Public Works and Government Services Canada
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Real Property Branch

MD 250005 — 2009

Energy Monitoring and Control Systems (EMCS) Design Guidelines

Guidelines for Building Owners, Design Professionals, and Maintenance Personnel

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Canada

PWGSC

Mechanical Design Guidelines

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Guidelines for Building Owners, Design Professionals, and Maintenance Personnel

Engineering and Technical Services

Advisory and Practices (Prof Services)
Professional and Technical Services Management
Real Property Branch
Public Works and Government Services Canada
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Public Information

Public Works and Government Services, Canada is pleased to present the document MD 250005 - 2009 "Energy Monitoring and Control System Design Guideline", intended for use in the design and specification of controls for HVAC systems in buildings. This document has been developed by Engineering and Technical Services, Advisory and Practices (Prof Services), Professional and Technical Services Management in consultation with specialists and engineers from various regions.

A previous version of this guideline, published in 2000, is now obsolete due to rapid technical changes in this field.

Clients, property managers, engineers and maintenance personnel should become familiar with this document, for consistency in application to projects throughout Canada. We encourage you to use this guideline for new projects and for major upgrades to existing systems.

This document is available either in hard copy or electronic format from the PWGSC Documentation Center at doc.centre@tpsgc-pwgsc.gc.ca.

Travaux publics et Services gouvernementaux Canada est heureux de présenter le document IM 250005 - 2009 « Lignes directrices pour la conception des systèmes de gestion de l’énergie » qui doit servir à la conception et à la description des commandes de CVCA dans les immeubles. Ce document a été élaboré par le Groupe du génie et des services techniques, Conseils et pratiques (Services professionnels), Gestion des services professionnels et techniques, Direction générale des biens immobiliers en collaboration avec des spécialistes et des ingénieurs régionaux.

La version précédente publiée en 2000 est maintenant désuète en raison de l’évolution technologique rapide de ce domaine.

Les clients, les gestionnaires immobiliers, les ingénieurs et le personnel d’entretien devraient se familiariser avec ce document afin d’assurer l’uniformité d’application dans les projets partout au Canada. Nous vous encourageons à utiliser ces lignes directrices dans les nouveaux projets et dans la modernisation des systèmes existants.

Ce document est offert en version imprimée ou électronique au Centre de documentation de TPSGC à l’adresse doc.centre@tpsgc-pwgsc.gc.ca.

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Preface

General

This document has been developed by the Engineering and Technical Services group of Professional and Technical Services Management Directorate at Public Works and Government Services, Canada.

Instructions for use of this Guideline

This guideline is intended to provide general guidance in the development of design for EMCS systems.

Except where specifically required, the criteria should not be considered as a rigid set of standards to be followed at the expense of innovative design, but rather as a benchmark of excellence against which design decisions should be compared.

Feedback

Corrections, recommendations, suggestions for modifications or additional information and instructions that will improve this document are invited. For this purpose the attached form entitled "Request for changes" may be used and mailed or faxed to the address shown. E-mail or other forms of electronic transmission may also be used for this purpose.

Conflicts

Any area of conflict between this document and the Project Brief/RFP/Terms of Reference shall be brought to the attention of the Project Manager for clarification.

MD250005 – 2009
EMCS Design Manual
REQUEST FOR CHANGES

Paul Sra, P Eng. A/Manager, Senior Mechanical Engineer Engineering and Technical Services Advisory and Practices (Prof Services) Professional and Technical Services Management Dir. Real Property Branch Public Works & Government Services Canada Portage III 9A1 - 11 Laurier Street Gatineau, Quebec K1A 0S5 Tel: (819) 956-3972. FAX: (819) 956-2720 E-mail: paul.sra@tpsgc-pwgsc.gc.ca	**Niraj Chandra, P Eng.** Mechanical Engineer Engineering and Technical Services Advisory and Practices (Prof Services) Professional and Technical Services Management Dir. Real Property Branch Public Works & Government Services Canada Portage III 9A1 - 11 Laurier Street Gatineau, Quebec K1A 0S5 Tel: (819) 956-6516. FAX: (819) 956-2720 E-mail: niraj.chandra@tpsgc-pwgsc.gc.ca

Type of change suggested:

- ☐ Correction of information
- ☐ Deletion of information
- ☐ Addition of Information

Details of suggested changes:

If necessary, photocopy relevant page(s) of this manual and attach to this sheet.

Page: Chapter: Paragraph no.:

Details of suggested changes:

(Use additional sheets if necessary)

Signature: _________________ Phone No:.________________ Date: _______________

Table of Contents

Chapter 1 General Requirements

1.1 Background

The original Energy Monitoring and Control System (EMCS) design guideline was first published by the Department of Public Works, as it was then called, in 1984 in response to a need for an orderly approach to the design of EMCS. The manual was intended for Engineers, Technologists, and Consultants involved in the design of EMCS.

Since then, many technological advances and changes have occurred resulting in the need to revise and update this document. In addition, considerable experience in the design, installation and operation of EMCS has been gained and these have resulted in the need to revise the document.

Please note that the previous designation number of the document, which was called MD13800, has been replaced with MD250005-2009 to reflect the new specification sections in the revised National Master Specifications issued by PWGSC.

1.2 Associated Documents

Name	Description
PROJECT BRIEF/TERMS OF REFERENCE	This remains the prime reference document for any project since it provides detailed design criteria.
NMS	Refer to the relevant EMCS specifications sections.

1.3 Application

The design principles and procedures developed in this guideline should not be confined to heating, ventilating and air conditioning (HVAC) systems. This guideline may be used for all EMCS Applications.

The System Architecture and VAV system identified as AHU-1 (Air handling unit – 1) in this document are provided only as examples to better illustrate the intent and the level of detail expected from the Consultant in the preparation of the EMCS tender documents. The design criteria for each system and project must be adapted to the specific requirements involved.

Chapter 2 Design Procedures - a step-by-step approach

The EMCS design is prepared using the following 10-step approach:

Step	Description
1	Collect information
2	Identify documentation requirements
3	Prepare control design schematics
4	Prepare input/output point summary table
5	Identify system components
6	Prepare sequence of operation
7	Prepare system architecture
8	Co-ordinate with other disciplines
9	Prepare EMCS specifications
10	Consider maintenance, testing and commissioning issues

Step 1: Collect Information

This includes:

1. Full description of the design criteria for the facility and how all systems and integrated system therein are required to operate. This shall include the results to be achieved, acceptable tolerances and interaction between each system. This data is usually found in the Project Brief/Terms of Reference.

2. Full description of design intents developed by the Designer to meet the design criteria.

3. Full description of each integrated system, and system to be controlled together with its sub-systems, equipment and components.

4. Full description of electrical systems including emergency power, fire alarm systems, interaction between fire alarm systems and the mechanical systems so served.

5. For existing systems, "record" drawings and specifications relating to the systems and controls.

Step 2: Identify Documentation Requirements

1. For each SYSTEM or GROUP, prepare the following documentation and incorporate into the contract working documents:

    1. Control design schematic. Refer to Step 3, "Prepare Control Design Schematics."

    2. Detailed narrative description of the sequence of operations. Refer to Step 6, "Prepare sequence of operations".

    3. Input/Output Point Summary Table. Refer to Step 4 "Prepare Input/Output Point Summary Table".

    4. Electrical wiring schematics. Refer to Step 3 "Prepare Control Design Schematics"

    5. Control Description Logic (CDL) may also be provided, as described in Appendix B.

2. Provide an overall EMCS Architecture Schematic, showing all systems, all network communication devices, all Operator Work Stations (OWS), etc. Refer to Step 7 "Prepare System Architecture".

3. Provide all other schematics, schedules, summaries, etc. as may be deemed necessary by the Consultant or by review personnel to clarify contractual requirements and to facilitate understanding of each system as well as of the overall installation.

4. A sample system AHU-1 is used as example in this guideline. Such a system is usually only one part of a number of systems that constitute the building's EMCS. The process shown in this guideline must be duplicated for each air handling system, as well as for perimeter heating systems, boilers, heat exchangers, water chillers, terminal units such as heat pumps, fan coils, etc. Each system (including identical systems) must have its own design documentation similar to the one described for "AHU-1" in this guideline, as an example.

Step 3: Prepare Control Design Schematics (CDS)

1. Prepare control schematic drawings for incorporation into the specifications, using a drawing format approved by PWGSC. The drawings should be prepared by the Controls Contractor and reviewed by the Engineer.

2. Ensure that the control schematic drawings are also suitable for use as graphic displays in the Operator Work Stations.

3. Prepare an electrical wiring schematic for each system and for each motor linked to the EMCS installation. The Electrical designer for the project may do this. Preferably these schematics shall be regrouped with the Control Design Schematic of the system they represent. They must form part of the tender documents. Refer to Figure 1 for an example.

4. All components in the electrical wiring schematic shall match the Input/Output Point Summary Table.

5. When the electrical wiring schematic is completed, coordinate closely with mechanical and electrical Divisions to eliminate duplication and ensure full complementarity.

6. Prepare a separate control design schematic for each system and sub-system in the entire facility, showing schematics of all basic components forming part of the system. For example, for a typical HVAC system the CDS must show mixing chambers (plenums), dampers, filters, coils, control valves, circulating pumps, humidifiers, air washers and pumps, fans, variable inlet vanes, variable speed drives, air flow stations, location of relays and contacts for digital output points, etc.

7 The CDS must also show the relative location of all sensors and controlled devices.

8 The unique identifier for each system, point and type of point (AO, AI, DO, DI) must appear on each CDS. Refer to Section 2.4.6 " Point Identification Explanation".

9 Include pertinent additional operational information points as required such as calculated, duplicated or virtual points as well as fail safe position of output points.

10. Figure 1 shows an example of a SYSTEM control design schematic (CDS) to be prepared by the Consultant. The CDS illustrates the type of system used, the type of points, the point identifiers and, the relative location of the system components. The CDS also includes the related SYSTEM wiring schematic diagram. Similar CDS's must be prepared for each system or group, to form part of the tender documents.

11. Figure 2 shows an example of a graphic display that the EMCS contractor must develop for each SYSTEM or GROUP forming part of the EMCS installation. These graphic displays will be used to illustrate the different SYSTEMS or Groups on all fixed, mobile or remote operator work station (OWS). These system or group displays are generally derived from the corresponding CDS prepared by the Consultant, and they must be included in the shop drawing package submitted for review by the Consultant.

12. Control Design Schematics and Input Output Point Summary Tables should form part of the EMCS Plans and Specifications.

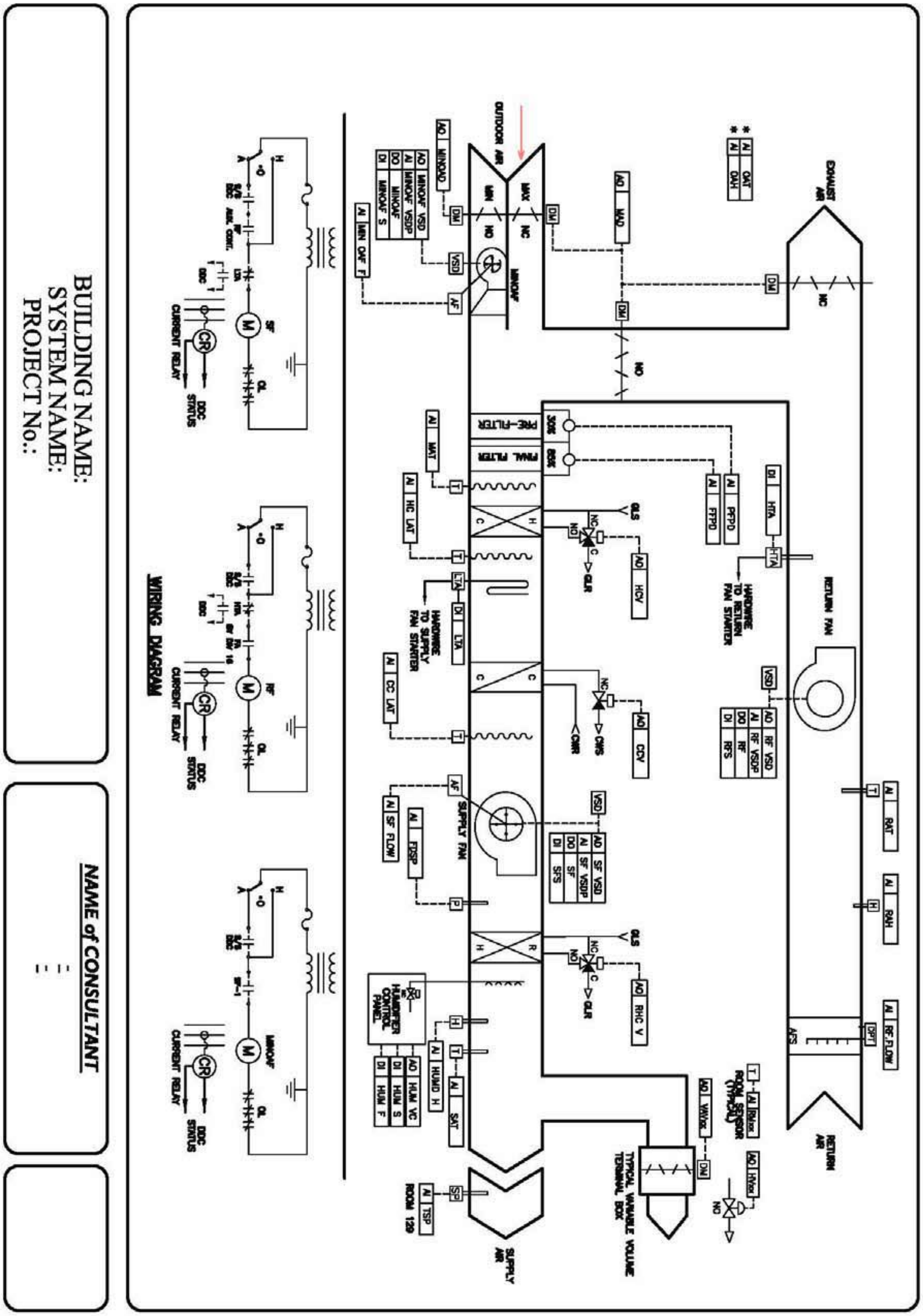

Figure 1 - Control Design Schematic

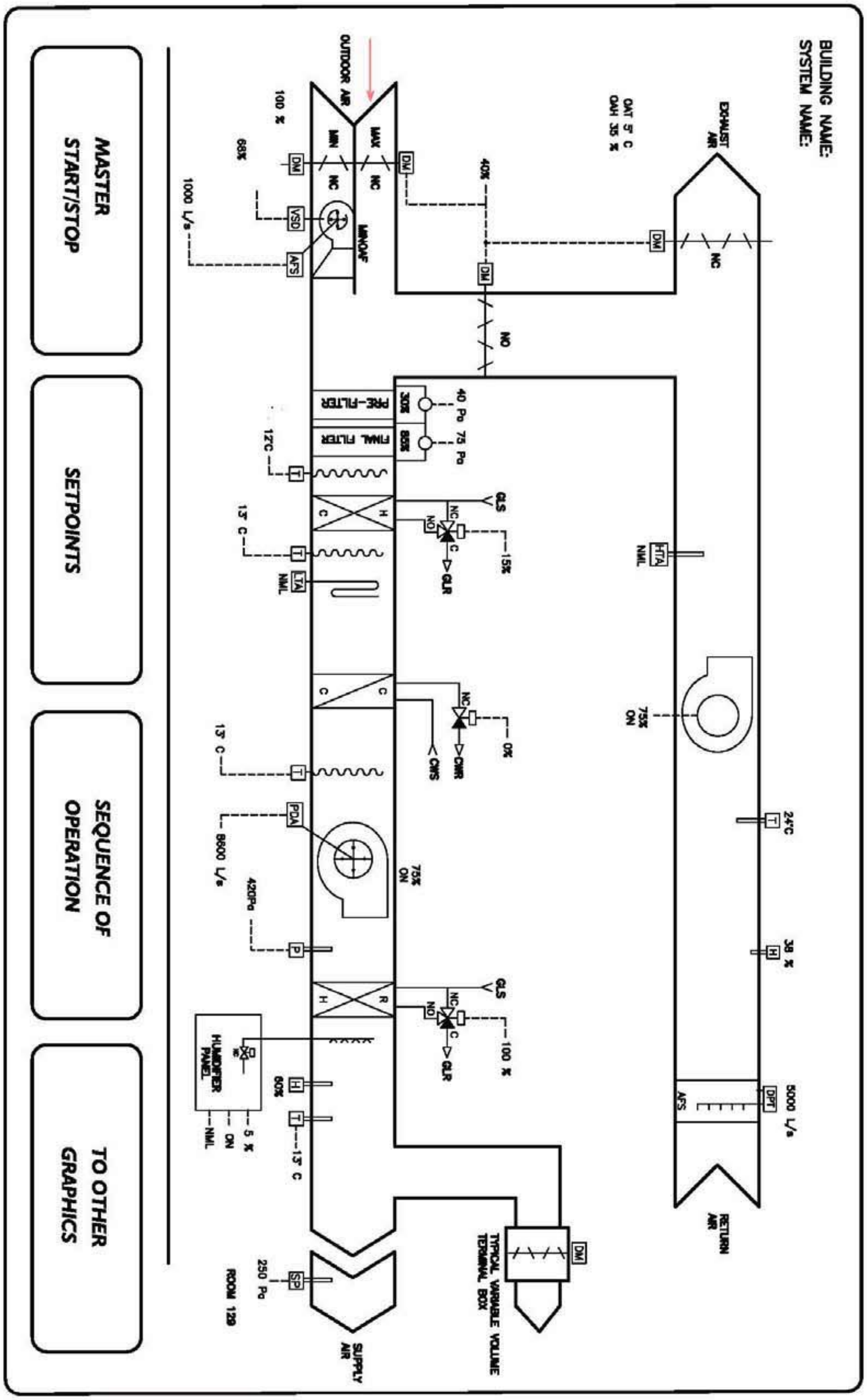

Figure 2 - Graphics Display

Step 4: Prepare Input/Output Point Summary Table

2.4.1 General

1. The I/O Point Summary shall supplement the specifications. They must provide all details not included in the sequences of operation. A legend describing symbols and abbreviations used throughout the I/O Point Summary must be produced for each project.

2. Boxes, which are irrelevant to the project, shall not be left blank but shall be filled in with a symbol such as an oblique or an "x" to indicate that no entry is required.

3. If, during the design phase, information is unavailable to accurately complete this schedule, the unfilled boxes shall be completed by the Designer with values that are estimated to most closely represent the true value. These values must, however, be identified as such in the table. Certain values that cannot be defined at design time (such as low amperage settings for adjustable current relays used to confirm motor status) may be identified as field (F) assignable at Testing, Adjusting and Balancing/Commissioning time.

4. For full details of systems labels, point's labels and their expansions, refer to section 2.4.6 "Point Identification Explanation".

2.4.2 Federal government official language policy

1. The official languages policy shall be applied to EMCS and all other computerized building control and monitoring systems and installations.

2. In applying this policy to EMCS, solutions must permit a safe and secure operation of federal buildings.

3. EMCS language requirements shall be uniformed throughout each PWGSC region.

4. In unilingual English PWGSC Regions, Levels 3 and 4 language must be English and the nomenclature used to identify non linguistic identifiers must be derived from the English language. (Refer to Table 1 in 2.4.3 EMCS Language).

5. In unilingual French PWGSC Regions, Levels 3 and 4 language must be French and the nomenclature used to identify non linguistic identifiers must be derived from the French language. (Refer to Table 1 in 2.4.3 EMCS Language).

6. In bilingual PWGSC Regions, Levels 3 and 4 languages shall be available in French or English through a selection feature readily accessible to the User. The nomenclature used to identify non linguistic identifiers must be derived from the dominant language used where the building is to be built. (Refer to Table 1 in 2.4.3 EMCS Language).

7. In unilingual English, unilingual French or bilingual PWGSC Regions, Level 2 language shall be as shown in clause Appendix A "Standard Identifiers and Expansions".

2.4.3 EMCS Language

The EMCS serves as a communication tool between building systems and the building user or operator. It uses several levels of languages to accomplish this and these are defined in Table 1 below:

Table 1: EMCS Language levels

Level	Title	Description
1	Commands	These represent various computer functions and routines.
	Operational commands	Relating to building operations and building system controls.
	Computer system commands	Relating to computer maintenance, upgrading or development software which is used by the Owner's "System Manager / Supervisor" to improve and maintain the application software for the building site.
2	System, equipment, component and control point expansions	These are unique alpha-numeric identifiers derived, by International convention, from English/French full names of the corresponding system, component and control point. Appendix A "Standard Identifiers and Expansions" identifies these expansions and their corresponding full names in English and French.
3	Full names of equipment and control points	The various systems, their equipment and components and all control points are named in accordance with Appendix A, "Standard Identifiers and Expansions".
4	Alarm and Operational messages.	At this level either English, French or bilingual, (as required by the Project Brief) shall be used to convey alarm conditions or operational messages.
5	Machine language.	These are languages specific to each manufacturer's product, used internally to perform its functions and routines.

2.4.4 Input/Output Point Summary Legend

Prepare an I/O Point Summary Legend to be inserted at the front end of the I/O Point Summary pages in Specification Section 25 90 01 Site Requirements, applications and Systems, Sequence of Operation. The legend should identify all acronyms, symbols and abbreviations used to identify messages, notes and program references in the I/O Point Summary for the project. The following is an example of a legend for the I/O Point Summary that can be used and modified for a specific project.

Table 2: I/O Point Summary Legend: Acronyms

Acronym	Description	Acronym	Description
ACR	Adjustable Current Relay	**IS**	Industrial Sensor
AFS	Air Flow Station	**L1**	Setting of CA, CR or OM low alarm
AI	Analog Input	**L/O**	Alarm Lockout
AL	Alarm condition	**MA**	Maintenance Alarm
AO	Analog Output	**MAC**	Maintained Contact on activation
CAT	Category	**MD**	Motorized Damper
CA	Cautionary Alarm	**MOC**	Momentary contact on activation
C/R	Closes on rise of the measured variable	**MV**	Motorized Valve
CR	Critical	**N**	No
DEL	Delay	**NC**	Normally Closed
DI	Digital Input	**NML**	Normal condition
DO	Digital Output	**NO**	Normally Open
DPT	Differential Pressure Transmitter	**O/R**	Opens on Rise of the measured variable
ET	Energy Totalisation	**RTT**	Run Time Totalisation
F	Field assigned	**SCH**	Scheduled
FA	Fire Alarm	**VSD**	Variable Speed Drive
H1	Setting of CA, CR or OM high alarm	**Y**	Yes
IC	Industrial Controller	**¤**	Virtual, Duplicated or Calculated point

Table 3: I/O Point Summary Legend: Programs

Programs	Description
P1	Auto Scheduling Calendar-Time of Day- Holiday-Temporary bypass
P2	Binary Run Time Totalisation
P3	Daily/Weekly/Monthly Event Totalisation
P4	Power Fail Restart Program
P5	Emergency Power Restart Program
P6	Heavy Motor Start Delay
P7	Day/Night or Occupied/Non-occupied set back
P8	Enthalpy Control
P9	Automatic Set Point Reset
P10	Automatic Restart on Fire Alarm Reset
P11	Analog/Pulse Totalisation
P12	Optimal Start and Stop
P13	Peak Demand Limiting & Load Shedding
P14	Energy Totalisation
P15	Night Purge
NOTES	These are examples of notes that may be used in the programs/notes column of the I/O Point Summary .
N1	Use High Priority interlock with corresponding Fire Alarm Zone Point
N2	Provide Fan Outlet Air Flow Station; use dual probe and totalisation if required.
N3	Provide Fan Inlet Air Flow Station; use dual probe and totalisation if required.
N4	On start up ramp to set point over prescribed period identified in sequence of operation
N5	Use double block sensor with one set of NO and one set of NC contacts.
N6	Lock Out H1 alarm if OAT < 5°C
N7	Lock Out L1 alarm if OAT > 15°C
N8	Automatically issue a stop command when system stop command did not originate from EMCS. This is done to prevent automatic restart on return to normal condition

2.4.5 Layout of Input Output Point Summary Table

1 Refer to Figure 4 for a copy of the generic I/O Point Summary that the Consultant must complete for each SYSTEM or GROUP. The symbols and columns are described below:

« 1 » PWGSC project reference number,

« 2 » Unique AREA identifier defined by client (generally the Building or Complex Identifier).

« 3 » AREA expansion defined by client to describe AREA identifier in full language.

« 4 » Name of EMCS Consultant.

« 5 » Reference number of the Master Controller used to link all I/O Point Summary TablePoints to the EMCS high speed communication network,

« 6 » Location (room #) where the Master Controller is to be installed,

« 7 » System name used in tender documents.

« 8 » Identifier used to define SYSTEM or GROUP of points covered by the I/O Point Summary Table at hand.

« 9 » Expansion used to define in full language the identifier of the SYSTEM

GROUP of points covered by the I/O Point Summary.

Column 1: Point #: point reference number for the SYSTEM or GROUP concerned.

Column 2: Point identifier: Unique identifier for each point in the SYSTEM or GROUP. Identical point identifiers may be repeated for other areas or systems. See 2.4.6 Point Identification Explanation.

Column 3: Point Expansion: Describes the SYSTEM/GROUP point identifier in expanded terms.

Column 4: Type of point: Example AI, AO, DI, DO.

Column 5: Eng. Units: Describes the engineering units used to define the measured value (ex: for AI:°C, kPa, Amp, Volt; AO:%; DI:OFF/ON, OPEN,CL,AL /NML; DO: OPEN/CLOSE, OFF/ON).

Column 6: Auxiliary device and/or type of sensor or output device: Lists, when applicable, any auxiliary device used in conjunction with the sensor or controlled device (ie: air flow station, transducer, probe, orifice plate, variable speed drive, humidifier control panel, adjustable current relay, well etc.) List the type of sensor or output device used (i.e.: duct, insertion, avg. RTD, pressure transmitter, industrial quality, matched pair of platinum sensors, actuator, contact etc.)

Column 7:	Division: Identifies division responsible for supply/ installation/ wiring of auxiliary devices listed in column 6.
Column 8:	Alarm Category: Defines the alarm category (ex. CR = Critical, CA = Cautionary, MA = Maintenance).
Column 9:	Analog Limits: Defines alarm activation level for analog inputs. (i.e.:. L1 = critical alarm low limit; H1 = critical alarm high limit.
Column 10:	Contact: Defines NORMAL condition of DO device when de-energized. (NC = normally closed- NO = normally open)
Column 11:	Action: Defines action of DI point (C/R = closes on rise of measured value and O/R = opens on rise of measured value)
Column 12:	Heavy motor delay: Identifies if controlled device is subject (Y/N) to heavy load restart program. The objective is to prevent multiple heavy electrical load motors from restarting simultaneously under auto start program, after fire alarm reset or on return to normal power following power interruption.
Column 13:	Applicable programs and notes: Use this column to identify special conditions or programs to which a particular point is associated such as:

Night setback; optimum start/stop; demand limiting (load shedding),

Optimization routines (eg. chiller optimization, supply air temperature optimization, enthalpy control) should be described as part of CDL's. Parameters for all application programs should be provided separately as part of the design documentation (eg. the Systems Operation Manual).

Note requirements for computer totalization, recording, print-out of accumulated value of a point over a period of time. If totalization depends upon a number of analog points, include for pseudo energy points. Run time totals: For calculation of operation of digital points. Optimum start/stop: Example: HVAC unit to start before scheduled occupancy; based upon HVAC unit, heat loss, interior and exterior environmental conditions, etc.

If space is not sufficient to list all requirements use reference notes annexed to the I/O Point Summary.

List identifying all applicable programs and notes is to be included in the I/O Point Summary Legend

Table 4: Input Output Point Summary Table (Generic)

PWGSC PROJECT NO:	«1»	CONSULTANT:	«4»	M&E System Reference:	«7»
AREA IDENTIFIER:	«2»	MCU NUMBER:	«5»	EMCS System Identifier:	«8»
AREA EXPANSION:	«3»	LOCATION OF MCU:	«6»	EMCS System Expansion:	«9»

1	2	3	4	5	6	7			8	9		10	11	12	13
POINT IDENTIFICATION					AUXILIARY DEVICES				ALARMS			DI/DO	DI	DO	
POINT #	POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROLLED OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	SUPPLIED	INSTALLED	WIRED	CR CA MA	ANALOG LIMITS		CONTACT	ACTION	HVY MOTOR	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE SECTION 259001
						DIVISION				L1	H1	NO NC	C/R O/R	DELAY	
1															
2															
3															
4															
5															
6															
7															
8															
9															
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20															
21															

NOTE 1: THE SHARED RESPONSIBILITIES SHOWN IN COLUMN 7 REFERS TO THE SUPPLY, INSTALLATION AND WIRING OF THE CONTROLLED DEVICE OR AUXILIARY SENSING DEVICE LISTED IN COLUMN 6.

NOTE 2: REFER TO PST LEGEND FOR LIST OF APPLICABLE SYMBOLS AND PROGRAMS OR NOTES IDENTIFIED IN COLUMN 13.

2.4.6 Point Identification Explanation

1. Since all modern EMCS installations are computer -based, they must respect the basic multi-level tree structure used for file-name identification in computers. In other words, as computers cannot accept identical paths to more than one particular file, the EMCS must use a unique "identifier" path for each input/output point.

2. The number of access levels for point identification may vary with each manufacturer but, as a minimum, to meet the standards outlined herein, a minimum of three levels of identification must be provided to access any given point:

   1 AREA,

   2 SYSTEM or GROUP,

   3 POINT.

3 Each AREA must be defined by means of a unique identifier. The area identifier usually corresponds to the name of a specific building or complex . It is usually provided by the client and it must be different from any other Federally owned facility. For any given project the AREA identifier must remain the same throughout.

4. A unique identifier must be assigned for each SYSTEM within a given AREA. Miscellaneous items not normally considered a SYSTEM may be grouped together under a unique GROUP identifier. This approach is frequently used for floor/ sector layouts and zones.

5. Provide a unique identifier for each POINT within a SYSTEM or GROUP. The same point identifier may be reused in another SYSTEM or GROUP.

6. The unique AREA identifier used for the existing project/building must be maintained. If necessary obtain identifier from PWGSC project manager. THIS REQUIREMENT IS CRITICAL

7. For a given AREA any new system identifier shall be unique and, within a system, each point identifier must be unique. This is a critical requirement.

8. A minimum total of 25 characters, including unused spaces, will be allocated for AREA/SYSTEM/POINT identifiers. SYSTEM identifiers shall be not more than 10 alpha-numeric characters including unused spaces and INPUT and OUTPUT point identifiers shall also be limited to 10 alpha-numeric characters including unused spaces. The letters shall be based upon the English or French language as indicated in Appendix A and should, to the extent possible, be the first letter of each word of the full name.

9. A minimum of 32 characters shall be allocated for the expansions (full name expansion of identifier) of each level of identifier (AREA, SYSTEM/GROUP and POINT). For bilingual installations an additional 32 characters must also be allocated for each level to accommodate the alternate language.

10. To avoid duplication at any level, tables of standardized identifiers and expansions have been prepared for each level of identification and are described in Appendix A "Standard Identifiers and Expansions". Any modification to these lists must be approved by PWGSC.

Refer to Appendix A "Standard Identifiers and Expansions"

2.4.7 Example of Input/Output Point Summary Table

The following is an example of the Input/Output Point Summary Table.

1. List all points and point data in the I/O Point Summary Table. Group points in order of priority of system operation, from the operator's point of view. Tables 5 & 6 provide examples of the I/O points used for HVAC system AHU-1. These pages, suitably edited, should form part of Section 25 90 01 Site Requirements, applications and Systems, Sequence of Operation of the tender documents prepared by the Designer.

2. In the summary, identify the location and the designated number of the Master Controllers used to link the system points to the high-speed communication network.

3. To ensure that the system can operate in stand-alone mode at all times, the primary points associated with a particular system must be linked to the high speed LAN via a common controller, as identified in the I/O Point Summary Table. If this is not done, control will not be possible when communication with other panels is lost. Primary I/O points include remote sensors that are critical for the proper operation of the HVAC system. Secondary points, such as terminal unit controls, or, points used for set point reset, need not necessarily be linked to the high speed LAN via the same unit controller. If stand-alone operation is required for extended periods (> 8 hrs) then operator intervention may be required to reset adjustable set points.

4. Select sensor ranges very carefully, to meet the needs of the control system. As an example, consider chilled water temperature sensors. A range of 0-100 °C would result in low accuracy, while a range of 0-15 °C may result in off-limit readings during winter, when the refrigeration system is shutdown. A range of 0-35°C range is appropriate for this application. Incorrect selection of ranges will result in poor control, loss of accuracy or erroneous readings. Consider grouping similar sensors together to use the same range.

5. Ensure that alarm limits are properly assigned, especially those, which activate equipment. Although these values may be modified during the system start-up and commissioning process, the initial values must be indicated in the tender documents and not left to the discretion of installation personnel. Some alarm limits cannot, however, be identified during design, for example current relay settings for motor status indicators. In such cases, the values should be assigned during TAB.

6. Review the I/O Point Summary. Move the most frequently used points to the top of the list if required, keeping inputs and associated outputs grouped together for ease of operations.

Table 5: Input Output Point Summary Table Example – 1

PWGSC PROJECT NO:	999999	CONSULTANT:	XYZ Consultants	System Reference:	Lab 1 AHU
AREA IDENTIFIER:	BBLDG	MCU NUMBER:	3	EMCS System Identifier:	AHU # 1
AREA EXPANSION:	Big Building	LOCATION OF MCU:	Mech Room # 1	EMCS System Expansion:	Air Handler # 1

1	2	3	4	5	6	7			8	9		10	11	12	13
POINT IDENTIFICATION					AUXILIARY DEVICES				ALARMS			DI/DO	DI	DO	
POINT #	POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROLLED OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	SUPPLIED	INSTALLED	WIRED	CR CA MA	ANALOG LIMITS		CONTACT	ACTION	HVY MOTOR	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE SECTION 259001
						DIVISION				L1	H1	NO NC	C/R O/R	DELAY	
1	SF	Supply Fan Stop/Start	DO	ON/OFF	Relay Contact	25	25	25				NO		Yes	P4, P10, N1
2	SF-S	Supply Fan Status	DI	ON/OFF	VSD Contact	25	25	25	CR/MA						P2
3	SFVSD-P	Supply Fan VSD Position	AI	%	VSD Contact	25	25	25	CA	40	90				
4	SFVSD	Supply Fan VSD Control	AO	%	VSD Contact	25	25	25							N4
5	SF FLOW	Supply Fan Air Flow	AI	L/S	AFS DP	25	23	25	CA	2000	4000				N2
6	RF	Return Fan Start/Stop	DO	ON/OFF	Relay Contact	25	25	25				NO		Yes	P1, P4, P10, N1
7	RF-S	Return Fan Status	DI	ON/OFF	VSD Contact	25	26	25	CR/MA						P2
8	RFVSD-P	Return Fan VSD Position	AI	%	VSD Contact	25	26	25	CA	40	90				
9	RFVSD	Return Fan VSD Control	AO	%	VSD Contact	25	26	25							N4
10	RF FLOW	Return Fan Air Flow	AI	L/S	AFS DP	25	23	25	CA	1500	3500				N3
11	RAH	Return Air Humidity	AI	%RH	Duct Sensor	25	25	25	CA	30	70				
12	RAT	Return Air Temperature	AI	°C	Duct Sensor	25	25	25	CA	15	27				
13	MAD	Mixed Air Dampers	AO	%	Damper Actuator	25	25	25							N4
14	MINOAD	Minimum OA Damper	AO	%	Damper Actuator	25	25	25							
15	PFPD	Pre Filter Pressure Drop	AI	Pa	Magnehelic DP	25	25	25	MA						
16	FFPD	Final Filter Pressure Drop	AI	Pa	Magnehelic DP	25	25	25	MA						
17	MAT	Mixed Air Temperature	AI	°C	Averaging Sensor	25	25	25	CA	8					
18	HCLAT	Heat Coil Leaving Temp.	AI	°C	Averaging Sensor	25	25	25	CA	14					
19	HCV	Heating Coil Valve	AO	%	Valve Actuator	25	22	25							
20	LTA	Low Temperature Alarm	DI	NML/AL	Low Temp Detector	25	25	25	CR	4°C			O/R		N5
21	CCLAT	Cool Coil Leaving Temp	AI	°C	Averaging Sensor	25	25	25	CA	10	20				

NOTE 1: THE SHARED RESPONSIBILITIES SHOWN IN COLUMN 7 REFERS TO THE SUPPLY, INSTALLATION AND WIRING OF THE CONTROLLED DEVICE OR AUXILIARY SENSING DEVICE LISTED IN COLUMN 6.

NOTE 2: REFER TO PST LEGEND FOR LIST OF APPLICABLE SYMBOLS AND PROGRAMS OR NOTES IDENTIFIED IN COLUMN 13.

Table 6: Input Output Point Summary Table Example – 2

PWGSC PROJECT NO:	999999	CONSULTANT:	XYZ Consultants	System Reference:	Lab 1 AHU
AREA IDENTIFIER:	BBLDG	MCU NUMBER:	3	EMCS System Identifier:	AHU # 1
AREA EXPANSION:	Big	LOCATION OF MCU:	Mech Room #	EMCS System Expansion:	Air Handler # 1

1	2	3	4	5	6	7			8	9		10	11	12	13
POINT					AUXILIARY				ALARMS			DI/DO	DI	DO	
POINT #	POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROLLED OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	SUPPLIED	INSTALLED	WIRED	CR CA MA	ANALOG LIMITS		CONTACT	ACTION	HVY MOTOR	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE SECTION 259001
						DIVISIO				L1	H1	NO NC	C/R O/R	DELAY	
22	CCV	Cooling Coil Valve	AO	%	Valve Actuator	25	22	25							
23	SAT	Supply Air Temp	AI	°C	Averaging Sensor	25	25	25	CR	15	21				
24	SASP	Supply Air Static Pressure	AI	Pa	DP Sensor	25	25	25	CR	250	500				
25	HUMV	Humidifier Valve	AO	%	Valve Actuator	25	22	25							N7
26	SAH	Supply Air Relative Humidity	AI	%RH	Duct Sensor	25	25	25	CR	20	90				
27	RHCV	Reheat Coil Valve	AO	%	Valve Actuator	25	22	25							
28	HTA	Return Air High Temp Alarm	DI	NML/AL	Duct Temp Switch	25	25	25	CR		30°C				N5
29	MINOA	Min Outdoor Air Fan Start/Stop	DO	OFF/O	Relay Contact	25	25	25							N1, P4, P10
30	MINOAF	Min Outdoor Air Fan Status	DI	OFF/O	Current Relay	25	25	25	CR						P2
31	MINOAF	Min Outdoor Air Flow	AI	L/S	AFS DP	25	23	25							N2
32	TSP	Terminal Static Pressure	AI	Pa	SP Probe DP	23	23	25	CA	125	250				
33	FA	Fire Alarm	DI	NML/AL	Fire Alarm Contact			25	CR						
34	HWST	Heating Water Supply Temp	AI	°C	Immersion Sensor & Well	25	22	25	CR	25	90				N7
35	HWRT	Heating Water Return Temp	AI	°C	Immersion Sensor & Well	25	22	25	CA	20	90				N7
36	HWP1	HW Pump # 1Start/Stop	DO	ON/OF	Relay Contact	25	25	25	CA						
37	HWP2	HW Pump # 2 Start/Stop	DO	ON/OF	Relay Contact	25	25	25	CA						
38	HWP1S	HW Pump # 1 Status	DI	ON/OF	Current Relay	25	25	25	CR			NC			P2
39	HWP2S	HW Pump # 2 Status	DI	ON/OF	Current Relay	25	25	25	CR			NO			P2
40	HWV	Heating Water Convertor Valve	AO	%	Valve Actuator	25	22	25							
41															
42															

NOTE 1: THE SHARED RESPONSIBILITIES SHOWN IN COLUMN 7 REFERS TO THE SUPPLY, INSTALLATION AND WIRING OF THE CONTROLLED DEVICE OR AUXILIARY SENSING DEVICE LISTED IN COLUMN 6.

NOTE 2: REFER TO PST LEGEND FOR LIST OF APPLICABLE SYMBOLS AND PROGRAMS OR NOTES IDENTIFIED IN COLUMN 13.

Step 5: Identify System Components

2.5.1 Field Instrumentation

1. Field instrumentation shall generally be of standard commercial quality, designed specifically for use in EMCS systems.

2. For special applications such as hospitals, laboratories, or, greenhouses, higher accuracy and faster response times may be required. In these cases, instrumentation shall be selected specifically for the application and may require the use of industrial quality devices.

3. All instrumentation shall be electronic, except where suitable end-devices already exist, or where faster speed of response is required. In such cases, pneumatic actuators with positioners and electric/pneumatic transducers may be required.

4. When different controlled devices must operate in unison, such as mixed air damper actuators, the devices must be provided with actuators using identical opening and closing response times.

5. Where fail-safe features are required (eg .in outside air dampers or in valves) fail-safe shall be by means of spring return. For perimeter heating valves, the fail-safe feature may also be provided by using spring-loaded actuators.

6. All safety devices (eg. Low temperature & high temperature devices) must be hard wired and remotely monitored. In most instances these devices will incorporate manual resets.

7. Logic that performs safety shutdown conditions shall not be capable of being over-ridden by the Operator (either by accident or deliberately).

2.5.2 Controllers

1. All controllers shall be stand-alone so that they perform their basic functions even if communication with other devices or communications links is disrupted. They shall have an automatic back-up mode of operation that will result in fail-safe operation of the basic control system.

2. All the primary points associated with a particular system must be connected to the same programmable controller and to the same master controller linking it to the communications network.

3. All master controllers and local controllers shall communicate on a peer-to-peer basis (ie. they shall not rely on any higher level device for communications between the controllers).

4. All equipment connected to emergency power shall be controlled by devices connected to the same emergency power source.

5. In addition, a Uninterrupted Power Supply (UPS) should be provided for those applications where sustained operations are required. The UPS will maintain control during the transition from regular power to emergency power. Each UPS unit shall be provided with a digital input alarm point to indicate battery deficiency.

6. The following devices, as a minimum, should be on UPS and emergency power:

    1. All Network devices including node controllers, gateways, routers and bridges,

    2. The default network devices – i.e. master controller,

    3. At least one Operator Work Station and

    4. Telephone interface unit.

2.5.3 Alarm Management

1. A well-developed approach to alarm management is essential for successful implementation of the EMCS.

2. It is essential that only real alarms are reported and that the concept of "Alarm Management by Exception" is adopted.

3. Fire alarm interface:
   At least one high priority general alarm input from the fire alarm system should be connected to the EMCS. This input shall notify the operator that a fire alarm has occurred and, also, indicate if any HVAC component has failed to respond in the correct manner. This input should also suppress any other alarms generated by the stoppage of the HVAC systems. Where HVAC systems are stopped on a zone basis provide a corresponding alarm for each applicable zone. When the fire alarm condition is over, the HVAC components will be turned on by the EMCS in a sequenced manner, avoiding the simultaneous start of a number of pieces of equipment.

4. Power failure interface:
   At least one high priority general alarm input from the emergency power system should be connected to the EMCS. This input shall notify the Operator that a power failure has occurred and also indicate if any HVAC component has failed to respond in the correct manner. This input should also suppress any other alarms generated by the stoppage of the HVAC systems. When the power failure ends, the HVAC components will be turned on by the EMCS in a sequenced manner, avoiding the simultaneous start of a number of pieces of equipment.

2.5.4 Large Motors

1. The EMCS should be designed to prevent the starting of several large motors at once. This could occur if interlocks are provided without appropriate time delays. Experience indicates that momentary starter circuits will provide the most reliable assurance to avoid these problems. Indicate in appropriate location on I/O Point Summary all loads subject to heavy loads restart program.

2.5.5 Special Program Features

1. Requirements for special features such as energy optimization packages shall be clearly identified in I/O Point Summary and they shall be clearly defined in detail, complete with logic statements wherever necessary. Application of special features may require extra sensor inputs and custom programming. Ensure that all required sensor inputs are specified and that the functional requirements are clearly defined.

2.5.6 Access Levels Associated with Commands

1. Access levels are associated with password features, and may be assigned a value between zero (0) and 8, level 0 being the lowest and level 8 being the highest level. One possible arrangement is show below; however, a smaller number of access levels may be used depending upon the requirements of the project.

Access Level	Description
0	Allows log-on capability.
1	Allows display or summary reports
2	Allows operator intervention of automatic process
3	Allows supervisory or control schedule changes
4	Allows full access to local controller memory, etc
5	Allows operational analysis of building performance
6	Allows full report generation and management functions
7	Allows total system access control except access control assignment
8	Allows total system access control including access control assignment

2. Modifications are permitted for levels 4,5 and 6, based on site conditions. However, levels 0, 1, 2, 3, 7, and 8 shall not change.

3. Access levels shall also allow grouping of points on a point-by-point basis, by point type, and/or, by function (eg. fire or security points may be separated from HVAC points).

Step 6: Prepare Sequence of Operations

Write a sequence of operation to describe the functioning of the system including pertinent details relating to the intended control concept and, interactions with other systems. The sequence must detail conditions in the following modes:

Stopped mode
Start-up process
Normal operation
Operation under emergency conditions (when applicable)
Emergency power mode (when applicable)

The following is the sequence for HVAC system AHU-1 VAV used as an example in this guideline. The sequence should be modified according to the needs of the project. For example, the sequence may indicate that the minimum outside air volume is controlled by CO2 sensors, if demand- control ventilation is used.

VAV System AHU-1.

Refer to Figures 1 and Tables 4 & 5

Stopped Mode

1. When the system is stopped, return fan (RF), supply fan (SF) and minimum outdoor air fan (MINOAF) are also stopped. Mixed air dampers (MAD) are in full recirculating position while minimum outdoor air damper (MINOAD) is closed.

2. Humidifier valve and cooling coil valve (CCV) are closed.

3. Heating coil valve (HCV) is modulated to maintain plenum temperature at 20°C, as sensed by (HC LAT), when the outdoor temperature is below 5°C. When the OAT is above 10°C heating coil valve (HCV) will bypass coil.

Start-up Mode

1. RF will be started first by an OWS manual command or by an automatic start/stop schedule program. The return fan system will start with all MAD dampers in full recirculating mode. The supply air fan (SF) and the minimum outdoor air fan (MINOAF) will be enabled via hardwire interlock. Under normal conditions (starter in auto mode) SF will be started immediately through software interlock and SF VSD will be ramped to the desired capacity over a 3-minute (adjustable) period to allow stabilization of the system.

2. Three minutes (adjustable) after start of SF, the MAD controls will be activated and the minimum outdoor air fan (MINOAF) will be started. Both MAD controls and MINOAF will then be ramped open to their prescribed set point over a 2-minute (adjustable) period.

Normal Operation

1. Return Fan Flow: The return fan airflow capacity will be modulated using flow tracking. RF VSD to maintain a return air flow as sensed by RF FLOW equal to the supply air flow SF FLOW minus a predetermined value based on an algorithm, to be determined during Commissioning

2. Supply Fan Flow: SF's airflow capacity will be modulated through SF VSD to maintain the terminal static pressure SF T SP at the required set point (200Pa initially; adjustable). The SFD SP will limit the supply fan discharge pressure to 275 Pa (adjustable from OWS) in case of duct breakage or fire damper closing.

3. Supply Air Temperature: The heating coil valve (HCV), the cooling coil valve (CCV) and the mixed air dampers (MAD) will be modulated in sequence to maintain the Supply Air Temperature (SAT) at the desired set point. The SAT set point will be readjusted inversely and linearly with the supply fan airflow capacity as follows:

SF VSDP≥ 55 %	SAT 13°C
SF VSDP≤ 45 %	SAT 15°C

4. Economizer cycle: System will incorporate all elements to operate under an enthalpy switch over economizer program but will initially be commissioned to switch over under an OAT dry bulb mode set at 20°C with a 2°C differential. In summer mode mixed air dampers (MAD) will be placed in full recirculating position in order to admit only the prescribed minimum outdoor air delivered by the MINOAF.

5. Minimum outdoor air: The minimum outdoor air fan (MINOAF) flow will be maintained at the desired scheduled set point assigned to its fan discharge air flow controller MINOAF VSD. The set point will be adjustable manually from the OWS or may be programmed to different set points, throughout the day, based on variable people occupancy loads. The initial set point to be 500 L/s.

6. Humidification: The 4-20 mA AO control point HUM V used to modulate the humidifier valve will be wired to the proper terminal points in the humidifier control panel. DI contacts for humidifier status and faulty operation to be taken from the humidifier control panel. An EMCS software interlock will insure that the airflow sensed at the fan inlet exceeds 1500 L/s before issuing a command to open the humidifier valve. The humidifier valve will be modulated to maintain the return air humidity (RAH) at the desired set point. The return air humidity control set point will be readjusted inversely and linearly with the following OAT as follows:

OAT ≥ 15° C	RAH = 30%RH
OAT ≤ - 30° C	RAH = 20%RH

The humidifier discharge humidity (HUMD H) will be used to initiate a critical alarm condition should the relative humidity at the supply fan discharge rise above 90% (adjustable).

7. Dehumidification: When the outdoor air temperature is above 15°C and the RAH %RH rises above 65% for a period exceeding 6 consecutive hours (adjustable) a dehumidification cycle will be initiated and the system heating zone pump will be restarted to allow use of the reheat coil. Once initiated, the dehumidification process will attempt to lower the RAH to 60%RH and the program will override any scheduled system shutdown to achieve this goal. In dehumidification mode the cooling coil valve CCV will be positioned to 100% open in order to maximize dehumidification while HCV will be fully closed. Reheat coil valve (RHCV) will be modulated to maintain the SAT at its prescribed set point. The dehumidification mode will be terminated when the RAH humidity is maintained below 62°F for 3 consecutive hours (adjustable). The zone-heating pump will be stopped.

8. Low temperature alarm: If the Low Temperature Thermostat (LTA) detects a temperature below 4°C, it will stop the supply fan, close the outside air damper, close the humidification control valve, initiate a critical alarm condition at the OWS and, stop the return fan through software interlock after a 2 minute delay (Adjustable).

9. Glycol Circulating Pump: The lead glycol heat exchanger coil-circulating pump will be restarted when the dehumidification cycle is initiated and stopped when the dehumidification cycle is terminated.

10. High temperature alarm: Hi-Limit return air thermostat HTA located at the return fan discharge will stop the return fan system through hardwire interlock if the duct temperature exceeds 51°C. HTA will simultaneously initiate a critical alarm condition at the OWS through a separate and independent NO dry contact in the thermostat. Supply fan (SF) and minimum outdoor air fan (MINOAF) will also be stopped through hardwired interlocks with return fan auxiliary contacts (by EMCS Contractor).

11. Fire Alarm: The HVAC system will be stopped through direct hardwire interlock to the Fire Alarm system in case a fire alarm is detected. The interlock with the fire alarm panel will initiate a high priority software program to initiate the alarm condition and inhibit any nuisance alarms caused by uncommanded system stoppage. When system stoppage occurs due to a fire alarm condition, the system will be reactivated, if so scheduled, when the alarm condition is reset at the fire alarm panel. Restart sequence to follow heavy motor restart provisions when applicable.

12. Power failure: On a return to normal power following a power failure, the system will be restarted automatically, if so scheduled. The restart sequence to follow the heavy motor restart provisions.

Step 7: Prepare System Architecture

1 Provide an overall EMCS System Architecture Schematic, showing all master controllers, operator workstations and network communication devices. Refer to Figure 3 for an example of a typical EMCS System Architecture Schematic.

2 To the extent possible, use soft connections to sub-systems such as chiller controls, boiler controls or VSDs to reduce the need for hard wiring.

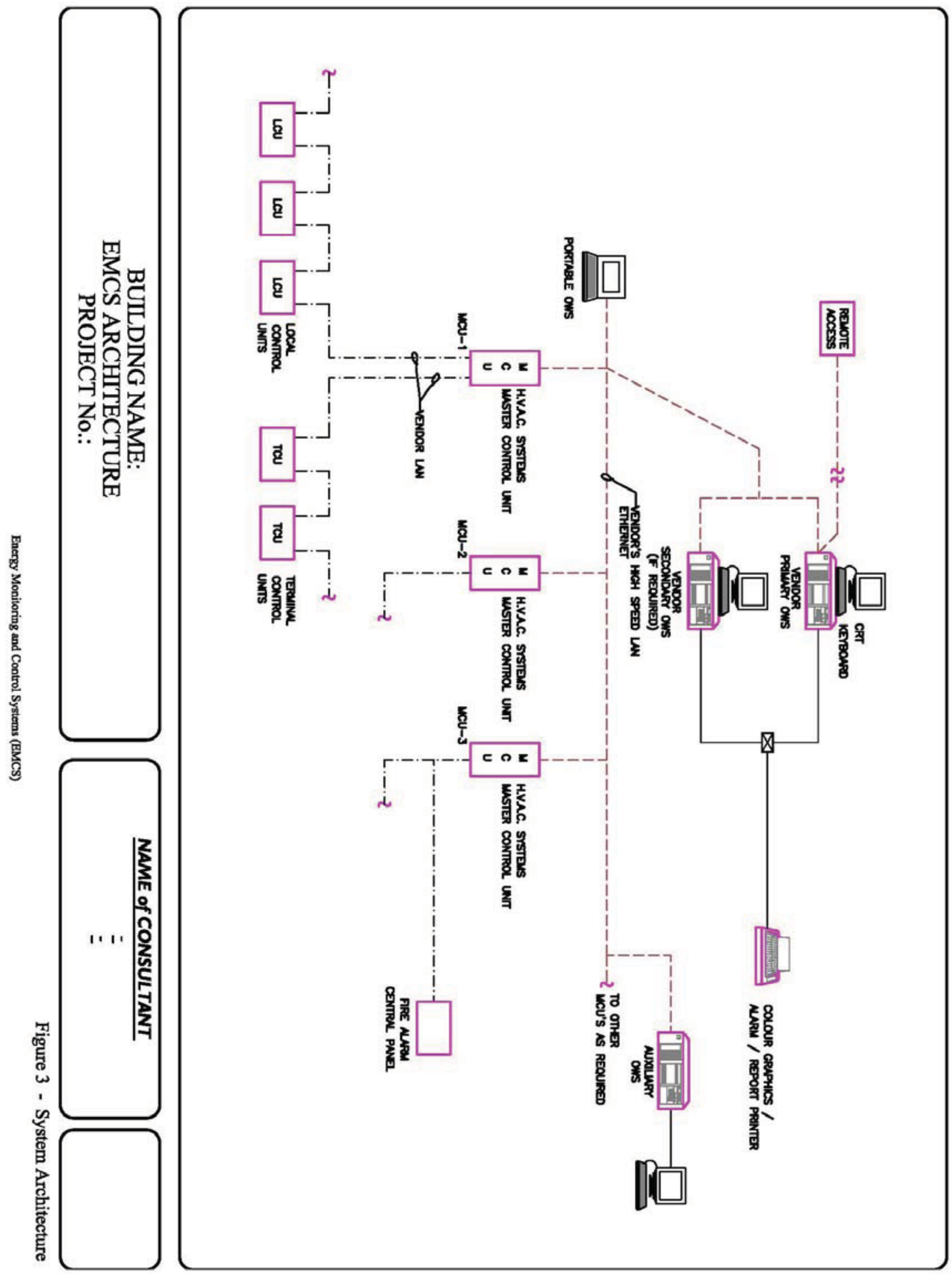

Figure 3 - System Architecture

Step 8: Co-ordinate with other disciplines

1. Review in detail, co-ordination of EMCS with mechanical and electrical design.

2. Prepare in co-operation with mechanical and electrical Designers, a Co-ordination Schedule, listing trade responsibility for each element of the system. This is essential for avoiding conflicts at a later date. A Co-ordination Schedule must be included in the specification for all trades involved. All EMCS related items must appear in the I/O Point Summary with the responsibilities clearly defined under column 7 in tables 4 & 5.

3. Describe in detail, requirements for interfacing and integration with all other mechanical/ electrical systems and equipment, such as

    - boilers
    - chillers
    - variable speed controllers
    - terminal units (e.g. VAV boxes, heat pumps)
    - laboratory fume hood and biological safety cabinet (BSC) controls
    - flow and energy metering (mechanical and electrical)
    - emergency generators
    - lighting
    - fire alarm systems and
    - security systems

4. Provide schedules for fire alarm re-start, power failure re-start, emergency power re-start. Include necessary time delays between re-starts. This requires detailed co-operation between mechanical and electrical Designers.

5. Review all schedules for control valves, dampers, airflow measuring stations, etc. (normally developed by the Mechanical Designer) from an EMCS perspective to verify types, sizes, locations, etc.

6. Verify the accuracy of all information (relative to the EMCS design) contained in motor starter and equipment control schedules and electrical control schematics (normally developed by the Electrical Designer). Refer also to "Mechanical Equipment Motor Controls Schedules" and "Electrical Control Schematics".

7. Coordinate potential shared areas of responsibility such as motorized dampers and valves, air and water flow stations, control installation for VAV boxes and other terminal units, wells, orifice plates, filter pressure drop indicators, wiring interlocks, relays etc.

8. Coordinate range and type of signals for AI or AO interfaced equipment(4-20 mA, 0-10 VDC, 0-1000 ohms etc...)

Step 9: Prepare EMCS Specifications

2.9.1 EMCS Warranty Period

The warranty period shall be in accordance with the National Master Specifications (NMS).

2.9.2 Service Contracts

The need for service contracts must be verified with PWGSC Project Manager. Include all requirements indicated in the EMCS specifications. If required, PWGSC will provide the necessary documents to be included in the EMCS specification.

2.9.3 Use of PWGSC Master Specifications for EMCS

These specifications serve as a general - purpose guide for the specification writer. They must be edited to suit PWGSC project-specific requirements.

Step 10: Consider Maintenance, Testing and Commissioning Issues

2.10.1 Maintenance

1. All controls and components shall be designed and installed for easy maintenance.
2. There shall be at least 1000 mm clear space in front of all equipment requiring calibration.
3. All components shall be located to permit easy calibration and performance verification.
4. Controls, relays, etc., shall be installed in well -lighted, easily accessible and easily maintainable control cabinets, located well away from vibrating machinery2.10.2 Testing and Commissioning

1. For a description of start-up, checkout, performance, verification and commissioning requirements, refer to the NMS EMCS specifications (latest version).

Appendix A Standard Identifiers and Expansions

1 *General*

This section lists standardized AREA (project/building), SYSTEM and POINT identifiers. These shall be combined to form a unique POINT address for each POINT used throughout the PWGSC portfolio of EMCS installations. Refer to Tables A, B and C below for accepted standard identifiers and expansions.

Air Handling Unit #1, Supply Air Temperature point identifier = AH1 SAT.
Secondary water Circulating Pump #2 Status point identifier = SWCP2 S

Table A
AREA (BUILDING) Descriptors and Expansions

English Descriptor (10 characters max)	English Expansion	Expansion française	Descripteur français (10 characters max)
TUPPER	Sir Charles Tupper	Sir Charles Tupper	TUPPER
BRKCLAX	Brooke Claxton	Brooke Claxton	BRKCLAX
JEANMANCE	Jeanne mance	Jeanne Mance	JEANMANCE
JCARL	Sir John Carling	Sir John Carling	JCARL
GOCBLNDN	Govt of Canada Bldg, London, Ont.	Govt. of Canada Building, London Ont.	GOCBLNDN

Table B
SYSTEM Descriptors and Expansions

English Descriptor (10 characters max)	English Expansion	Expansion française	Descripteur français (10 characters max)
CHW	Chilled water system	Syst. d'eau refroidie	ER
CNDW	Condenser water system	Syst. d'eau du condenseur	ECOND
DTW	Dual temperature water system	Syst. d=eau double température	EDT
GLYCOL	Glycol system	Syst. d'eau glycolée	GLYCOL
HTHW	High temperature hot water system	Syst. d'eau chaude haute temp.	ECHT
		Syst. de chauffage à eau chaude	CEC
HWH	Hot water heating system	Syst. de chauffage radiant	CRAD
RADN	Radiation system	Syst. Eau chaude primaire	EPRIM
PRIWS	Primary water system	Syst. d'eau secondaire	ESEC
SECWTR	Secondary water system	Syst. solaire	SOLAIRE
SOLAR	Solar system		
SCRET	Steam condensate return	Syst. retour condensée vapeur	RCV
HPSTEAM	Steam - High pressure system	Syst. de vapeur haute pression	VHP
LPSTEAM	Steam - Low pressure system	Syst. de vapeur basse pression	VBP
DCW	Domestic cold water system	Syst. d'eau froide domestique	EFD
DHW	Domestic hot water system	Syst. d'eau chaude domestique	ECD
DHWC	DHW circulation system	Syst. de circulation - ECD	CECD
SAN	Sanitary sewage - pumped system	Syst. de pompage - eaux usées	PEU
		Syst. de pomp. - eaux pluviales	PEP
STORMW	Storm water - pumped system		
SPKD	Sprinkler - Dry pipe system	Syst. de gicleurs sous air	GSA
SPKW	Sprinkler - Wet pipe system	Syst. de gicleurs sous eau	GSE
FHC	Fire standpipe & hose system	Syst. cabinets incendie	CI
CH1	Chiller [#1]	Refroidisseur [#1]	REF1
BLR2	Boiler [#2]	Chaudière [#2]	CHAUD2
HUM	Humidification system **	Sys. d'humidification **	HUM
** Use only when local or central steam generators are used with distribution piping. Do not use when humidifiers are part of HVAC unit.		** Utiliser seulement lorsque des génératrices de vapeur locales ou centrales sont utilisées avec tuyaux de distribution. Ne pas utiliser si les humidificateurs font partie d'une unité CVC.	
FA	Fire alarm system	Syst. d'alarme incendie	SAI
SC	Smoke control system	Syst. de contrôle - fumée	SCF
LGT	Lighting control system	Syst. de contrôle - éclairage	SCE

Table C
POINT Descriptors and Expansions
Descripteurs et Expansions de POINTS

English Descriptors (10 characters max)	English Expansion (32 characters min)	Expansion française (32 caractères min)	Descripteurs français (10 caractères max)
A	Alarm	Alarme	A
CAP	Capacity	Capacité	CAP
F	Flow rate	Débit	D
H	Humidity	Humidité	H
P	Pressure	Pression	P
S	Status	État	E
T	Temperature	Température	T
SP	Static pressure	Pression statique	PS
D	Damper	Volet motrisé	VM
V	Valve	Soupape	S
DP	Differential pressure	Pression differentiel	PD
OA D	Outside air dampers {control}	Volets motorisé d'air ext. {contrôle}	VM AE
MINOA D	Outside air dampers (minimum) {control}	Volets motorisé d'air ext. min.{contrôle}	VM AEMIN
MAXOA D	Outside air dampers (maximum) {control}	Volets motorisé d'air ext. max.{contrôle}	VM AEMAX
OA T	Outside air temperature	Température - air extérieur	T AE
OA H	Outside air humidity	Humidité - air extérieur	H AE
OA F	Outside air flow rate	Débit - air extérieur	D AE
RA D	Return air damper {control}	Volet motorisé d'air de retour {contrôle}	VM AR
RA T	Return air temperature	Température - air de retour	T AR
RA H	Return air humidity	Humidité - air de retour	H AR
RA SP	Return air static pressure	Pression statique - air de retour	PS AR
RAF	Return air flow	Debit - air de retour	D AR
MA D **	Mixed air dampers **	Volets motorisé d=air de mélange **	VM AM **
MA T	Mixed air temperature	Température - air de mélange	T AM
MA SP	Mixed air static pressure	Press. stat. - air de mélange	PS AM
** Use "MAD" for applications where outside air and return air dampers are controlled from one (1) only output signal.		**N=utilisez "VM AM" que là où les volets d'air extérieur et de retour sont contrôlés par un (1) seul signal de sortie.	
EA D	Exhaust air damper {control}	Volets motorisé d=air vicié (évac).	VM AV
EA T	Exhaust air temperature	Température - air vicié (évac).	T AV
EA F	Exhaust air flow rate	Débit - air vicié (évac)	D AV

Table C
POINT Descriptors and Expansions
Descripteurs et Expansions de POINTS

English Descriptors (10 characters max)	English Expansion (32 characters min)	Expansion française (32 caractères min)	Descripteurs français (10 caractères max)
CC CC S CC V CC LAT CC EWT CC LWT	Cooling coil {control} Cooling coil status Cooling coil valve Cooling coil leaving air temperature Cooling coil entering water temperature Cooling coil leaving water temperature	Serpentin de refroidissement {contrôle}. État serpentin de refroisissement Soupape - serpentin de refroidissement Témpérarture d=air sortie serp. refroid Température. d'eau entrée serp. refroid. Temp. d'eau sortie, serpent. refroid.	SR E SR S SR TAS SR TEE SR TES SR
HUM HUM S HUM V HUMD H	Humidifier {control} Humidifier status Humidifier valve Humidifier discharge humidity	Humidificateur {contrôle}. État humidificateur Soupape humidificateur Humidité décharge humidificateur	HUM E HUM S HUM H DHUM
SP SP S SP F SP LWP	Spray pump {control} Spray pump: status Spray pump flow Spray pump leaving water pressure	Pompe à vaporisation {contrôle}. État - pompe à vaporisation Débit - pompe à vaporisation Press. d=eau sortie pompe à vaporisation	PV E PV D PV PES PV
SF[1] SF[1] S SF HS SF HSS SF LS SF LSS SF F SF CAP SF VSD SF VSD P	Supply fan [#1] {control} Supply fan [#1] status Supply fan high speed {control} Supply fan high speed status Supply fan low speed {control} Supply fan low speed status Supply fan flow Supply fan capacity Supply fan variable speed drive {control} Variable speed drive position	Ventilateur alimentation [#1] {contrôle} État - ventilateur alimentation [#1] Haute vitesse vent. alimentation contrôle} État haute vitesse vent. alimentation Basse vitesse vent alimentation. {contrôle} État basse vitesse. - vent. alimentation Débit du ventilateur d'alimentation Capacité du ventilateur d'alimentation Entaînement. vitesse variable vent alim. Pos. ent. vitesse variable vent.alimentation	VA[1] E VA[1] HV VA E HV VA BV VA E BV VA D VA CAP VA EVV VA PEVV VA

Table C POINT Descriptors and Expansions Descripteurs et Expansions de POINTS			
English Descriptors (10 characters max)	English Expansion (32 characters min)	Expansion française (32 caractères min)	Descripteurs français (10 caractères max)
SA F SA T SA H SA SP	Supply air flow Supply air temperature Supply air humidity Supply air static pressure	Débit - air d'alimentation Température - air d'alimentation Humidité - air d'alimentation Pression statique - air d'alimentation	D AA T AA H AA PS AA
RF[2] RF[2] S RF H RF HS S RF LS RF LS S RF V RF CAP RF VSD RF VSDP	Return fan [#2] {control} Return fan [#2] status Return fan high speed {control} Return fan high speed status Return fan low speed {control} Return fan low speed status Return fan volume Return fan capacity Ret. fan variable speed drive Ret. fan variable speed drive position	Ventilateur de retour [#2] {contrôle} État - ventilateur de retour [#2] Haute vitesse vent. de retour{contrôle} État haute vitesse vent. de retour. Basse vitesse vent. de retour.{contrôle} État basse vit- vent. de retour. Débit du ventilateur de retour Capacité du ventilateur de retour Entrainement vitesse variable vent retour Position ent. vitesse variable vent. retour	VR[2] E VR[2] HV VR E HV VR BV VR E BV VR D VR CAP VR EVV VR P EVV VR
EF[3] EF[3] S EF V	Exhaust fan [#3] {control} Exhaust fan [#3] status Exhaust fan Capacity	Ventilateur d'évacuation [#3] {contrôle} État - ventilateur d'évac. [#3] Capacitée - ventilateur d'évac.	VE[3] E VE[3] CAP VE
EA T EA_F	Exhaust air temperature Exhaust air flow rate	Température d=air vicié (évacuation) Débit d=air vicié (évacuation)	T AV D AV
CH F CH LWT CH LWP CH EWT CH EWP CDN EWT	Chiller flow Chiller Leaving water temperature Chiller Leaving water pressure Chiller Entering water temperature Chiller Entering water pressure Condenser Entering	Débit d= eau refroidisseur Temp. de sortie d=eau. du refroidisseur Pression de sortie d= eau du refroidisseur Temp. d=entrée d=eau au refroidisseur Pression entrée d=eau au refroidisseur Temp. d=entrée d=eau au	D R TSE R PSE R TEE R PEE R TEE CDN

Table C
POINT Descriptors and Expansions
Descripteurs et Expansions de POINTS

English Descriptors (10 characters max)	English Expansion (32 characters min)	Expansion française (32 caractères min)	Descripteurs français (10 caractères max)
	water temp.	condenseur	
CDN EWP	Condenser Entering water pressure	Pression d= entrée d=eau au condenseur	PEE CDN
CDN LWT	Condenser Leaving water temp.	Temp. de sortie d=eau du condenseur	TSE CDN
CDN LWP	Condenser Leaving water pressure	Sortie de sortie d=eau du condenseur	PSE CDN
CT1	Cooling tower [#1]	Tour de refroidissement [#1]	TR[1]
CT EWT	Cooling tower entering water temp.	Temp. d=entrée d=eau à la tour de refr.	TEE TR
CT EWP	Cooling tower entering water pressure	Pression d=entrée d=eau à la tour de refr**.**	PEE TR
CT LWT	Cooling tower leaving water temperature	Temp. de sortie d=eau de la tour refroid.	TSE TR
CT1 S	Cooling tower [#1] status	État - tour de refroidissement [#1]	E TR[1]
OA T	Outside Air temp	Température - air extérieur	T AE
OA H	Outside Air relative humidity	Humidité relative - air extérieur	H AE
CHWP4	Chilled water pump [#4] {control}	Pompe eau refroidie [#4] {contrôle}	PER4
CHWP F	Chilled water pump flow rate	Débit - pompe eau refroidie	D PER
CHWP LWP	Chilled water pump leaving water press.	Press. de sortie eau - pompe eau refroidie	PSE PER
CHWP S	Chilled water pump status	État - pompe eau refroidie	E PER
CP3	Circulating pump [#3] {control}	Pompe de circulation [#3] **{contrôle}**-	PC3
CP F	Circulating pump [3] flow rate	Débit - pompe de circulation	D PC3
CP LWP	Circulating pump[3] leaving water pressure	Press. de sortie eau pompe circulation [#3]	PSE PC3
CP3 S	Circulating pump [#3] status	État - pompe de circulation [#3]	E PC3
CDNP2	Condenser water pump [#2] {control}	Pompe d=eau [#2] condenseur.{contrôle}	PC2
CDN F	Condenser water pump Flow rate	Débit- pompe du condenseur	D PC
CDN LWP	Condenser pump leaving water pressure	Press. sortie d=eau pompe du condenseur	PSE PC
CDNP S	Condenser water	État - pompe du condenseur	E PCDN

Table C
POINT Descriptors and Expansions
Descripteurs et Expansions de POINTS

English Descriptors (10 characters max)	English Expansion (32 characters min)	Expansion française (32 caractères min)	Descripteurs français (10 caractères max)
	pump Status		
HTA LTA HTC LTC HLA LLA HLC LLC	High temperature alarm Low temperature alarm High temperature cut-out Low temperature cut-out High level alarm Low level alarm High level cut-out Low level cut-out	Alarme - haute température Alarme - basse température Interrupteur - haute température Interrupteur- basse température Alarme - haut niveau Interrupteur - bas niveau Interrupteur - niveau élevé Interrupteur - bas niveau	AHT ABT IHT IBT AHN IBN IHN IBN
HW F HWS T HWR T	Heating water flow rate Heating water supply temperature Heating water return temperature	Débit - eau de chauffage Temp. d=alimentation - eau de chauffage Temp. - retour d'eau de chauffage	D EC T AEC T REC
STP STF	Steam pressure Steam flow rate	Pression de vapeur Débit de vapeur	PV DV
Rxxx T Rxxx H Rxxx SP	Room xxx temperature Room xxx humidity Room xxx dif. static press. (incl ref. Pt)	Température de la pièce xxx Humidité de la pièce xxx Press. stat. - pièce (+ point de réf.)	T Pxxx H Pxxx PS_Pxxx
xxx identifies room number		xxx identifie le numéro de la pièce	
GA SA TRA Z5A	General alarm Smoke alarm Trouble alarm Zone [#5] Alarm	Alarme générale Alarme de fumée Alarme de trouble Alarme de zone [#5]	AG AF ATR AZ5
NOTE: 1. The word "{control}" is only shown in the expansion to indicate the purpose of the point. It shall NOT be used in the EMCS point expansion list.		NOTE: 1. Le mot {contrôle} n=est utiliséque pour illustrerla nature, ou le but du point. Il ne doit PAS faire partie des expansions de points du SGE	

Appendix B Control Description Logic (CDL)

B 1: Description of CDL's

1. Each logic statement shall be written in proper sequential order of events.

2. In the IF-THEN-ELSE logic, each system is broken down into Analog Output (AO) and Digital Output (DO) "loops".

B 2: Description of CDL's

The "IF-THEN-ELSE" logic format for each loop shall be as follows:

1. IF (logic statement is true

2. AND/OR (2nd logic statement) is true

3. THEN (procedure "A")

4. ELSE (procedure "B")

B 3: Description of CDL's

If X < Y	If X > Y	If X ≤ Y
If X ≥ Y	If X = Y	If X is not = toY
If X is ON	If X is OFF	If X is equivalent to Y
If X is on HIGH SPEED	If X is on LOW SPEED	If X is OPEN
If X is CLOSED	If X is IN MINOP	IF X is IN MAXOP
If X is IN CR ALARM	If X is IN MA ALARM	
If X is EQUIV TO Y	etc.	

where X and Y refer to a point, I/O, variable or value.

B 4 Defining Terms in CDL Logic Statements

When writing the operating logic for each loop, the following terms shall be defined:

Measured value (MV)	This may be SAT, SAP, etc.
Set-point (SP)	This may be °C, kPa, SP, another AO ±☐ (value), cascade control, etc
Auto set point curve (ASP)	
Output:	This is usually %, but could also be output of another AO, unison control, designated combination of P, I and D, etc. (0% = no flow,100% = full flow, independent of normally open (NO) or normally closed (NC).
Auto-ramp:	This feature is used to designate a time period used to reach set point (gradually opening or closing of controlled device until set point is attained). Ramping is generally used to stabilize system or to prevent cycling during the system start up process.
Minimum Output (MINOP)	Expressed as %.
Maximum Output (MAXOP)	Expressed as %.
Direct acting (DA)	Increase in measured variable or value causes increase in output signal. This defines the action of the loop as a whole.
Reverse acting (RA)	Increase in measured variable or value causes decrease in output signal. This defines the action of the loop as a whole.
Priorities:	These shall be established as required and so indicated (eg. fire alarm or freeze shut-down shall not be over-ridden by operator command).

B 5: Analog Output (AO) and Digital Output (DO) Loops

When writing IF-THEN-ELSE logic statements for AO and DO loops, it is recommended that each loop be divided up into three (3) sections as follows:

1. Safety conditions.

2. Operating logic.

3. Position to be assumed on controller failure.

The examples on the following pages illustrate this requirement.

B 6: Sample Control Description Logic (CDL)

DO RF RETURN FAN CONTROL

If LTA = Alarm
or
If MAT ≤ L2 or HC LAT ≤ L2 for > 30 second period
THEN ON
If MAT > L2 and HC LAT > L2
THEN

1. Auto schedule optimal start/stop schedule.

2. Power failure Automatic re-start schedule on return to normal including Large motor delays.

3. Fire Alarm shut-down Manual re-start schedule on FA reset including Large motor delays.

AO RF/VSD RETURN FAN VARIABLE SPEED DRIVE CONTROL

If RF S = OFF then output = 0%
If LTA = Alarm
or
If MAT ≤ L2 or HC LAT ≤ L2 for > 30 second consecutive period
THEN output = 50%
ELSE output = PID calculation
Measured variable = RF F
Set point = ASP curve RA = [95% of (AI/SF SF F minus MINOA F less algorithm defined at TAB time: use 0 L/s as initial value)]
Ramp to set point over 3 minute period on start-up
Fail mode = RF stopped - output = 0%

DO SF SUPPLY FAN CONTROL

If DI/RF S = OFF then OFF
If DI/RF S = ON
and
LTA = NORMAL
and
MAT L2 and HC LAT L2 are not = to Alarm for > 30 consecutive seconds
then output = ON after prescribed start delay (0 second initially)
Else OFF ie. safety shut-down
Fail mode = SF stopped Output = OFF

AO SF/VSD SUPPLY FAN VARIABLE SPEED DRIVE CONTROL

If SF S = OFF then output = 0%
If SF S = ON
and
If SFD SP => 275 Pa
then MV = SFD SP
and set point = 270 Pa RA
else
MV = TSP
Set point = 200 Pa RA
Ramp to set point over 3 minute period on start-up
Fail mode: VSD closed Output = 0%

DO MINOAF MINIMUM OUTDOOR AIR FAN

If DI/SF S = OFF then OFF
If DI/SF S = ON
and
LTA = NORMAL
and
MAT L2 and HC LAT L2 are not = to Alarm for > 30 consecutive seconds
then output = ON after prescribed supply fan VSD ramp time is completed (3 minutes initially)
Else OFF ie. safety shut-down
Fail mode = SF stopped output = OFF

AO/MINOAF VSD MINIMUM OUTDOOR AIR FAN VSD

If MINOAF S = OFF then output = 0%
Else
Ramp to set point
Measured value MINOAF F
Set point = adjustable manually from OWS (initially to 500 L/s)
Ramp to set point over 3 minute period on start-up
Fail mode: output = 0%

AO/MINOAD MINIMUM OUTDOOR AIR DAMPER

If MINOAF S = OFF then output = 0% ie. damper closed
else
output = adjustable manually from OWS (initial 100%)

AO MAD MIXED AIR DAMPERS (ie. return, outside air and exhaust air)

If DO/SF S = OFF then output = 0% (ie. outside air dampers closed).
If DO/SF S = ON
and
If OAT >20°C then output = 0% (ie. minimum outside air provided by minimum outdoor air fan only).
ELSE output = PID calculation
Measured variable =AI/SAT
Set point = ASP curve RA = SF VSD ≥ 55% ☐ SAT 13 ☐C and
SF VSD ≤ 45% ☐ SAT 15 ☐C
Ramp to set point on start-up
Fail mode = OAD and EAD closed - output = 0%

AO HCV HEATING COIL CONTROL VALVE

If DI/SF S = OFF
and
OAT < 5°C then output = PID calculation
then
measured variable = HC LAT
Set point = 20°C
else
OAT ≥ 5°C then output = 100% (valve closed to coil)
Fail mode = output = 0% (full heating)
else
If DI/SF S = ON
and

OAT ≥ 10°C then output = 100% (valve closed to coil)
else
output = PID calculation
Measured variable = AI/SAT
Set-point = MAD set-point
Fail mode = valve open Output = 0%

NOTES:

1. The output value must reflect work being done, not necessarily the default value.

2. The terms "normally open" and "normally closed" must be used carefully, with due consideration of the type of device (eg. control valve, damper).

AO CCV COOLING COIL CONTROL VALVE

If OAT < 11°C then output = 0% (ie. valve closed)
If DI/SF S = OFF then output = 0%
ELSE Output = PID calculation
Measured variable = SAT
Set-point = set-point AO/MAD plus 0.5°C
Fail mode = valve closed Output = 0%

B 7: Sample Alarm and Maintenance Messages

1. Alarm messages:

The following are examples of alarm messages that could relate to a typical HVAC system:

#1 SUPPLY FAN OFF; RETURN FAN ON - MANUAL RESET ON FREEZE STAT; AFTER 1600 H CALL JOE DOE AT 123-4567
#2 SUPPLY FAN OFF - DUE TO EXCESSIVE PRESSURE
#3 SUPPLY FAN; CALL MAINTENANCE; EXT 789

2. Maintenance Messages:

The following are examples of alarm messages that could relate to a typical HVAC system:

#21 SUPPLY FAN - RUN TIME EXCEEDS LIMIT
#22 CHECK OUTSIDE AIR DAMPER FOR TIGHT SHUT-OFF OR BINDING MOVEMENT
#23 CHECK INLET VANE OPERATION - NOT CLOSING