Alarm Handling Subsystem (AHS) Requirements Specification

Enterprise Building Management System (EBMS)

MACQUARIE University

DOCUMENT HISTORY

Version	Description	Date issued
0.1	DRAFT	5/10/2012
0.2	Delete references to alarms being created in Server. Specification modified to require alarms to be created at lowest possible Niagara device.	13/2/2013
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CIRCULATION APPROVAL

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1.0 PURPOSE

The purpose of this document is to describe the campus wide Alarm Handling Sub system and defines how alarms are generated and handled to limit the alarms generated to the minimum number of alarms required to communicate critical and maintenance conditions.

The Alarm Handling Sub-System is part of the Campus EBMS AX Supervisor. This document should be read in conjunction with the “Guideline Design Standard for Building Management Systems (BMS)”.

2.0 SCOPE

This Specification covers all alarms generated by any BMS's on campus and the distribution of alarms to VARIOUS stake holders via the campus wide EBMS (AX Supervisor).

3.0 REFERENCES AND STANDARDS

- Macquarie University, Sydney. Guideline Design Standard for Building Management Systems (BMS) Version 2.00
- National Institute of Standards and Technology (NIST). GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet
- American Society of Heating Refrigeration and Air-conditioning Engineers. BACnet PICs (protocol Implementation Conformance Statement)
- NiagaraAX Platform Guide

4.0 DESIGN CONSIDERATIONS

4.1 ASSUMPTIONS

The alarm handling sub-system shall interface to (and be integrated with) the existing EBMS AX Supervisor alarm subsystem. For legacy systems if a compatible interface does not exist, a JACE (running Niagara framework) will be used to interface to the existing AX Supervisor.

4.2 CONSTRAINTS

Many of the systems report alarms on a point by point bases, where no consideration has been given to either consolidating the alarms in to one event or to reduce the nuisance alarm flooding that occurs during a major failure i.e. equipment losing control during a fire trip.

4.3 DEPENDENCIES

Alarm reporting depends on a fully functional campus wide area network. No backup or secondary paths exist from the building controllers.

Alarm processing and distribution is via the AX Supervisor.

5.0 DEFINITIONS AND ABBREVIATIONS

ACU, Air Conditioning Unit

AHU, Air Handling Unit

AI, Analog Input a value that can be read from a controller

Alarm, An event that must be acknowledged by an user (i.e. a Critical or Maintenance alarm). As distinct from an event that is logged to the archive for future reference

Alarm Class, A method of grouping classifying alarms to simply handling of alarms.

Alarm Handling Subsystem (AHS), The alarm handling subsystem including the EBMS Server and Campus WAN link to each building.

AO, Analog Output, value that be read from a controller and written to by software

AV, Analog Value, a holding variable such as a setpoint

AX Supervisor, The main EBMS software and server used to interface to all campus building control systems.

BACnet, Interoperability protocol ISO 16484-5

BACnet Advanced Application Controller (BACnet AAC), application controller

BACnet Application Specific Controller (BACnet ASC), application controller for VAV, FCU etc.

BACnet Building Controller (B-BC), controller device profile for high level network based controllers.

BACnet Operator Workstation (B-OWS), network level workstation

BACnet Advanced Workstation (B-AWS), advanced operator workstation

BCS, Building Control Station, a high level BMS controller typically connected directly to the MACQUARIE UNIVERSITY WAN. Commonly used to control chillers, large Air handling systems and other complex equipment. Must conform to BACnet B-BC device profile.

BI, Binary Input, a digital value read from a controller

BMS, Building Management System, A control and management system installed at a building level.

BV, Binary Value, a digital holding variable

DSC, Distributed Control System

DMZ, Demilitarized Zone

EBMS, Enterprise Building Management Server, Enterprise wide server interfacing individual Building Management Systems.

Event, A change of state captured by alarm management software either at BMS or EBMS level. An event may be logged for future reference or may be an alarm.

FCU, Fan Coil Unit

JACE, Java Control Engine, Application controller manufactured by Tridium Inc.

LDAP, Lightweight Directory Access Protocol

Lonworks, Echelon Corporation Lonworks network standard

Modbus/RTU, Modbus over serial link (RS-485)

Modbus/TCP, Modbus over IP (Transmission Control Protocol)

Native BACnet system, a system that can be proven to be designed around the BACnet standard. Excludes systems that provide BACnet gateways or BACnet integration at only the LAN level. Native BACnet should support a majority of BACnet objects including but not limited to Points, Services, Alarms, Time Schedules, Trendlogs and Programs.

NMS, Network Management System, a software system for monitoring network devices.

NTP, Network Time Protocol

OFM, Office of Facilities Management

RDC, Remote Distributed Controller, BACnet application oriented controllers, typically linked to a BCS or a BACnet router for supervisory functionality, may reside on a lower speed (78Kbs) peer to peer LAN. Commonly provide VAV, FCU, small AHU, and Packaged Equipment local control. Required to support B-AAC or B-ASC profile.

RDP, Remote Desktop Protocol (multi-channel allowing remote clients to connect to Microsoft Terminal Services).

SDD, System Design Document, includes all design information for approval prior to installation

SNMP, Simple Network Management Protocol

SMTP, Simple Mail Transfer Protocol

VAV, Variable Air Volume (referencing the controller/actuator)

VPN, Virtual Private Network

UTC, Coordinated Universal Time

6.0 GENERAL REQUIREMENTS

- Deliver alarms to the end user or users so the appropriate actions can be taken or scheduled.
- The maintainer of the EBMS server is responsible for the delivery of alarms to the users, whether to graphics, email, SMS, SNMP or other delivery mechanism. Individual building BMS systems will not transmit alarms directly to users, except with the express agreement of MU Property and the EBMS Maintainer. This requirement is to ensure that alarms are centrally managed to prevent alarm flooding, missed alarms, or incorrectly programmed alarms.
- The central alarm handling system is required to achieve Total Availability of T(av) = 0.996. This implies a maximum annual downtime of approximately 32 hours including routine maintenance of server and Campus network outages.
- To ensure that alarms for critical equipment such as fridges and freezers are transmitted to the Service Desk reliably, the Mean Time to Repair (MTTR) of the Server after a fault or routine maintenance shall be no greater than 8 hours. Combined with the availability requirement, no more than 4 outages of 8 hours duration are permitted in each 12 month period.
- Alarms will be created at the Building Level (the nearest Niagara device in the chain of communications to the server) and will be sent to the EBMS server using the Station recipient mechanism. This capability shall enable:
  - Standalone operation with a standalone server where the building is required to process and display alarms locally from a local server
  - Where speed of response is critical (such as capture of fleeting alarms from electrical measurements or other local processes)
  - Where complex alarm logic produces a derived output state that is time critical (although it is preferred that the output state is sent to the EBMS server for alarm processing)
- The EBMS shall be able to manage (including acknowledgement) all alarms in accordance with the BACnet AWS profile.
- The EBMS will provide alarm monitoring of all building services.
- Alarms that have been acknowledged and returned to normal shall be removed from the visible display and moved to the archive. At any time the user shall be able to view the archive by a simple selection from the current alarm display. This function shall not require any special reporting tools or software.
- The alarm management system shall be capable of processing at least 1,000 events per day at the EBMS Server with less than 1% error. The alarm management system must be able to present at least 250 alarms per day to the users with less than 1% failure rate.
- A link from any alarm to a context relevant graphic shall be provided at the EBMS server There will be no graphics stored in the BMS in the field other than those required for critical maintenance or backup. All alarm to graphics links shall be created solely for graphics and alarms stored at the EBMS server level.
- As well as being able to receive alarms from BACnet systems, it shall be possible to program alarms at the EBMS for any point imported to the EBMS.
- At any time it shall be possible to produce a report of all points in alarm, all alarms suppressed and an all alarms history.
- The EBMS will provide for each building to have its own separate alarm queuing and handling, allowing for display of alarms on each buildings graphical web page.
- BCS time clock's must be able to synchronise with Macquarie University Time Server (Network Time Protocol and local alarm buffering for up 500 alarms offline from the server.

7.0 FUNCTIONAL REQUIREMENTS

7.1 USERS AND ROLES

Macquarie University has four (4) main stakeholders groups that are responsible to monitor and act on the alarms events.

The Alarm Handling System shall have the ability to define Users and allocate roles to the user based on the functions required by their roles. Where a role is defined it shall be possible to create new users and assign these users to the selected role.

The User Groups currently accommodated by the Alarm Handling system are:

7.1.1 Macquarie Property Staff

Macquarie Property Staff are responsible for:

- Maintaining building environmental conditions
- Maintaining the campus building and plant equipment.

7.1.2 Security Staff

Security staff are responsible for:

- Responding to and reporting alarms 24 hours per day, 7 days per week, including contacting responsible Macquarie Property Staff to attend to critical alarms.

7.1.3 Facilities Staff (including facility operators and department staff)

Staff are responsible for:

- The environmental conditions in selected laboratories, or facilities such as swimming pool.
- Responding to alarms on selected equipment (i.e. fridges, freezers, etc.).
- Allocating service and repair contractors as required and authorised.

7.1.4 Contractors and consultants

Contractors and consultants are responsible for:

- Providing and / or maintaining compliant building systems, mechanical or electrical plant to this Specification.

7.2 PLANT GROUPS

Plant groups shall be used to define the following:

- Each plant group shall be defined such that users are assigned permissions to the plant groups for which they have access rights within the BMS.
- Plant groups can be defined to be complete buildings, or campus wide systems, such as Cogen, District Cooling, External Lighting or similar.
- Any valid user will have READ ONLY permission for all Plant Groups
- Users shall be granted specific WRITE or INITIATE permission only to assigned Plant Groups. For example, it shall be possible to grant WRITE access to staff in the pool to change room setpoints within the pool facility, however pool staff shall not have access to change setpoints in other buildings.
- It shall be possible to assign users to more than one Plant Group.

7.3 ALARM TYPES

Alarm types shall be defined and setup as follows:

- Alarm conditions are programmed in each building's BMS. Alarms shall be classified as per the requirements of this Specification.
- The BMS System shall generate the appropriate alarm on detection of a fault or out of limit quantity.

The BMS shall be capable of generating alarms of the following types:

- Failure of any controller or component of the BMS System
- Failure of communications between the EBMS and the BMS controllers or controller networks
- Discrepancy between required output and measured response
- Set Boolean or Analog thresholds.
- Deviation from setpoint (where programmed).

The following general requirements apply to alarm events generated by the BMS:

- Critical alarms must be able to be received at the EBMS server within 10 seconds of occurrence.
- Where more than one alarm event can be generated from a single failure or out of specification condition (i.e. fire trip), one alarm event will be generated as the notification event and all other associated alarms should be at a lower priority or suppressed so that the alarm system is not flooded with nuisance alarms.
- The generation of environmental out of limits alarms must be programmed such that they are suppressed when the controlled plant is not operating.
- Where quantities can vary as part of a process, suitable hysteresis will be used to ensure nuisance alarms are not generated.
- Suitable user adjustable time delays shall be assigned (to both on and off transitions) as well as alarm thresholds (low limit, low level, high level, high limit) and deadbands to prevent nuisance alarms and alarm flooding.
- Any alarm shall be able to be suppressed temporarily such that no further alarms are sent to the EBMS during periods of maintenance or repair of faulty equipment.
- It shall be possible for an adjustable time delay to be added to return the alarm to normal function without user intervention.
- Critical alarms are to be individually programmed with instructions, contact details and phone numbers provided within the alarm message.

In addition to handling and distributing alarms received form the BMS the EBMS shall be capable of generating the following alarms:

- Software failure within the EBMS
- Failure of communications between the EBMS and the BMS controllers or controller networks

7.4 ALARM RECORD FORMAT

All alarms are to have the same format and provide the following information at a minimum.

- Each alarm point is to be based on the Point Naming Convention (location and equipment type) Refer Macquarie University object naming methodology.
- Type of alarm condition (High Level, High Limit etc).
- Occurrence date and time.
- Return date and time.

- Acknowledge date, time and operator identification.
- Value of the point at the time of alarm occurrence.
- All alarms will be logged to permanent storage
- Default alarm shall not be logged at the EBMS during system testing.

7.5 ALARM CLASSES

Alarms shall be grouped by their importance and type. The following generic Alarm Classes shall be defined:

7.5.1 Critical Alarm

Alarms that need immediate attention. Critical alarm classes will be grouped by building service type:

- HVAC
- Electrical
- Fire
- Hydraulic
- Other

7.5.2 Maintenance Alarm

Alarms that do not need immediate attention but are required to be visible via an Alarm Console graphic. Maintenance Alarm classes will be grouped by building service type:

- HVAC
- Electrical
- Fire
- Hydraulic
- Other

7.5.3 Information Alarm

Events that require an alarm to be captured at the AX Supervisor for information only to used by MUP clients (ie Faculty personnel) or other reasons.

7.5.4 Niagara Network Health

Niagara Network Health alarm class is reserved exclusively for Network Offline alarms only.

7.5.5 Default Alarm Class

The Default Alarm Class exists within the B-BC (typically a Niagara JACE) only and shall not be routed external to the building BMS. The purpose of the DefaultAlarmClass is to allow BMS Contractors to programme alarms for commissioning or testing purposes without confusing MUP personnel by having these alarms being received by the EBMS.

7.5.6 Alarm Class Naming Convention

Alarm Classes shall be named using the format:

7.5.6.1 Building Number Priority Building Service.

For example building E8A Critical HVAC alarm class shall be “E8A_Critical_HVAC”. No spaces shall be allowed.

7.5.7 Ad Hoc Alarm Classes

Additional alarm classes may be defined to suit operational requirements. Additional alarm classes must be approved by MUP and must follow the naming convention of:

BuildingNumber_Priority_Descriptor.

The first two components of the name must be the Building Number and the Priority.

For example an alarm class to separate critical alarms from Room 123 in Building E8A may be:

E8A_Critical_Room123

7.6 ALARM WORKFLOW GENERAL

There shall be a workflow function to allow the user to program actions to be taken upon receipt of any alarm, for example, send an email, print a report and activate logic.

Alarms shall be routed to the appropriate recipient or recipients by the “AX Supervisor” alarm subsystem. This includes alarm queues and email recipients. The alarm subsystem must route the alarms to the correct recipients.

Local Building Controllers (B-BC) may have a local alarm console within the controller for commissioning and service purposes. Only Default Alarm Classes are routed to a local alarm console.

Alarms from each BMS will be gathered for local displaying and link to the EBMS for global alarm management. The EBMS shall maintain an active alarm queue allowing views of each individual buildings alarms or aggregated and managed as a single queue.

It shall be possible to redirect alarms to any network printer available to the EBMS server. Printing format shall be a line by line report or detailed alarm report.

Graphical Display of Alarms

Displaying of alarms graphically is achieved by the Console Recipient Function. The following Console Recipients shall be defined as a minimum:

- Building Alarm Console
- Master Alarm Console
- Security Alarm Console

7.7 AX SUPERVISOR ALARM WORKFLOW CONFIGURATION

7.7.1 Overview of Alarm Workflow Configuration

ALARM CLASS	BUILDING ALARM CONSOLE	MASTER ALARM CONSOLE	SECURITY ALARM CONSOLE	EMAIL OF ALARMS
Critical	Yes	Yes	Yes	As required
Maintenance	Yes	Yes	No	As required
Information	No	No	No	As required
Niagara Network Health	No	No	Yes	As required

7.7.2 Critical, Maintenance, Information and Niagara Network Health Alarm Classes shall be routed to the AX Supervisor using the Station Recipient function. Refer Figure 1 below.

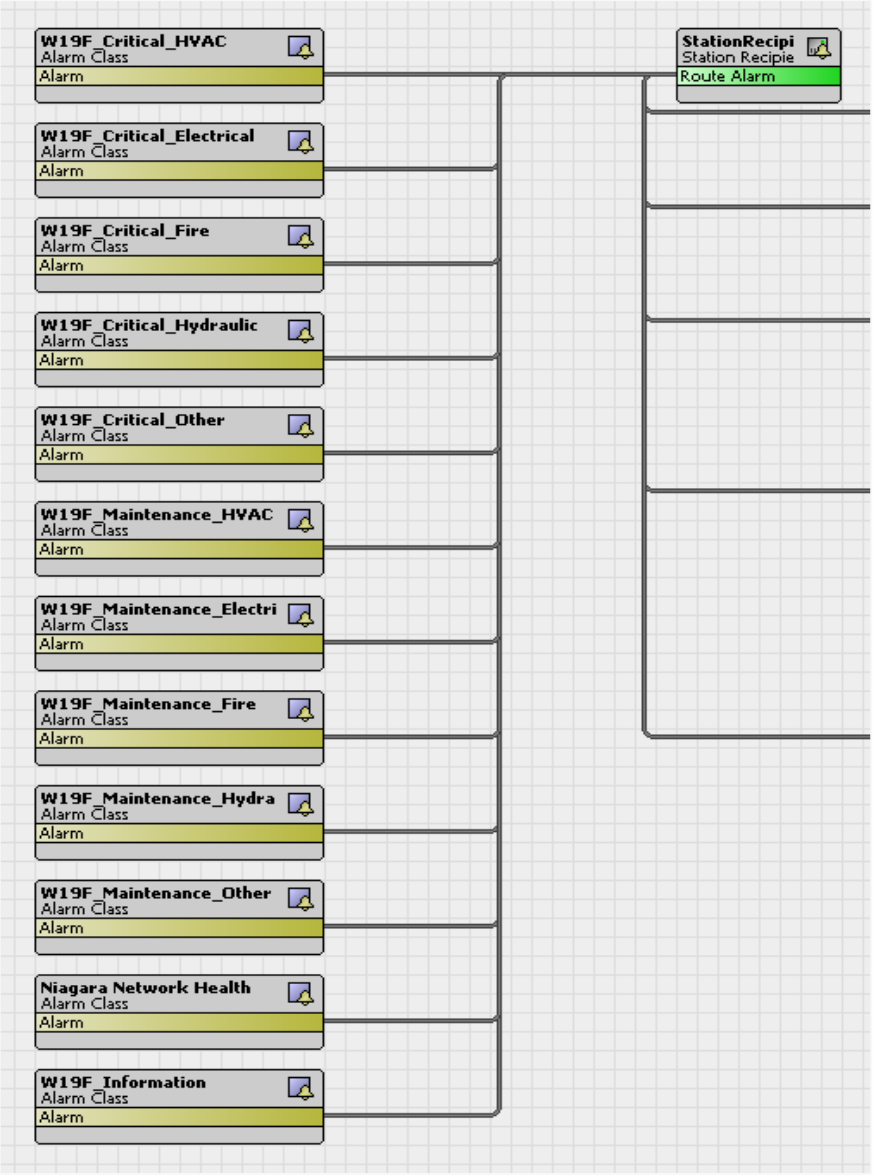

Figure 1 *Example routing of Alarm Classes in JACE*

Each building is to have a Local Console graphic accessible via the building web graphic.

Critical Alarms shall be displayed on the Building Alarm Console, the Master Alarm Console and the Security Alarm Console.

Maintenance Alarms shall be displayed on both the Building Console Display and the Master Console Display.

An Email Recipient can be defined and linked to any Alarm. By default alarms will not be sent via emails unless requested.

Additional Alarms Consoles and Email recipients can be added as required by Macquarie University Property.

NOTE: Alarm notification relies solely on the campus WAN infrastructure being operational. Any outage will result in the alarms not being delivered.

Alarm queue and graphical point colouring in the graphic shall be as per the following table:

ALARM COLOUR	*ALARM DESCRIPTION*
RED **-Fail**	This indicates a failure of a piece of equipment on a facility which is in need of attention and also means that the equipment may not be available. An example would be a Chiller Failure. This type of alarm requires immediate attention. The alarm screen in the security desk will flash and beep simultaneously until acknowledged.
YELLOW **– Fault**	There is either a fault on a particular part of an equipment, the primary piece of equipment has failed and the secondary is in use. E.g. “UPS on battery”.
GREY **-log only**	Event record only
GREEN **– Clear**	An alarm that has gone from either, Red or Yellow to Green means that the equipment has returned to its full operational status.

APPENDIX A

Each JACE will require a minimum of 11 off Alarm Classes as stated in the table below. For each Building and each JACE Alarm Class there will be a corresponding alarm class set up in the Supervisor.

The following table indicates the preferred mapping for each building to the AX Supervisor:

JACE ALARM CLASS	AX SUPERVISOR ALARM CLASS	PRIORITY COLOUR
A1B_Critical_HVAC	A1B_Critical_HVAC	Red
A1B_Critical_Electrical	A1B_Critical_Electrical	Red
A1B_Critical_Fire	A1B_Critical_Fire	Red
A1B_Critical_Hydraulic	A1B_Critical_Hydraulic	Red
A1B_Critical_Other	A1B_Critical_Other	Red
A1B_Maintenance_HVAC	A1B_Maintenance_HVAC	Yellow
A1B_Maintenance_Electrical	A1B_Maintenance_Electrical	Yellow
A1B_Maintenance_Fire	A1B_Maintenance_Fire	Yellow
A1B_Maintenance_Hydraulic	A1B_Maintenance_Hydraulic	Yellow
A1B_Maintenance_Other	A1B_Maintenance_Other	Yellow
A1B_Information	A1B_Information	Grey
Niagara_Network_Health	Niagara_Network_Health	Grey
DefaultAlarmClass	Not mapped to AX Supervisor	Nil

Where A1B denotes the building number

APPENDIX B

In principle, the BMS system will include those alarms that are considered by Macquarie University to be significant plant and environmental related alarms. The project specification will define specific alarms for that particular project.

The following alarm parameters are the minimum required:

BUILDING SERVICE HVAC

ALARM	FUNCTION	PRIORITY COLOUR
Chiller Fail to Start	Duty Chiller failed to start after start delay	Yellow
Chiller Fault	Duty Chiller status OK but Fault	Yellow
No Chiller Available	Generated when standby Chiller Fault or Fail to Start resulting in no chillers being available	Red
Pump Fail to Start	Pump failed to start after start delay	Red
VSD Fault	VSD Fault with VSD status running	Yellow
AHU/FCU Fan Fail to Start	Fan status (pressure) fail to follow start/stop	Yellow
AHU/FCU General Fault	AHU Fault while status indicating running	Yellow
Process Cooler Fault	Process cooler fault active and not running	Yellow
Processor Cooler Unavailable	Generated when standby Process cooler fault and not running resulting in no Process Cooler being available.	Red
Critical Temperature outside limits	Lo, lo lo, hi, hi hi on critical temp – nominally chilled or CW only	Red
Condensor Water failed	No flow in condenser water circuit	Yellow
TES Fail	Thermal Energy Storage system failure	Yellow

BUILDING SERVICE ELECTRICAL

ALARM	FUNCTION	PRIORITY COLOUR
Mains Fail	Incoming mains has failed	Red
Phase Fail	A phase fail relay has tripped	Red
Generator Fail	Generator failed	Red

BUILDING SERVICE HYDRAULIC

ALARM	FUNCTION	PRIORITY COLOUR
Domestic water pump fail	Domestic water pump failed to start	Red
Subsoil drainage pump fail	Subsoil drainage pump failed to start	Red
Main Pressure	Mains pressure fallen below required value	Yellow
Rain Water System	Rain Water System fault	Red
Sewage Pump Fail	Sewage Pump has failed	Red

BUILDING SERVICE FIRE MONITORED BY BMS

ALARM	FUNCTION	PRIORITY COLOUR
Building Fire alarm	General building fire alarm	Red
VESDA fault	VESDA fault	Red
VESDA Level 1 alarm	Smoke level trips VESDA level 1	Yellow
VESDA level 2 or 3 alarm	Smoke level trips VESDA level 2 or 3	Red
Gas system discharge	Gas system has operated	Grey
Gas system fault	Gas system has indicated a fault	Grey