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APPENDIX 1 – AUTOMATION AND CONTROL SYSTEMS – SCHEDULE OF CHANGES – VERSION 6.4

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

Revision	Changes	Date
General revision		
No changes		August 2004
4.1	Major rewrite	July 2005
4.2	General revision	September 2013
5	Major rewrite	July 2015
5.1	General revision	April 2016
5.2	General revision	March 2017
6	Major rewrite	March 2018
6.1	Critical alarm section updated	April 2019
6.2	Major rewrite, 2.9 Graphical Standards added, 2.8 CAMS Alarm Matrix added	September 2019
6.3	Minor rewrites	January 2020
6.4	Minor updates	January 2022

1 ACRONYMS & TERMS OF REFERENCE

BACnet	BMS communication protocol
BMS	Building Management System
BTL	BACnet Testing Laboratories
Cardax	Access Control and Security System
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
FDD	Fault Detection Diagnostics
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HLI	High Level Interface
HMI	Human Machine Interface
I/O	Input / Output – Field monitoring and control devices
IoT	Internet of Things
IAQ	Indoor Air Quality
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
PLC	Programmable Logic Controller
SAT	Site Acceptance Test
SIF	Safety Instrument Function
TCP/IP	Network Protocol
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 135-2020 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.

2.2 Nominated Original Equipment Manufacturer (OEM) Products

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

- WebCTRL® – Logical Building Automation Pty Ltd
- StruxureWare® – Schneider Electric Buildings Australia Pty Ltd
- Enterprise Buildings Integrator (EBI) - Honeywell Building Solutions

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 Pre-Construction Documentation

BMS Pre-Construction documentation shall be submitted for approval by EM Engineering detailing:

- Project Functional Description
 - As-Built Building Functional Description shall be graphically available from the incumbent BMS web interface.
 - Improvement, extension or fit out projects Function Descriptions may be submitted for approval separate to the As Built Building Functional Description, however, must be included in the As Built Building Functional Description documentation set at the completion of the project.
- Project BMS Network Schematic and Asset register
 - Network Schematic shall be graphically available from the incumbent BMS web interface.
 - Improvement, extension or fit out projects Network Schematics shall be submitted for approval as part of the complete As Built Network Schematic documentation set.
 - Network Schematics shall include detail of IP Ethernet Network, IP addresses, BACnet instances MS/TP and VLAN number settings.

- Asset Register shall be submitted for approval with the Network Schematic detailing IP addresses, BACnet instances MS/TP and VLAN number settings controller numbering, MAC address, model, configuration settings and details, passwords, locations and general information.
- Project BMS Network Asset Register
 - Network Asset Register shall be submitted for approval for each project.
 - Asset Register shall be submitted for approval detailing building, controller location, numbering, MAC address, model, configuration settings and details, passwords and general information. EM approved Asset Registers shall detail IP addresses and VLAN configuration settings, BACnet device instance ranges and MS/TP numbering.
- Project BMS Points List
 - As Built Points List shall be graphically available from the incumbent BMS web interface.
 - Improvement, extension or fit out projects Built Points List may be submitted for approval separate to the As Built BMS Points List, however, must be included in the As Built Building Built BMS Points List documentation set at the completion of the project.

2.5 System Architecture

The system architecture shall comprise of the required hardware and software 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.

All BMS Hardware and Software provided shall be BACnet compliant BTL listed and communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135, a shall be installed to the OEM and BACnet standard.

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.

2.5.1 TCP/IP Ethernet Network

Dedicated BMS TCP/IP Ethernet Network and associated managed devices shall be provided by the incumbent contractor connecting all BMS and subsystem hardware at the building level enabling communication and function as a stand-alone system. Device numbers on a network or subnet shall be the lesser of that determined by the by the OEM standards, or the number of devices that will not impact or degrade overall system performance. TCP/IP Ethernet Network speeds shall be set to operate at the maximum speed specified by the OEM documentation and that determined by connected equipment. All dedicated TCP/IP Ethernet Network cabling shall be Cat 6 and 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 schematic or topology.

The dedicated BMS TCP/IP Ethernet Network will be connected to the CBACS network and nominated VLAN via ethernet data ports provided by the University IT Unit.

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 topology or schematic is required for approval by EM Engineering prior to project commencement.

2.5.2 Field Network Configuration

Field Network MS/TP, Modbus RTU, and approved others shall be wired in a daisy chain configuration only. Device numbers on a subnet shall be the lesser of that determined by the OEM standards, or the number of devices that will not impact or degrade overall system. Star or tee connections are not permitted unless recommended by the OEM. Field Network speeds shall be set to operate at the maximum speed specified by the OEM documentation and that determined by connected equipment. All MS/TP and Modbus RTU communication cables shall be Yellow in colour.

NOTE: Field Controllers, and HLI devices shall have separate dedicated MS/TP networks; mixed Field 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.

2.5.3 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 dedicated 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.

2.5.4 Uninterruptable Power Supply (UPS)

BMS installations shall be installed with APC Smart-UPS (or approved equivalent) located within or adjacent to the designated control enclosure to supply power to all components if centralised building UPS is provided. UPS shall be monitored to indicate fault condition and alarmed on the BMS. UPS shall be installed with a bypass switch for maintenance and replacement purposes.

2.6 Hardware and Software

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

All BMS hardware and 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, port numbers etc. shall be supplied pending initial Pre-Construction Documentation approval by EM Engineering (refer to Section 2.4). 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. Backup copies of software and documentation shall be made and saved to the UNSW provided CBACS NAS. 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's and physical user interfaces are not required unless otherwise specified.

2.6.1 Engineering Code/DDC

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

2.6.2 System Passwords

Administration level passwords for Operating Systems shall be provided and detailed as part of the As Built documentation. 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.

2.7 BACnet Configuration and Naming Convention

2.7.1 BMS Hardware

BMS hardware naming descriptions are to be pre-fixed with the UNSW building grid reference, followed by the item location room code, followed by the function/plant served. Example: D26_8Q05_Chilled_Water_Plant_Control

- Building Pre-fix: D26
- Room Code: 8Q05
- Plant/Component: Chilled_Water_Plant_Control

2.7.2 Point Database

Physical I/O and software point database naming descriptions are to be pre-fixed with the UNSW building grid reference, followed by the item location room code, 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_603_Lab_221_Exhaust_Fan_3.2_Enable

- Building Pre-fix: D26
- Room Code: 603
- Plant/Component: Lab_221
- Description: Exhaust_Fan_3.2
- State: Enable

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

2.7.3 Trend-logs

Trend-logs are to be set up on all general system inputs, variable set points at a fifteen (15) minute period, with operational outputs trended on Change Of Value (COV) for 12 months, after which time the trend data shall be archived to the appropriate Server. Critical system trend-logs are to be set up on all system inputs, variable set points, and binary and variable outputs at a five (5) minute period for 12 months, after which time the trend data shall be archived to the appropriate Server. Trend-Log point description shall be in-line with the Point Database (1.12) naming convention.

2.7.4 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 (1.12) naming convention.

2.7.5 Alarms

Alarms are to be categorised and configured as per section 2.8. All alarms shall be BACnet compliant and exposed to the relevant network.

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2.8 Alarm Management

UNSW's Alarm Management is structured to separate operational and critical events. All alarms shall be categorised and configured as per the Alarm Matrix (below). All alarms shall be BACnet alarms. Alarm names shall not be abbreviated. Alarm descriptions are to be prefixed with the UNSW building grid reference, followed by the room code, 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/Alert point description shall be in-line with the alarm type naming convention.

Alarm Matrix

Alarm Type	Equipment Monitored	Recipients	Monitoring Systems	Time Schedule
Critical Plant & Infrastructure (CPI)	Central Plant Failure Central Plant Water Temperature Central Plant Water Pressure Critical Space Temperature/Humidity Critical Space Pressure Critical Space Ventilation Process Plant Failure Process Plant Water Temperature Process Plant Water Pressure Flood Detection Fume Cupboard Electrical Failure Generator Operation UPS Failure Fire Trip	Security Control Building Management EM Contractors Research Staff (upon request)	CAMS	24/7
Critical Life Safety Systems (LSS)	Toxic Gas Detection Oxygen Depletion Emergency Stop/Shutdown	Security Control Research Staff Building Management EM Contractors	CAMS	24/7
Critical User Equipment (CUE)	Fridges Freezers Incubators Cool Rooms Cryo Storage	Security Control Faculty On-Call Phone Research Staff	CAMS	6pm-6am Mon-Fri 24/7 Weekends and Public Holidays
BMS Health	BMS Comms/Power Failure	Security Control EM Contractors EM Engineering	CAMS	24/7
Analytics/FDD	HVAC Operation Building Services Operation Critical Spaces Operation	EM Engineering Building Management	BMS	24/7

2.8.1 CAMS Alarm Configuration

Critical Alarm Management System - CAMS is an enterprise layer of integrated systems that provides alarm response for UNSW operations and first responders. Critical alarms shall be displayed on a graphical interface for integration with CAMS. Software isolation shall be programmed and represented via a graphical alarm summary per building.

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)

2.8.2 Critical Plant and Infrastructure (CPI) Alarms

CPI refers to monitoring of HVAC systems, mechanical systems, electrical systems, hydraulic systems, process systems, fire systems, laboratory exhaust, fume cupboards, generators 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 in-line with 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.

CAMS CPI alarm descriptions shall not be abbreviated. CAMS alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the room code, 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. Critical Alarms point description shall be in-line with the Point Database (1.12) naming convention and shall have an alarm state of CRITICAL_ALARM.

Example: H6_LG20_MSB1_Electrical_Mains_Failure_CRITICAL_ALARM

- Building Pre-fix: H6
- Room Code: LG20
- Area/Component: MSB1
- Description: Electrical_Mains_Failure
- State: CRITICAL_ALARM

2.8.3 Life Safety System (LSS) and Gas Detection Alarms

Life Safety System and Gas Detection shall be monitored 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.

CAMS LSS alarm descriptions shall not be abbreviated. CAMS alarm descriptions are to be pre-fixed with the UNSW building grid reference, followed by the room code, 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. Critical Alarms point description shall be in-line with the Point Database (1.12) naming convention and shall have an alarm state of CRITICAL_ALARM.

Example: E26_619_Oxygen Depletion CRITICAL_ALARM

- Building Pre-fix: H6
- Room Code: 619
- Description: Oxygen_Depletion
- State: CRITICAL_ALARM

NOTE: Refer to Section 2.9.15 and Section 0.

2.8.4 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 via a roof mounted connection to BMS via an XLR Plug (or EM Engineering approved equivalent) for each piece of equipment, hardwired for monitoring in a fail-safe configuration. Connection to the equipment will be XLR Plug 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 black in

colour. Software isolation for each alarm port shall be programmed and represented via a graphical alarm summary with isolation and alarm recipient change options.

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

Example: C27_Lab123_Alarm_Port_4

- Building Pre-fix: C27
- Room Code: Lab123
- Alarm Port: Alarm_Port_4

2.8.5 BMS Health Alarm Management

BMS Health alarms shall be configured for BMS infrastructure to indicate component comms loss or power failure. 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 (1.12) naming convention.

2.8.6 Analytics/FDD Alert Management

Analytics and Fault Detection Diagnostics (FDD) alerts shall be configured for plant and/or condition variables providing indication on abnormal operation. Analytics/FDD points shall be BACnet alarms exposed to the CBACS network. All alerts are to have point names descriptive of the associated equipment or software point. Fault/Alert point description shall be in-line with the Point Database (1.12) naming convention.

2.9 Integrated Components & Sub-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 Modbus RTU HLI, or LLI if not available.

2.9.2 Building Electrical Systems

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

2.9.3 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.

2.9.4 Thermal Energy Meters

Energy Meters shall be installed for each individual chiller and boiler, with secondary and/or tertiary water circuits separately, detailing Kilowatt Refrigeration (kW_r), 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 meters shall be of Magflow Ultrasonic type, and shall be Siemens UH50 or approved equivalent. Proposed meters shall be 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.

2.9.5 MCC Electrical Energy Meters

MCC electrical energy meters shall be of Type 1. Connection shall be via BACnet MS/TP or Modbus RTU HLI.

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Any electrical meters monitored via the BMS shall have the capability to expose the meters to the UNSW CBACS via Modbus TCP/IP.

Reference [Appendix 7 – UNSW Energy Management Metering Requirements](#), relating to EMACS for metering functionality.

2.9.6 Utilities Metering (EMACS)

Contractors must note the details given in [Appendix 7 – UNSW Energy Management Metering Requirements](#), relating to EMACS for metering functionality.

2.9.7 Fire Systems

Fire systems monitoring shall be BMS monitored via Modbus RTU HLI. Please refer to [Section E.3.3 Special Systems](#) for approved FIP solutions.

2.9.8 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, status and sash position monitoring shall be provided.

2.9.9 Generators

Generators shall be BMS monitored via or Modbus RTU.

2.9.10 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.

2.9.11 Hydraulic Systems

Hydraulic Systems shall be BMS monitored via Modbus RTU HLI, or LLI if not available.

Bore water systems shall conform to [Section E.1 Hydraulic Services](#).

2.9.12 IAQ Sensors

Indoor Air Quality (IAQ) Sensors with Temperature, Humidity and CO2 shall be used as a minimum standard for all zone or room space sensing regardless if the sensors are used for plant control and shall be graphically represented on a floor plan. Additional sensors may be included depending on the application and control requirement.

2.9.13 IoT Sensors

BMS shall interface with IoT Sensors via BACnet or approved HLI/API and be graphically represented on a floor plan. BMS control functions from IoT sensors shall be edge based, not cloud based via the local BACnet gateway.

2.9.14 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.

2.9.15 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.

2.9.16 Lift Systems

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

2.9.17 Lighting Systems - Internal

BMS shall monitor internal lighting systems via approved BACnet HLI, and be graphically represented on a floor plan.

PIR monitoring shall be via BACnet or approved HLI (refer to Section 2.10.8 Occupancy & After-Hours Air Conditioning (AHAC))

Please refer to [Section E.3.2 Lighting](#) for system requirement details.

2.9.18 Lighting Systems - External

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

Occupancy/Utilisation Systems

BMS shall interface with Occupancy and Utilisation systems via BACnet or approved HLI, and be graphically represented on a floor plan (refer to Section 2.10.8 Occupancy & After-Hours Air Conditioning (AHAC))

2.9.19 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.

2.9.20 VRV/VRF DX Air Conditioning Systems

VRV/VRF DX Air Conditioning Systems shall be integrated into CBACS. 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.

For more information, refer to **Section E.2.16** of [Section E.2 – Mechanical Services](#).

2.10 Control System Functionality

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

2.10.1 Actuator Position Monitoring

Actuators with position feedback monitoring shall be provided for all air side plant. FDD shall be created and alarmed for operational deficiencies (refer to Section 2.8.6).

2.10.2 Automatic Lockout Resets

Plant alarm/fault/failure software lockouts shall automatically reset and not require reset via the BMS. Plant shall have the functionality to restart once the local plant/machine alarm/fault/failure condition has been cleared.

2.10.3 Cooling and Heating Plant Staging Strategies

Energy Meters referencing plant loads and conditions shall be used to stage cooling and heating plant (refer to Sections 2.9.4 and 2.9.5).

2.10.4 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.

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2.10.5 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.

2.10.6 Maintenance Mode – Main Plant

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

Maintenance mode shall be clearly defined via the graphics, and associated alarms shall be disabled.

2.10.7 Manual Staging Control

Central plant shall have functionality to manually stage plant as an operator from the graphical interface.

2.10.8 Occupancy & After-Hours Air Conditioning (AHAC)

All Air Side Plant and Terminal Units shall have occupancy control via Lighting System integration, IAQ sensor integration, IoT sensor integration or EM Engineering approved HLI.

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

Building Cooling and Heating Calls shall be graphically represented detailing control parameters. 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.

2.10.10 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

2.10.11 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. EDHs shall additionally be monitored via current transducer (CT) switches to confirm operation. Additional Off-Coil sensors shall be installed where dew point, or humidity control is required to verify operation. FDD shall be created and alarmed for operational deficiencies (refer to Section 2.8.6).

2.10.12 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.

2.11 Graphical Standards

Graphics standards shall be in-line with the current format of the nominated BMS OEM products (refer to Section 2.2) and shall include:

- Intuitive navigation shall be provided for point and click active link to access inputs, outputs, trend logs, schedules, alarms, control loops, and all other virtual or physical control points.
- All systems plant/components serving a space or area shall be represented on a single graphic where possible e.g. PC2 lab with various supply and extraction plant/components on a single graphic representing operation of all plant/components, total air flow and pressure regime and for the lab.
- Layer control shall be used to represent all BMS system and sub-system operational functionality.

- Air and water schematics graphics shall be used and correctly represent operational functionality as-built systems.
- Total Cooling/Heating Call management shall be graphically represented.
- Floor plans shall be graphically displayed showing all spaces, room numbers and controlled plant/equipment; a navigational directional key shall be provided for orientation.
- Each Installation shall have graphical links to O&M Documentation set and associated 'As-Built' workshop drawings for mechanical, electrical and hydraulic trades.

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

2.12 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 to alarms or CAMS alarms are made without the written approval of the University
- No DDC control or graphical 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 and documentation shall be made and saved to the UNSW provided CBACS NAS.

2.13 Commissioning

Validation and commissioning documentation shall be collated and submitted as part of the O&M Documentation set (refer to Section 2.14). 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.

2.13.0 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 BMS Functional 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 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 network integration and operational functionality of all commissioned, controlled, and monitored systems and sub-systems shall be reviewed and tested against the design intent and BMS Function Description, and shall include an Integrated Systems Test (IST).

2.13.1 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 Documentation set.

2.13.2 Practical Completion

In addition to Sections 2.13.0 and 2.13.1, contractors are required to:

- Demonstrate and confirm that all systems and sub-systems are programmed and operating correctly through the SAT process.
- Ensure BMS network topology, point database, system configuration and addressing for BMS communication is identified and documented in the SAT and IST documentation and incorporated in the BMS O&M Documentation set.
- Ensure I/O and HLI point databases are documented and incorporated in the BMS O&M Documentation set.

2.14 Documentation

At practical completion, a compiled set of “As-Built” documentation shall be provided to form a complete Operation and Maintenance (O&M) Documentation set. The O&M Documentation set shall include all modifications that occurred during the defect liability period. The O&M Documentation set should be provided at handover and shall represent the BMS as a fully furnished system that represents:

- Finalised As-Built Pre-Construction Documentation set (refer to Section 2.4)
- Finalised Commissioning Documentation set (refer to Section 2.13)
- Product literature and technical data sheets for all hardware, software and integration components for the various systems and sub-systems of the BMS.

The above shall be depicted on the system graphics and linked, thus enabling easy accessibility for operational and maintenance needs. Backup copies of software and documentation shall be made and saved to the UNSW provided CBACS NAS.

3 LIFE SAFETY SYSTEM

3.1 General

This section shall be used as a guideline for the architecture of Life Safety Systems (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, alarm devices, and programmable controllers-based infrastructure associated with Life Safety Systems and gas detection and Monitoring systems.

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, Programmable Controllers, 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.

3.2 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 S009 - Installation requirements for customer cabling (Wiring rules).

3.3 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

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changed without adverse effect to other SIFs, panels or nodes on the network.

3.3.1 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 LSS 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.

3.3.2 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.

3.3.3 Mean Time To Repair (MTTR)

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

3.3.4 LSS Control Panel HMI

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

HMI should indicate location of the sensors associated to the gas monitoring system.

The HMI interface shall include the following information as a minimum:

- a. System Overview (including Room Numbers)
- b. Zone Alarm
- c. History Trending
- d. System Status / Alarm History
- e. Sensor Status and Readings
- f. Connectivity
- g. Malfunction Alarm
- h. Calibration Mode

3.3.5 Audible Alarms

The LSS shall trigger all Audible Alarms associated with life safety functions. Audible alarms in high noise areas shall be rated for the db levels present and shall be adjustable.

3.3.6 Visual Alarms

The LSS shall trigger all Visual Alarms stacks and strobes associated with life safety functions. Outdoor strobes shall be designed for visibility in daylight conditions.

3.3.7 Emergency Stops

The LSS shall monitor and control all Emergency Push Button functionality and safety functions. Provide colour coded, mushroom style, Emergency Pushbuttons with Push – Pull action. Emergency Push button shall denote shutdown or interlock information.

3.3.8 LSS 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 2.9.15).

3.3.9 Field Devices for Safety Functions

Should be installed by LSS specialist. Safety functions and interoperability of BMS controlled equipment shall be interfaced between LSS and BMS via hardwired LLI.

3.3.10 Power

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

3.3.11 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.

3.3.12 Oxygen and Gas Sensors

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

3.4 Operator Interface Hardware and Software

Where LSS hardware and User Interface PCs 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.

3.4.1 Engineering Code

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

Source code shall be provided to UNSW EM in soft copy.

3.4.2 System Passwords

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

3.5 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: E26_619_Oxygen Depletion CRITICAL_ALARM

- Building Pre-fix: H6
- Room Code: 619

- Description: Oxygen_Depletion
- State: CRITICAL_ALARM

3.6 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 soft copies of source code and software shall be provided to UNSW EM

3.7 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.

3.7.1 Fire Trip

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

3.7.2 Fan Failure

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

3.7.3 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 2.9.15).

3.8 Commissioning

3.8.1 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.

Validations documents should include the controller software checksum at the time of testing.

3.8.2 Practical Completion

In addition to Section 3.8.1 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.
- Source code and software of the system shall be provided via soft copy to UNSW EM.

3.8.3 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.

3.8.4 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.

LSS BMS and subsystems IST shall be documented and submitted.

3.9 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.

3.9.1 Pre-Construction Design Documentation

LSS Pre-Construction documentation shall be submitted for approval by EM Engineering detailing:

- LSS Network Topology - Full system, including integration to other systems
- Project LSS Points List including register for interface for BMS
- Project Functional Description – To be added to the building Functional description

3.9.2 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.