMS infrastructure shall be connected directly the CBACS VLAN using UNSW supplied data ports, and shall conform to the ASHRAE Standard 135-2016 BACnet protocol using BACnet® compliant BTL® listed hardware and software to meet the system's functional specifications. The integrated multivendor BMS network and associated interconnected campus, facility and building systems shall be referred to in the following document hereafter as CBACS.

UNSW's CAMS integrates BMS, CBACS sub-systems, and UNSW Security system Cardax® to monitor critical events for comprehensive critical alarm response. CBACS and CAMS and associated sub systems are supported by UNSW's IT network infrastructure creating a very large and complex platform; as such it is essential EM Engineering is engaged for direction on systems configuration, CBACS integration, project specifications, familiarity with campus conditions and existing equipment, communication types, and other matters impacting the BMS, CBACS and CAMS, sub-systems, and the UNSW IT network.

2.2 Nominated Original Equipment Manufacturer (OEM) Products

Only the following nominated OEM products and local distributors shall be used for new major capital construction works:

- WebCTRL® – Logical Building Automation Pty Ltd
- Metasys® – Johnson Control Australia Pty Ltd
- StruxureWare® – Schneider Electric Buildings Australia Pty Ltd

Where BMS infrastructure is being implemented in an existing building or facility it is essential EM Engineering is engaged for OEM products proposed to ensure the integrity of incumbent system within existing buildings is maintained.

2.3 Standards & Reference Material

The BMS shall be installed complying with all:

- National and local statutory regulations.
- Occupational Health & Safety legislation and codes of practice.
- SAA Wiring Regulations (AS3000).
- Building Code of Australia.
- OEM instructions and recommendations.
- ASHRAE Standard 135 BACnet.

2.4 System Architecture

BACnet compliant BTL listed Software, System Controllers, High Level Interfaces, Application Controllers, and all I/O devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135.

The system architecture shall comprise the following components, networked together to provide a system of connected devices that operate as a single BMS for the entire project, and integrate without adverse effect to the CBACS:

- System Controllers with Ethernet network linking to the CBACS VLAN (Ethernet Ports shall be provided by UNSW IT Unit).
- Application Controllers with I/O sensing and control for field peripherals.

- BACnet HLI for plant, infrastructure and integrated components and systems (refer to Section 2.9).

All materials and products used shall be new and current generation OEM products commercially available for a minimum of five years after project completion. Untested products shall not be used, unless explicitly approved by the EM Engineering in writing.

2.4.1 IP Network Configuration

The BMS VLAN connected to the CBACS is Ethernet IP network ports and infrastructure provided by the University IT Unit. All CBACS ethernet CAT5/CAT6 cables shall be Yellow in colour.

Network configuration including IP Addresses, Subnets, UDP/IP Port Number, MS/TP Network Number, Network Number and Device Instances will be supplied by EM Engineering upon approval of the initial BMS network architecture or topology.

NOTE: It shall be the responsibility of contractors to ensure that the BMS design interconnects with CBACS and the University IT network to achieve full system functionality, without impact to other BMS and CBACS infrastructure. The initial BMS network architecture or topology is required for approval by EM Engineering prior to project commencement.

2.4.2 MS/TP & Modbus Network Configuration

MS/TP and Modbus network shall be wired in a daisy chain configuration only. Star or tee connections are not permitted unless recommended by the OEM. Network speeds shall be set to operate at the maximum speed specified by the OEM documentation and connected equipment. All MS/TP and Modbus RTU communication cables shall be Yellow in colour.

***NOTE*:** Application Controllers, and HLI devices shall have separate dedicated MS/TP networks; mixed MS/TP networks are not acceptable. Critical Plant and Infrastructure, User Equipment and HLI devices shall have dedicated MS/TP and power segmented from other non-critical devices. The initial BMS network architecture or topology is required for approval by EM Engineering prior to project commencement.

2.4.3 Power Supply

All power for BMS equipment shall be from dedicated circuits. BMS installations shall be fed from Essential Services supply with Generator back-up (where applicable). All Voltage Transformers shall be located within designated control enclosures. Separate Voltage Transformers shall be used for each BACnet Network Segment. I/O field peripherals and control peripherals shall be separately powered from the BACnet Network Segments. Power shall not be obtained by tapping into miscellaneous circuits that could be inadvertently switched off.

2.4.4 Uninterruptable Power Supply (UPS)

BMS installations shall be installed with UPS located within or adjacent to the designated control enclosure to supply power to all components if centralised building UPS is not specified. UPS shall be monitored to indicate fault condition and alarmed on the BMS.

2.5 Operator Interface Hardware and Software

Operator interface hardware and software shall be on existing CBACS Servers provided by UNSW built to the OEM's minimum requirements.

All BMS hardware is to be BACnet compliant, BTL listed, and configured to current UNSW naming conventions in-line with the UNSW building grid references. IP addresses, subnet configuration, device instances, network numbers, port numbers etc. shall be supplied pending initial BMS network topology design approval by EM Engineering.

All software is to be BACnet compliant, BTL listed, and configured to current UNSW naming conventions in-line with the UNSW building grid references. IP addresses, subnet configuration, device instances, network numbers etc. are available from UNSW Estate Management Engineering upon request. All operating software including but not limited to system software, licenses, administration level passwords, drivers, registration details, backups etc. shall be submitted to EM Engineering on approved media. Operator Interface Software shall be on existing CBACS Servers provided by UNSW which are remotely accessible, and on a mobile platform; as such terminal PC and physical user interfaces are not required unless otherwise specified.

2.5.1 Engineering Code/DDC

Software tools required to access, review and/or edit DDC/Engineering code for all installed equipment shall be provided.

2.5.2 System Passwords

Default hardware System, Application Controller, and HLI hardware configuration passwords shall be changed to passwords allocated by EM Engineering required to access, review and/or edit DDC/Engineering.

2.6 Graphical Displays

Dynamic graphic floor plans with consistent north-south orientation shall be prepared, showing all spaces on the work site and schematics of all controlled systems. Provide intuitive links so that every controlled input, output, and software point can be accessed from floor plans and schematic views. Provide point and click active links from the schematics to access inputs, outputs, trend logs, schedules, alarms, control loops, and any other virtual or physical control points. Air and water schematics graphics shall be used and correctly represent as-built documentation. Floor plans shall be graphically displayed showing all spaces, room numbers, duct layouts and controlled plant/equipment; a navigational directional key shall be provided for orientation. Each Installation shall have graphical links to O&M documentation, wiring diagrams, functional descriptions and associated workshop drawings.

NOTE: Sample graphics shall be reviewed for approval by EM Engineering at the FAT prior to final graphics implementation.

2.7 BACnet Components

Point naming descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, and point description. All hardware and software points are to have point names descriptive of the associated equipment or software point to form the point database.

Example: D26 Lab 1.2 Exhaust Fan 3 Enable

- Building Pre-fix: D26
- Plant/Component: Lab 1.2
- Description: Exhaust Fan 3
- State: Enable

***NOTE*:** Points Lists must be submitted for approval by EM Engineering prior to project commencement.

2.7.1 Trend-log Management

Trend-logs are to be set up on all system inputs, variable set points, and operation critical points at a fifteen (15) minute period for 12 months, after which time the trend data shall be archived to the appropriate Server. Critical Plant and Infrastructure trend-logs are to be set up on all system inputs, variable set points, and operation critical points at a five (5) minute period for 12 months, after which time the trend data shall be archived to the appropriate Server. Trend descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type. Trend-Log point description shall be in-line with the point database naming convention.

2.7.2 Time Schedules

Upon initial setup, the following schedules shall be programmed for each facility, with separate scheduling for each floor, area and plant.

- <Building Prefix> Normal Schedule: 8:00am – 6:00pm
- <Building Prefix> Extended Schedule 1: 8:00am – 9:00pm
- <Building Prefix> Extended Schedule 2: 7:00am – 10:00pm
- <Building Prefix> Cooling/Heating Plant Lockout Schedule: 9:00pm – 7:00am
- <Building Prefix> Critical Schedule: 24 hours

Additional Time Schedules shall have point names descriptive of the associated equipment, device, or software point, to form the point database. Time Schedule descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type. Time Schedule point description shall be in-line with the point database naming convention.

2.7.3 Alarm Management

Alarm names shall not be abbreviated. Alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, alarm description, and fault type. All alarms are to have point names descriptive of the associated equipment or software point. Alarm/Fault point description shall be in-line with the point database naming convention.

2.8 Critical Alarm Management

CAMS alarm shall be configured for Critical Plant and associated plant and/or condition variables. CAMS alarms and associated points shall be BACnet Alarm and exposed to the CBACS network. CAMS alarm descriptions shall not be abbreviated. CAMS alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, alarm description, and fault type. All CAMS alarms are to have point names descriptive of the associated equipment or software point. Alarm grouping may be required into a single BACnet BV (Binary Value) summarising the geographic location, or equipment/system. CAMS alarms shall be displayed on a graphical interface for integration with the Cardax® security system. Software isolation shall be programmed and represented via a graphical alarm summary.

CAMS Alarms shall be categorised in three groups for each BMS installation:

- **CPI** – Critical Plant and Infrastructure
- **LSS** – Life Safety Systems
- **CUE** – Critical User Equipment (Schneider StruxureWare® product only)

All CAMS alarms are to have point names descriptive of the associated equipment or software point. Critical Alarms point description shall be in-line with the point database naming convention and shall have an alarm state of CRITICAL ALARM.

Example: H6 MSB1 Electrical Mains Failure CRITICAL ALARM

- Building Pre-fix: H6
- Area/Component: MSB1
- Description: Electrical Mains Failure
- State: CRITICAL ALARM

NOTE: It is essential that contractors seek direction from UNSW Estate Management Engineering on alarm configuration, and CAMS configuration and commissioning.

2.8.1 Critical Plant and Infrastructure (CPI) Alarms

CPI refers to monitoring of HVAC and integrated building systems associated with Critical Plant. Hardwired monitoring points shall be wired in a fail-safe configuration, where in the event of power failure, alarms will be sent. CAMS alarms shall not be abbreviated. CAMS alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, alarm description, and fault type. CPI alarms shall be generated for points including, but not limited to temperature, pressure, flow, humidity, power failure, flood detection, and plant fault/failure conditions. Safety functions and interoperability of BMS controlled equipment shall use N+1 configuration using multiple points of fault verification to generate an alarm via hardwired LLI in a failsafe wiring configuration.
All CAMS alarms are to have point names descriptive of the associated equipment or software point.

2.8.2 Life Safety System (LSS) and Gas Detection Alarms

Life Safety System and Gas Detection shall be monitored via HLI via the BMS. Hardwired monitoring points shall be wired in a fail-safe configuration, where in the event of power failure, alarms will be sent. Safety functions and interoperability between the BMS and LSS shall be via LLI. CAMS alarms shall not be abbreviated. CAMS alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, alarm description, and fault type. LSS alarms monitored via the BMS shall be generated for all possible alarm conditions. Safety functions and interoperability of BMS controlled equipment shall use N+1 configuration using multiple points of fault verification to generate an alarm via hardwired LLI in a failsafe wiring configuration.

All CAMS alarms are to have point names descriptive of the associated equipment or software point.

***NOTE*:** Refer to Section 2.9.9 and Section 3.

2.8.3 Critical User Equipment (CUE) Alarms

CUE monitoring shall be via the Schneider StruxureWare® product only, independent of the incumbent BMS infrastructure. CUE refers to User (School and Faculty) Freezers, Fridges, and Incubators etc. used for storing and/or facilitating research. CUE Monitoring shall be connected to BMS via a Cat5 RJ-45 data port (or EM Engineering approved equivalent) for each piece of equipment, hardwired for monitoring in a fail-safe configuration. Connection to the equipment will be via Cat5 or Cat6 patch lead (or EM Engineering approved equivalent) for monitoring of the general alarm in fail-safe configuration, at a length allowing movement of the equipment without causing damage to the cable or connection. CUE cable shall be Yellow in colour. Software isolation for each alarm port shall be programmed and represented via a graphical alarm summary.

CUE alarm names shall not be detailed. Alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the equipment area, and alarm port number.

Example: C27 Lab 123 Alarm Port 4

- Building Pre-fix: C27
- Area: Lab 123
- Alarm Port: 4

2.9 Integrated Components & System Interfaces

Integrated components and systems make up a considerable portion of the BMS control and monitoring, with hardwired LLI (Low Level Interface) and communication HLI (High Level Interface) as the interconnection mediums.

NOTE: Alternative or equivalent integration options shall be explicitly approved by EM Engineering in writing.

2.9.1 Bulk Tank Storage

Bulk Tank Storage System conditions shall be BMS monitored via BACnet MS/TP or Modbus RTU HLI.

2.9.2 Electrical Systems

Electrical systems shall be BMS monitored via BACnet MS/TP or Modbus RTU HLI.

2.9.1 Essential Services Circuit Breaker Monitoring

Critical and research-intensive buildings shall have voltage loss and trip of essential services circuit breakers BMS monitored via BACnet MS/TP or Modbus RTU HLI.

2.9.2 Energy Meters

Energy Meters shall be installed for individual chilled and heating hot water plant totalising primary, secondary, or tertiary water circuits separately, detailing Kilowatt Refrigeration (kWr), Flow Rate (L/s), and Plant Coefficient of Performance (COP). Flow meters using BMS supply and return sensors to calculate energy shall not be accepted.

Approved types include Siemens, and Onicon with proposed meters chosen to suit the application, static pressure and pressure drop. Connection shall be via BACnet MS/TP or Modbus RTU HLI. Alternative products shall be approved by EM Engineering in writing.

2.9.3 Fire Systems

General Fire Trip signals shall be BMS monitored via LLI. Please refer to **Section E.3.3 Special Systems Specifications** for approved FIP solutions.

2.9.4 Fume Cupboards

Centralised building wide Fume Cupboard installation monitoring shall be BMS monitored via BACnet MS/TP or Modbus RTU HLI. Where small Fume Cupboard's numbers are specified, LLI fault monitoring shall be provided.

2.9.5 Generators

Generators shall be BMS monitored via BACnet MS/TP or Modbus RTU.

2.9.6 Heating Ventilation & Air Conditioning Plant

HVAC equipment including, but not limited to Chillers, Boilers, and VSDs shall be BMS controlled via LLI and monitored via a BACnet MS/TP or Modbus RTU HLI.

2.9.7 Hydraulic Systems

Research and Critical Facilities shall have Hydraulic System BMS monitored via Modbus RTU HLI. Other Facilities shall have Hydraulic System fault, alarm and operation status BMS monitored via LLI. Fault, Alarm and Operation status shall be BMS monitored via LLI and monitored via BACnet MS/TP or Modbus RTU.

2.9.8 Laboratory Air Management Systems

Laboratory Air Management Systems shall be BMS monitored via BACnet MS/TP or Modbus RTU, on an independent network and power segment and shall not be mixed with the BMS network. Alternatives shall be considered upon approval by EM Engineering.

2.9.9 Life Safety Systems (LSS) & Gas Detection Systems

Safety Alarms that are part of a SIF shall be hard wired directly to the BMS via LLI. Safety functions and interoperability of BMS controlled equipment shall use N+1 configuration using multiple points of fault verification to generate an alarm via hardwired LLI in a failsafe wiring configuration. The LSS shall be connected to the incumbent BMS infrastructure via Modbus RTU for BMS monitoring of LSS alarm and fault conditions only.

2.9.10 Lift Systems

Lift System alarm and operation status shall be BMS monitored via LLI.

2.9.11 Internal Lighting Systems

Internal Lighting control shall be the Philips Dynalite® product. All system functionality, control monitoring and graphical interface shall be installed on the centralised Dynalite Systems Virtual Machine. Please refer to **Section E.3.2 Lighting Specifications** for details. PIR monitoring shall be via BACnet or approved HLI (refer to 2.10.4 Occupancy & After-Hours Air Conditioning (AHAC))

2.9.12 External Lighting Systems

External Lighting shall be via the Schneider StruxureWare® product only and be integrated to the Campus Wide External Lighting System.

2.9.13 Uninterruptable Power Supplies (UPS)

Centralised building wide UPS monitoring shall be BMS monitored via BACnet MS/TP or Modbus RTU HLI. Distributed UPS's shall be monitored via LLI.

2.9.14 Metering

Contractors must note the details given in Appendix 7 relating to EMACS for metering functionality.

2.9.15 VRV/VRF DX Air Conditioning Systems

VRV/VRF DX Air Conditioning Systems shall be integrated into CBACS via the VRV/VRF Central Controller only. VRV/VRF systems shall only be BACnet monitored in critical applications, or where the VRV/VRF component makes up a considerable component of the HVAC system. In critical applications where small VRV/VRF unit numbers are specified, Indoor Unit interface cards shall be used to provide LLI control and monitoring via the BMS.

2.10 System Functionality

In addition to and in line with the design intent, the following system functionality and components shall be provided and programmed for each BMS installation to assist building tuning, operation and energy use.

2.10.1 Global Override Modes - Zone Temperature Set Point Adjustment

Zone temperature set point override shall be provided for air side plant via the graphical interface for each installation. Deselection functionality shall be provided for individual terminal.

2.10.2 Global Override Modes – Chilled & Hot Water Valves

Global override of chilled and hot water valves for air side plant shall be adjustable via the graphical interface for each installation.

2.10.3 Maintenance Mode – Main Plant

Major plant shall be graphically selectable for Maintenance Mode, where selected plant will be omitted from staging, sequencing and operation.

2.10.4 Occupancy & After-Hours Air Conditioning (AHAC)

All plant shall have AHAC provision using occupancy or people counting via BACnet or EM Engineering approved HLI. General and open areas shall have AHAC control via Internal Lighting PIR HLI (refer to 2.9.11) and time schedule control. Meeting spaces shall have AHAC provision via Internal Lighting PIR HLI or local PIR and push button control. Teaching spaces and Lecture Theatres and CATS rooms shall have people counting (occupancy monitoring) and push button control, or interconnection to the CATS AMX system (where available) for on demand air conditioning.

2.10.5 Rogue Zone De-Selection - Building Cooling/Heating Call

Chilled Water Valves, Heating Water Valves and Electric Duct Heaters shall be selectable for addition/subtraction to the building heating and cooling calls to omit rogue zones. Selection shall be made available via equipment summary graphics.

2.10.6 Rogue Zone De-Selection – Air Side Plant Demand

All Terminal Units and VAV's shall be selectable for addition/subtraction to the main plant temperature and/or pressure demand to omit rogue zones. Selection shall be made available via equipment summary graphics

2.10.7 Supply Air Temperature Monitoring

Supply air temperature sensors shall be provided for all air side plant. This includes downstream temperature monitoring of main air side plant, terminal units, EDHs etc. EDH's may be monitored via CT switches to confirm operation.

2.10.8 Setpoint Reset Strategies

Temperature and pressure Setpoint Reset Strategies shall be applied where possible based on building/plant loads for cooling, heating and air side plant.

2.10.9 Cooling and Heating Plant Staging Strategies

Energy Meters referencing plant loads and conditions shall be used to stage cooling and heating plant.

2.11 Change Management Procedures

The BMS Contractor shall work with the University's representative to develop a mutually satisfactory change management procedure that will be applied to any changes that affect the BMS or CBACS. The change management procedure shall ensure that:

- No change is made without the written approval of the University
- No set points are adjusted without written approval of the University
- Every change is fully documented, and O&M manuals are updated as necessary
- Backup copies of software are made as described below.

2.12 Commissioning

Validation and commissioning shall be documented and submitted as part of the O&M. Commissioning shall be conducted in accordance with CIBSE Commissioning Code C: Automatic Controls, which includes season commissioning that is required to ensure the BMS control loops are fully tuned to cater for all specified design conditions. FAT, SAT and IST validation and shall be included as part of the commissioning process.

2.12.1 Acceptance Testing (FAT and SAT)

When the contractor is satisfied with the BMS design, EM Engineering representative shall be invited to witness Factory Acceptance Testing (FAT), where the operational functionality of all BMS controlled systems shall be reviewed and tested against the design intent and function description. At this time other system functions such as system graphics, trending and alarm generation shall be reviewed. FAT shall be conducted as early in the design process as practically possible to mitigate any potential non-conformance or failure issues.

At practical completion, an EM Engineering representative shall be invited to witness a Site Acceptance Test (SAT), where CBACS integration, and operational functionality of all commissioned, controlled, and monitored systems shall be reviewed and tested against the design intent and function description, and shall include an Integrated Systems Test (IST).

2.12.2 Integrated Systems Testing (IST)

IST shall include all interoperable functionality across all controlled and monitored systems and sub-systems. Alarm functionality and configuration shall be validated and tested as part of the IST. EM Engineering shall be invited to witness an IST in line with the Specification, Functional Description and design intent. IST validation and commissioning shall be documented and submitted as part of the O&M.

2.12.3 Practical Completion

In addition to Sections 2.12.1 and 2.12.2, contractors are required to:

- Demonstrate and confirm that all systems are programmed and operating correctly.
- Ensure BMS network topology, point database, system configuration and addressing for BMS communication is identified and documented in the SAT and IST reports, and incorporated in the BMS Operation and Maintenance Manuals.
- Ensure I/O and HLI point databases are documented and incorporated in the BMS Operation and Maintenance Manuals.

At practical completion, a complete set of "as–built" documents shall be provided.

2.12.1 As Built Documentation

These documents shall represent the BMS as specified, subject to approved modifications, and include schematic and single line diagrams that represent:

- Various systems of the BMS.
- Final system architecture, system configuration, including communication network (with associated interfacing devices and field devices).
- System topology- i.e. a schematic diagram showing all devices, IP addresses, LAN types and network numbers, port numbers, and MAC addresses.
- The physical location of each controller and field device.
- I/O point database.
- Wiring diagrams.
- All system settings and set points for proper system operation.
- Commissioning and FAT, SAT and IST details and results.

The above shall be depicted on the system graphics, thus enabling easy accessibility for operational and maintenance needs, and saved to the UNSW provided CBACS NAS.

3 LIFE SAFETY SYSTEM

3.1 General

This section shall be used as a specification for the architecture of LSS at UNSW, and the requirement for integration of the electronic LSS into the building/facility BMS and CBACS only. LSS hereafter refers to the electronic, sensing, I/O and PLC based infrastructure associated with Life Safety Systems and Toxic Gas Monitoring.

The LSS shall be designed as a de-centralized system so that any Lab, Zone, or Facility and its associated LSS infrastructure can be isolated, maintained or serviced without interruption to surrounding Labs, Zones, or Facilities. Individual SIFs shall have the ability to be independently managed, calibrated, isolated and changed without impact to other SIFs or components of the LSS.

LSS shall include design, supply, and installation of LSS hardware and software, sensors, PLCs, Safety Relays, HMIs and panels. FAT and SAT validation of the system shall meet the requirements of the Cause and Effect Matrix developed through the HAZID, HAZOP study and SIF and SIL determination. The LSS integration with the building/facility BMS, CBACS and CAMS should be considered in the SIF and SIL determination of the overarching system.

UNSW's CAMS integrates with CBACS sub-systems, and UNSW Security system Cardax® to monitor critical events for comprehensive critical alarm response. The integration of CBACS and its associated interconnected sub systems with Cardax, supported by UNSW's IT network infrastructure creates a very large and complex system. As such it is essential EM Engineering is engaged for direction on systems configuration, BMS and CBACS integration, project specifications, communication types, and other matters impacting the LSS and the greater CBACS.

Where LSS infrastructure is being implemented in an existing building or facility it is essential incumbent products are used as an extension to the existing LSS.

NOTE: Please refer to project specific standards, HAZID, HAZOP studies, relevant UNSW hard services specifications and project specifications for holistic LSS mechanical, hydraulic and electrical system details and requirements.

3.1 Standards and Reference Material

The LSS shall be installed complying with all:

- National and local statutory regulations.
- Occupational Health & Safety legislation and codes of practice.
- SAA Wiring Regulations (AS3000).
- Building Code of Australia.
- Original Equipment Manufacturer's (OEM) instructions and recommendations.
- AS 60079.29 Parts 1,2,3 Explosive Atmospheres - Gas Detectors.
- AS 61508 - Functional safety of electrical/electronic/programmable electronic safety.
- AS 61511 - Functional safety - Safety instrumented systems for the process industry sector.
- AS/CA S00 9:201 3 - Installation requirements for customer cabling (Wiring rules).

3.2 System Architecture

LSS networks shall be installed independent to UNSW's IT network. The system architecture shall comprise of LSS panels or nodes networked together to operate in a de-centralized topology, where any SIF, node and/or component of the LSS can be isolated, maintained and changed without adverse effect to other SIFs, panels or nodes on the network.

3.2.1 Network Architecture

Where LSS User Interface PCs are required Network configuration including IP Addresses, Subnets, UDP/IP Port Numbers will be supplied by EM Engineering upon approval of the initial BMS network architecture or topology. All LSS ethernet CAT5/CAT6 cable shall be Yellow in color. LSS Panels shall be interconnected using common industry Field Bus protocols including but not limited to Modbus, Profibus, Safety Ethernet etc on network infrastructure as per OEM requirements, network standards, and relevant Australian Standards.

3.2.2 LSS Components

LSS components shall be selected to meet the requirements of the Specification, and Cause and Effect Matrix developed through the HAZID, HAZOP study and SIF and SIL determination to ensure the minimum SIL level is met. All materials and products used shall be new and current generation OEM products commercially available for a minimum of five years after project completion. Untested products shall not be used, unless explicitly approved by EM Engineering in writing.

3.2.3 Mean Time To Repair (MTTR)

For verification of SIL design shall use a MTTR of less than forty (40) mins.

3.2.4 LSS Panel HMI

Each Lab, Zone or Facility shall have a HMI alarm management, notification and annunciation panel. Floor Level HMI shall be installed where large numbers of Labs/Zones are localised.

3.2.5 Audible Alarms

The LSS shall trigger all Audible Alarms associated with life safety functions.

3.2.6 Visual Alarms

The LSS trigger all Visual Alarms stacks and strobes associated with life safety functions.

3.2.7 Emergency Stops

The LSS shall monitor and control all Emergency Push Button functionality and safety functions.

3.2.8 BMS HLI

The LSS shall be connected to the incumbent BMS infrastructure via Modbus RTU for BMS monitoring of LSS alarm and fault conditions only (refer to Section 2.9.9). Safety functions and interoperability of BMS controlled equipment shall be via hardwired LLI.

3.2.9 Power

All power for LSS equipment shall be from dedicated circuits. LSS installations shall be fed from Essential Services supply.

3.2.10 Uninterruptable Power Supply (UPS)

LSS installations shall be installed with UPS located within or adjacent to the designated control enclosure to supply power to all components if centralised building UPS is not specified with greater than thirty (30) minute battery life to power all LSS components. UPS shall be monitored to indicate fault condition and alarmed on the LSS.

3.2.11 Oxygen and Gas Sensors

All Oxygen and gas detection sensors supplied shall have a minimum three (3) year life span.

3.3 Operator Interface Hardware and Software

Where LSS hardware and User Interface PC's are required Network configuration including IP Addresses, Subnets, and UDP/IP Port Number will be supplied by EM Engineering upon approval of the initial LSS network architecture or topology. All LSS hardware and software shall be configured to current UNSW naming conventions in-line with the UNSW building grid references. IP addresses, subnet configuration, device instances, network numbers, port numbers etc.

All software shall be configured to current UNSW naming conventions in-line with the UNSW building grid references. IP addresses, subnet configuration, device instances, network numbers etc. are available from UNSW Estate Management Engineering upon request. All operating software including but not limited to system software, licenses, administration level passwords, drivers, registration details, backups etc. shall be submitted to EM Engineering on approved media.

3.3.1 Engineering Code

Software tools required to access, review and/or edit the Engineering Code and system configuration for all installed equipment shall be provided.

3.3.2 System Passwords

Administration level password for the LSS to enable full functionality of all areas of the software interface, HMI, PLC, and programming software platforms required to view and edit the LSS.

3.4 Point Database

Point naming descriptions are to be pre-fixed with the UNSW building grid reference, followed by the plant/component type, and point description. All points are to have point names descriptive of the associated equipment or software point to form the point database.

Example: E10 Lab 1.2 Oxygen Depletion Alarm

- Building Pre-fix: E10
- Plant/Component: Lab 1.2
- Description: Oxygen Depletion
- State: Alarm

3.5 Change Management Procedures

The LSS Contractor shall work with the University's representative to develop a mutually satisfactory change management procedure that will be applied to any changes that affect the Cause and Effect matrix LSS, BMS or CBACS. The change management procedure shall ensure that:

- No change is made without the written approval of the University
- No set points are adjusted without written approval of the University
- Every change is fully documented and O&M manuals are updated as necessary
- Backup copies of software are made as described below

3.6 Integrated Systems

Integrated systems make up a considerable portion of the LSS control and monitoring, with hardwired LLI (Low Level Interface) as the interconnection medium for all safety functions.

NOTE: Alternative or equivalent integration options shall be explicitly approved by EM Engineering in writing.

3.6.1 Fire Trip

The LSS shall monitor Fire Trip directly from the FIP via hardwired LLI.

3.6.2 Fan Failure

The LSS shall monitor Fan Failure via the BMS or MCC using hardwired LLI.

3.6.3 BMS

Safety Alarms that are part of a SIF shall be hard wired directly to the BMS via LLI. Safety functions and interoperability of BMS controlled equipment shall use N+1 configuration using multiple points of fault verification to generate an alarm via hardwired LLI in a failsafe wiring configuration. The LSS shall be connected to the incumbent BMS infrastructure via Modbus RTU for BMS monitoring of LSS alarm and fault conditions only (refer to Section 2.9.9).

3.7 Commissioning

3.7.1 Commissioning and Programming

One hundred percent (100%) proof test of every SIF shall be conducted as per AS 61511. Validation and commissioning shall be documented and submitted as part of the O&M.

3.7.2 Practical Completion

In addition to Section 3.7.1 contractors are required to:

- Conduct FAT and SAT to demonstrate and confirm that all systems are programmed and operating correctly in line with the Cause and Effect Matrix. See “Acceptance Testing” below.
- Document LSS network topology, point database, system configuration and addressing for LSS communication shall be identified and documented in the commissioning report, and incorporated in the LSS Operation and Maintenance Manuals.
- Document I/O and HLI point databases in the commissioning reports in the LSS Operation and Maintenance Manuals.

3.7.3 Acceptance Testing

FAT documentation shall be submitted for review. When the contractor is satisfied that the LSS is operating correctly, EM Engineering shall be invited to witness the SAT and IST. Validation and commissioning shall be documented and submitted as part of the O&M.

3.7.4 Integrated Systems Testing (IST)

As part of the SAT, EM Engineering shall be invited to witness an IST in line with the Cause and Effect Matrix. Validation and commissioning shall be documented and submitted as part of the O&M.

3.8 Documentation

At practical completion, a complete set of “as–built” documents shall be provided. These documents shall be modified incorporating any changes that occurred during the defects liability period. This revised documentation should be provided at handover.

Printed points list, wiring diagrams and Cause and Effect matrix shall be laminated and mounted within each panel enclosure detailing the revision number and date.

3.8.1 As-Built Documentation

These documents shall represent the LSS as specified, subject to approved modifications, and include, but not be limited to:

- FAT, SAT, IST, HAZID, HAZOP, Cause and Effect Matrix, SIL Determination.
- Various sub-systems of the LSS.
- System topology - i.e. a schematic diagram showing all HMI and PLC addressing, LAN types and network numbers, MAC addresses and IP addressing.
- The physical location of each node/controller and I/O field device.
- I/O point database.
- Wiring diagrams.
- All system settings for cause and effect operation.
- Commissioning and acceptance test details and results.

The above shall be depicted on the system graphics, thus enabling easy accessibility for operational and maintenance needs.