PART 1 - GENERAL

1.1 REFERENCES

.1 Section 25 05 01 - EMCS: General Requirements.

1.2 DEFINITIONS

.1 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.2 Downtime: results whenever EMCS is unable to fulfill all required functions due to malfunction of equipment defined under the responsibility of EMCS contractor. Downtime is measured by duration, in time, between the time that the Contractor is notified of failure and the time system is restored to proper operating condition. Downtime not to include following:

- .1 Outage of main power supply in excess of back-up power sources, provided that:
  - .1 Automatic initiation of back-up was accomplished.
  - .2 Automatic shut-down and re-start of components was as specified.
- .2 Failure of communications link, provided that:
  - .1 Controller automatically and correctly operated in stand-alone mode.
  - .2 Failure was not due to failure of any specified EMCS equipment.
- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  - .1 System recorded said fault.
  - .2 Equipment defaulted to fail-safe mode.
  - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.3 ACRONYMS

.1 Acronyms: refer to Section 25 05 01.

1.4 SYSTEM DESCRIPTION

.1 Work includes:

- .1 Start-up testing and verification of all systems.
- .2 Check out demonstration of proper operation of all components.
- .3 On-site operational tests.

.2 Perform work under direction of, and in presence of, Departmental Representative.

.3 Provide test equipment, two-way radios.

.4 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no later than 2 months prior to tests.

.5 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to each test. Indicate:

- .1 Location and part of system to be tested.
- .2 Testing procedures, anticipated results.
- .3 Names of testing personnel.

.6 Co-ordinate with other trades.

.7 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.

.8 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.9 Load system with project software.

.10 Perform tests as required.

1.5 QUALITY ASSURANCE

.1 Pre-Installation Testing

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controllers including ECU's, MCU's, LCU's, TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.

.7 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.

.8 Departmental Representative to mark instruments tracking within 5% in both directions as "approved for installation".

.9 Transmitters above 5% error will be rejected.

.10 DP switches to open and close within 10% of setpoint.

.2 Completion Testing

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software. Provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.3 Control System Breakdown Confirmation Testing

.1 Perform tests to verify all items on Control System Breakdown Confirmation Sheet Section 25 01 11.01.

.2 Record results on Control System Breakdown Confirmation Sheet.

.3 Provide assistance with consultant’s verification of tests.

.4 Final Startup Testing

.1 Upon satisfactory completion of tests, perform point-by-point test of entire system and control system sequence verification under direction of Departmental Representative. Contractor to allow for minimum of 4 days (32 hours) on site technician for the final startup testing.

.2 Provide:

.1 Technical personnel capable of re-calibrating field hardware and modifying software. All necessary programming and graphics changes to be done on-site during the testing period.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Key document for recording procedures to be listing of system database, including keyname, English description, point type and address, engineering units, low and high limits. Include space on listing for remarks and signatures of commissioning technician and Departmental Representative.

.4 Departmental Representative's acceptance signature to be on executive and applications programs.

.5 Final Operational Testing

.1 Purpose: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to the commencement of 30 day test Contractor must demonstrate that operating parameters (setpoints, alarm limits and CDL's) have been implemented so as to ensure proper operation and operator notification in event of off-normal operation. Repetitive alarm conditions to be resolved so as to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in item 1.2.2. must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

End of Section

Control System Confirmation Breakdown Sheet

Section 25 01 11.01

DCS Event Matrix

Revision 2 (14-Sep-2012) *Changes in RED*

Event Code	Event Name	Event Class	Trigger	End Condition	AA-CR, 1A-22 Soft Tone Audible Alarm on Stack Light (Controls room and Obs. Building)	AA-E, 1A-28 Loud Tone Audible Alarm Inflation Building Exterior	RWL-CR, 1A23 RWL-OB, 2A-01 RWL-E, 1A-29 Red Warning Light Controls Room, Operations Building, and Inflation Building Exterior	YWL-CR, 1A-25 YWL-OB, 2A-02 YWL-E, 1A-30 Yellow Warning Light Controls Room, Operations Building, and Inflation Building Exterior	GWL-CR, 1A-25 GWL-OB, 2A-03 GWL-E, 1A-31 Green Warning Light Controls Room, Operations Building, and Inflation Building Exterior	WWL-CR, 1A26 WWL-OB, 2A-04 WWL-E, 1A-32 White Warning Light Controls Room, Operations Building, and Inflation Building Exterior	BWL-CR, 1A27 BWL-OB, 2A-05 BWL-E, 1A-33 Blue Warning Light Controls Room, Operations Building, and Inflation Building Exterior	TS-CR, 1A-?? TS-OB, 2A-?? Communication Screen Controls Room and Operations Building	Operator Work Station Control System Communication	H_2 VALVE 1 1A-43 Master Shutoff Valve (S-1)	H_2 VALVE 2 1A-44 Dispensing Valve (S-2)	HOGEN-ESD 1A-?? HOGEN ESD	EF1 ON/OFF 1A-04 Lead Exhaust Fan	EF2 ON/OFF 1A-07 Lag Exhaust Fan	HEATER ON A1-11 Heater Control	WALL VENT TEMP 1A-36 Heated Wall Vent Power Relay	EMERGENCY DISCHARGE 1A-46 Emergency Discharge Valve on Hydrogen Tank	EVENT NOTES:	Controls Contractor Confirmation - Prior to Environment Canada arrival (Sign & Date - include any notes)	Indicate which signals were simulated (if needed i.e. HOGEN responses or status)	Consultant or Designer Confirmation - Prior to Environment Canada arrival (Sign & Date - include any notes)
AOK	**All OK**	Status	Default event if no 'Error' class events occurring. Over ridden by HOG-PROD	No End, Default Event		OFF	OFF	OFF	**ON** Continuous	OFF	OFF	Display All OK	Show All OK Status	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Default event			
CGD-A-IR	**Gas Level A in Inflation Room**	Error	Control system reads ≥ SET-CGD-IR-A on input 1A-41 (H2 Level Inflation Room)	If control system reads < SET-CGD-IR-A on input 1A-41. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 2.0s ON, 1.0s OFF	OFF	**ON** Intermittent 2.0s ON, 1.0s OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-IR-A' value in place of 'A'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	First level gas alarm event. Functions as a warning. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Does not effect HOGEN Room systems.			
CGD-B-IR	**Gas Level B in Inflation Room**	Error	Control system reads ≥ SET-CGD-IR-B on input 1A-41. Latching items reset by RST-ALRM event.	If control system reads < SET-CGD-IR-B on input 1A-41. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 0.5s ON, 0.5s OFF	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-IR-B' value in place of 'B'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Second level gas alarm event. Functions as a evacuation warning. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Does not effect HOGEN Room systems. Overrides CGD-A-IR.			
CGD-C-IR	**Gas Level C in Inflation Room**	Error	Control system reads ≥ SET-CGD-IR-C on input 1A-41 (H2 Level Inflation Room)	If control system reads < SET-CGD-IR-C on input 1A-41. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Continuous	**ON** Intermittent 0.3s ON, 0.3s OFF	OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-IR-C' value in place of 'B'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	**NORMAL** Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Third level gas alarm event. Functions as a warning that the gas level has escalated. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Does not effect HOGEN Room systems. Overrides CGD-A-IR and CGD-B-IR.			
CGD-FLT-IR	**Gas Detector Fault Inflation Room**	Error	Fault signal received by control system on 1A-13 1A-41 (H2 Level Inflation Room)	If control system no longer receives fault signal on 1A-41. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	OFF	**ON** Intermittent 1.0s ON, 1.0s OFF	Display Event Name	Record Event Name	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Gas detector fault warning. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Does not effect HOGEN Room systems			
CGD-A-HR	**Gas Level A in HOGEN Room**	Error	Control system reads ≥ SET-CGD-HR-A on input 1A-13 (H2 Level Hydrogen Room)	If control system reads < SET-CGD-HR-A on input 1A-13. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 2.0s ON, 1.0s OFF	OFF	**ON** Intermittent 2.0s ON, 1.0s OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-GR-A' value in place of 'A'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	**MAX** Maximum Fan Speed	**MAX** Maximum Fan Speed	NORMAL Temperature controlled by set point (SET-GR-TEMP)	**OPEN** Heated Wall Vent Power Cut Off	CLOSED	First level gas alarm event. Functions as a warning. Disable HOGEN (only possible source of gas), run HVAC on high to clear room. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs.			
CGD-B-HR	**Gas Level B in HOGEN Room**	Error	Control system reads ≥ SET-CGD-HR-B on input 1A-13 (H2 Level Hydrogen Room)	If control system reads < SET-CGD-GR-B on input 1A-13. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 0.5s ON, 0.5s OFF	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-GR-B' value in place of 'B'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	**MAX** Maximum Fan Speed	**MAX** Maximum Fan Speed	NORMAL Temperature controlled by set point (SET-GR-TEMP)	**OPEN** Heated Wall Vent Power Cut Off	CLOSED	Second level gas alarm event. Functions as a evacuation warning. HOGEN already disabled, HVAC on high to clear room. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Overrides CGD-A-GR.			
CGD-C-HR	**Gas Level C in HOGEN Room**	Error	Control system reads ≥ SET-CGD-HR-C on input 1A-13 (H2 Level Hydrogen Room)	If control system reads < SET-CGD-GR-B on input 1A-13. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Continuous	**ON** Intermittent 0.3s ON, 0.3s OFF	OFF	OFF	OFF	OFF	Display Event Name including actual gas reading	Record Event Name with 'SET-CGD-GR-C' value in place of 'B'	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	**MAX** Maximum Fan Speed	**MAX** Maximum Fan Speed	NORMAL Temperature controlled by set point (SET-GR-TEMP)	**OPEN** Heated Wall Vent Power Cut Off	CLOSED	Third level gas alarm event. Functions as a warning that the gas level has escalated. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Overrides CGD-A-GR and CGD-B-GR.			
CGD-FLT-HR	**Gas Detector Fault HOGEN Room**	Error	Fault signal received by control system on 1A-13 (H2 Level Hydrogen Room)	If control system no longer receives fault signal on1A-13. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	**ON** Intermittent 0.5s ON, 0.5s OFF	OFF	OFF	**ON** Intermittent 1.0s ON, 1.0s OFF	Display Event Name	Record Event Name	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Low Fan Speed if 1A-16 (HOGEN Enable) is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	**OPEN** Heated Wall Vent Power Cut Off	CLOSED	Gas detector fault warning. Due to compromised detection capability, non-EXP rated equipment must be disabled. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs.			
OFD-IR	**Fire Detected in Inflation Room**	Error	1A-40 (Inflation Room Fire) signal received by control system	If control system no longer receives 1A-40. Latching items reset by RST-ALRM event. A1A-22, 2A-067, and 1A-28 (AA-CR, AA-OB, and AA-E) to remain on for 1.0 min after 1A-40 signal ends.	**ON** Intermittent	**ON** Intermittent 0.3s ON, 0.3s OFF	**ON** Continuous	OFF	OFF	OFF	OFF	Display Event Name	Record Event Name	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Fire alarm event. Functions as an evacuation warning. Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. Does not effect HOGEN Room systems.			
OFD-HR	**Fire Detected in HOGEN Room**	Error	1A-12 (HOGEN Room Fire) signal received by control system	If control system no longer receives 1A-13 signal. Latching items reset by RST-ALRM event. A1A-22, 2A-067, and 1A-28 (AA-CR, AA-OB, and AA-E) to remain on for 1.0 min after 1A-13 signal ends.	**ON** Intermittent	**ON** Intermittent 0.3s ON, 0.3s OFF	**ON** Continuous	OFF	OFF	OFF	OFF	Display Event Name	Record Event Name	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	**OPEN** HOGEN Disabled LATCHED	**OFF** Disabled LATCHED	**OFF** Disabled LATCHED	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Fire alarm event. Functions as an evacuation warning. HOGEN and HVAC disabled to reduce air circulation and oxygen supply (HOGEN produces oxygen). Audible alarms switched off by RST-ALRM event. Latched outputs clear only if event is no longer occurring and RST-ALRM occurs. **INTAKE AND EXHAUST DAMPERS MUST MOVE TO FULL CLOSED**			
HR-TEMP-ALRM	**HOGEN Room Temperature < Temp Alarm Setting**	Error	Control system reads ≤ SET-GRTEMP-ALRM-A on input AI-GR-TEMP	If control system reads > SET-GRTEMP-ALRM-A on input AI-GR-TEMP. Latching items reset by RST-ALRM event.	OFF	OFF	OFF	OFF	OFF	OFF	**ON** Intermittent 1.0s ON, 1.0s OFF	Display Event Name including actual temperature reading	Record Event Name	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	**OFF** Disabled LATCHED	**OFF** Disabled LATCHED	**HIGH** Heaters at 100% output	CLOSED Heated Wall Vent receiving power	CLOSED	HOGEN Room Temperature Alarm. Risk to HOGEN damage if freezing occurs. Heaters to switch to 100% output. HOGEN to remain enabled, operator can purge tank below 200psi to turn on HOGEN and use as heat source (4200W during production). Audible alarms switched off by RST-ALRM event.			
DSP-ACT	**Hydrogen Dispensing Circuit - Activated**	Status	Dispensing function is activated by touch screen and no error events which close 1A-43 (H2 Valve 1) are occurring.	Dispensing is disabled by touch sreen, or an error event which closes 1A-43 (H2 Valve 1) occurs.	OFF	OFF	OFF	OFF	**ON** Continuous	**ON** Intermittent 1.0s ON, 1.0s OFF	OFF	Display Event Name	N/A	OPEN	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Status event, occurs with default AOK event. Event ended if an error event involving the disabling of AO-DSP-MSV occurs. Dispense button (AI-DSP-GO) becomes illuminated. Activated through touch screen, causes dispensing button to illuminate.			
DSP-DSP	**Hydrogen Dispensing Circuit - Dispensing**	Status	Dispensince has been activated by touch screen and control system reads signal on input 1A-38 (Dispensing Button)	State of 1A-38 changes, or an error event which closes1A-43 (H2 Valve 1) occurs.	OFF	OFF	OFF	OFF	**ON** Continuous	**ON** Continuous	OFF	Display Event Name	Record Event Name	OPEN	OPEN	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Status event, occurs with default AOK event. Event ended if an error event involving the disabling of AO-DSP-DSP occurs. Activated with dispensing button.			
DSP-LEAK	**Hydrogen Dispensing Circuit - Leak Detected**	Error	Control system reads flow signal on input 1A-45 (H2 Flow) and outputs 1A-43 (H2 Valve 1) and 1A-44 (H2 Valve 2) indicate closed.	State of 1A-45 indicates flow no longer present. Latching items reset by RST-ALRM event.	**ON** Intermittent	**ON** Intermittent 2.0s ON, 1.0s OFF	**ON** Continuous	OFF	OFF	**ON** Continuous	OFF	Display Event Name	Record Event Name	**CLOSED** Disabled LATCHED	**CLOSED** Disabled LATCHED	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Flow switch checks for flow when 1A-43 and 44 should be closed. A flow signal indicates valve is leaking. No impact to HOGEN room. Operator will be required to manually close tank outlet valve and investigate failure. Audible alarms switched off by RST-ALRM event.			
HOG-PROD	**HOGEN Generator Producing Hydrogen**	Status	Control system reads ON signal on input 1A-16 (HOGEN Enable)	State of 1A-16 changes to OFF.	OFF	OFF	OFF	OFF	**ON** Intermittent 1.0s ON, 1.0s OFF	OFF	OFF	Display Event Name	N/A	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	**HIGH** 100CFM overall exhaust flow rate	**HIGH** 100CFM overall exhaust flow rate	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Status event used to trigger 100CFM air exchange rate for HVAC. Air exchange required to safely operate HOGEN during production mode. Flashing green light overrides continuous green for default AOK event.			
HVAC-FLO-ALRM	**HVAC Flow Restriction Detected**	Error	Control system reads CLSOED signal on input 1A-01 (Fresh Air Flow) when event HOG-PROD is occurring	State of 1A-01 changes to OPEN, or event HOG-PROD is no longer occurring. Latching items reset by RST-ALRM event.	OFF	OFF	OFF	OFF	OFF	**ON** Continuous	**ON** Continuous	Display Event Name	Record Event Name	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	**OPEN** HOGEN Disabled LATCHED	**MAX** Maximum Fan Speed	**MAX** Maximum Fan Speed	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Flow switch checks for HVAC air exchange rate during hydrogen production (while HOG-PROD event is occurring). Upon reset, the HVAC shall run according to the HOG-PROD event, even if there is no 1A-16 (HOGEN Enable) signal for a minimum of 2 minutes to confirm flow restriction is cleared. Audible alarms switched off by RST-ALRM event.			
HOG-FLT	**Hogen Generator Fault**	Error	Control system reads CLOSED signal on input 1A-15 (HOGEN Stat)	State of 1A-15 (HOGEN Stat) changes to OPEN. Latching items reset by RST-ALRM event.	OFF	OFF	OFF	**ON** Continuous	OFF	**ON** Continuous	OFF	Display Event Name, prompt for error code input by user.	Record Event Name and error code input by user.	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	The HOGEN has internal fault detection capability. Faults are used to open a relay in the back of the HGOEN (P145 connector) which is connected to the control system. The fault shall be indicated by the control system as shown. An input in the touch screen shall be prompted to record the error code (3 digits, alphanumeric: A-99) since the HOGEN does not have a error memory. Audible alarms switched off by RST-ALRM event.			
HWV-ALRM	**Heated Wall Vent Low Temperature**	Error	Control system reads ≤ SET-HWV-TEMP on input 1A-35 (Wall Vent Temp)	If control system reads > SET-HWV-TEM on input 1A-35 (Wall Vent Temp). Latching items reset by RST-ALRM event.	OFF	OFF	OFF	**ON** Continuous	OFF	OFF	**ON** Continuous	Display Event Name including actual temperature reading	Record Event Name	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	The heated wall vent (connected to the HOGEN) will be monitored. It is not required to disable the HOGEN as it will detect an over pressure and turn itself off. The actual temperature should be displayed on the touch screen during the error event. Audible alarms switched off by RST-ALRM event.			
EDD-ACT	**Emergency Discharge Device Activated**	Error	Control system reads OPEN signal on input 1A-37 (Emergency Discharge - Observations Building)	State of 1A-37 changes to CLOSED, or event ESD-ACT occurs.	**ON** Intermittent 0.5s ON, 0.5s OFF	**ON** Intermittent 0.5s ON, 0.5s OFF	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	Display Event Name	Record Event Name	**CLOSED** Disabled	**CLOSED** Disabled	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	**OPEN** Hydrogen Venting to Outdoors	Used only in the event of fire, but qualified fire personelle to reduce risk by emptying hydrogen storage tank to a safe area.			
ESD-ACT	**Emergency Shut Down Button Activated**	Error	Control system reads OPEN signal on input 1A-?? (Emergency Shut Down Button)	State of input 1A-?? changes to CLOSED. Latching items reset by RST-ALRM event.	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	**ON** Continuous	Display Event Name, prompt for error text string input by user.	Record Event Name and error string input by user.	**CLOSED** Disabled	**CLOSED** Disabled	**OPEN** HOGEN Disabled LATCHED	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	The ESD buttons (located in the generation room and operations building) shall disable dispensing and production. It is required for the user to input a text string to describe the reason for ESD activation. Audible alarms switched off by RST-ALRM event.			
RST-ALRM	**Alarm Reset Button Activated**	N/A	Alarm is reset by touch screen	Not applicable, momentary event.	OFF	OFF	OFF	OFF	OFF	OFF	OFF	N/A	Record Event Name	NORMAL Waiting for event DSP-ACT	NORMAL Waiting for event DSP-DSP	CLOSED HOGEN Powered	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Low Fan Speed if AI-H2-ENBL is OFF	NORMAL Temperature controlled by set point (SET-GR-TEMP)	CLOSED Heated Wall Vent receiving power	CLOSED	Used to reset alarms. If depressed during an alarm event the audible alarm is turned off, however the lights remain illuminated until the error event is no longer occurring. Latched outputs clear only if the error event is no longer occurring and the RST-ALRM event occurs.			
OUTPUT NOTES:					Soft tone alarm use as a initial warning in the Controls and Obs. Room.	Loud tone alarm on the Inflation Building exterior driven by the same signal.	Red indicator light in Controls Room, Operations Building, and Inflation Building exterior driven by the same signal.	Yellow indicator light in Controls Room, Operations Building, and Inflation Building exterior driven by the same signal.	Green indicator light in Controls Room, Operations Building, and Inflation Building exterior driven by the same signal.	White indicator light in Controls Room, Operations Building, and Inflation Building exterior driven by the same signal.	Blue indicator light in Controls Room, Operations Building, and Inflation Building exterior driven by the same signal.	Communication Screen in Generation Room and Operations Building driven by the same signal. Capable of input on either screen.	Control system to record event information as described. Storage location should be in Operations Building. Stored data to logged with date and time stamp and be accessible over internet.	Master shutoff valve located in Inflation room, inside Dispensing Valve Assembly.	Dispensing valve located in Inflation room, inside Dispensing Valve Assembly.	HOGEN remote ESD input is located in the P145 connector at the back of the HOGEN.	HVAC Primary Fan. Flow rate controlled by dampers. Operates as needed for temperature control.	HVAC Secondary Fan. Flow rate controlled by dampers. Operates as needed for temperature control.	Heater control to use HOGEN Room temperature sensor 1A-14 (HOGEN Room Temp) as feedback to achieve and maintain set point (SET-HR-TEMP)	Heated Wall Vent powered by 120V, power delivery controlled by relay or contactor.	Emergency Discharge Valve located in Inflation Room attached to the Hydrogen Storage Tank (Part of Tank Assembly supplied by customer).	***Alarm De-escalation*** : In the case of the gas and temperature alarms, multiple levels exist. In the event that a secondary or tertiary level is achieved, as the trigger returns to normal (gas level or temperature) it is expected that the lower events once no longer over ridden by a higher level event, will be indicated. For example a a CGD-C-GR event occurred and the gas level has now dropped below SET-CGD-C-GR, but is still higher than SET-CGD-B-GR, then the event shall switch to CGD-B-GR. A de-activated audible alarm will not reoccur on de-escalation but must occur on event escalation.			

PART 1 - GENERAL

1.1 TRAINING PROPOSAL

.1 Provide training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of commencement of training.

.1 List name of trainer, visual and audio aids to be used.

.2 Show coordinated interface with other EMCS mechanical and electrical training programs.

1.2 INSTRUCTORS

.1 To be competent, thoroughly familiar with all aspects of EMCS installed in this facility.

.2 Departmental Representative reserves right to approve instructors, based on qualifications.

1.3 INSTRUCTION

.1 Provide instruction to designated personnel in adjustment, operation, maintenance, pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.4 TIME FOR INSTRUCTION

.1 Number of person-days of instruction to be as specified in this section (1 person-day = 8 h including two 15 min breaks and excluding lunch time).

1.5 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Provide manual for each trainee, describing in detail data included in each training program.

1.6 TRAINING PROGRAM

.1 To be in 1 phase:

.1 Phase 1: for 2 days before 30 day test period at time mutually agreeable to Contractor, Departmental Representative. Train O&M personnel in functional operations and procedures to be employed for system operation. Supplement with continuous on-the-job training during 30 day test period. To include overview of system architecture, communications, operation of computer and peripherals, report generation; detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

1.7 MONITORING OF TRAINING

.1 Departmental Representative will monitor training program and retains right to modify schedule and content.

End of Section

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 250111 - EMCS: Start-up and Checkout.
.2 Section 250112 - EMCS: Training.
.3 Section 250502 - EMCS: Shop Drawings, Product Data and Review Process.
.4 Section 250503 - EMCS: Project Record Documents.
.5 Section 250554 - EMCS: Identification.
.6 Section 250560 - EMCS: Field Installation.
.7 Section 251001 - EMCS: Local Area Network (LAN).
.8 Section 251002 - EMCS: Operator Work Station (OWS).
.9 Section 253001 - EMCS: Building Controllers Family of Controllers.
.10 Section 253002 - EMCS: Field Control Devices.
.11 Section 253003 - EMCS: Master Control Unit (MCU).
.12 Section 259001 - EMCS: Sequence of Operation.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)
  .1 ANSI/ISA S5.5-1985, Graphic Symbols for Process Displays.
  .2 ANSI/IEEE 260.1-1993, Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch-Pound Units and Certain Other Units).
  .3 ANSI/ASHRAE 135, A Data Communication Protocol for building automation and control networks, latest edition.
.2 Canadian Standards Association (CSA)
  .1 CAN/CSA-C22.2 No.0-M91(R1997), General Requirements, Canadian Electrical Code, Part II.
  .2 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.
.3 Electrical and Electronic Manufacturers Association (EEMAC)
  .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

.1 Acronyms used in EMCS.
  .1 AI - Analog Input
  .2 AO - Analog Output
  .3 BACnet - Building Automation and Control Network (ANSI/ASHRAE Standard 135, latest edition).
  .4 CAD - Computer Aided Design
  .5 CDL - Control Description Logic
  .6 COSV - Change of State or Value
  .7 CPU - Central Processing Unit
  .8 DI - Digital Input
  .9 DO - Digital Output
  .10 ECU - Equipment Control Unit
  .11 EMCS - Energy Monitoring and Control System
  .12 HVAC - Heating, Ventilation, Air Conditioning
  .13 IDE - Interface Device Equipment
  .14 I/O - Input/Output
  .15 ISA - Industry Standard Architecture
  .16 LAN - Local Area Network
  .17 LCU - Local Control Unit

.18 LonTalk - Echelon Corporation (proprietary protocol)
.19 MCU - Master Control Unit
.20 OS - Operating System
.21 O&M - Operation and Maintenance
.22 OWS - Operator Work Station
.23 OTS - Operator Touch Screen
.24 PC - Personal Computer
.25 PCI - Peripheral Control Interface
.26 PCMCIA - Personal Computer Micro-Card Interface Adapter
.27 PWS - Portable Work Station
.28 RAM - Random Access Memory
.29 ROM - Read Only Memory
.30 TCU - Terminal Control Unit
.31 USB - Universal Serial Bus
.32 UPS - Uninterruptible Power Supply

.2 Definitions:
.1 Point: a point may be logical or physical. Logical points are values calculated by system such as totals, counts, derived corrections i.e. as result of and/or statements in CDL's. Physical points are inputs or outputs which have hardware wired to controllers which are measuring or providing status conditions of contacts or relays providing interaction with related equipment (stop, start) or valve or damper actuators.

.3 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISAS 5.5.
.1 Printouts: to ANSI/IEEE 260.
.2 Refer also to Section 13836 - EMCS: Identification.

1.4 PERMITS AND FEES

.1 In accordance with General Conditions of Contract.
.2 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.

1.5 GENERAL DESCRIPTION

.1 Refer to control schematics for system architecture.
.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
.1 Building Controllers MCU, LCU TCU.
.2 All control devices as required.
.3 Data communications equipment necessary to effect an EMCS data transmission system based on 10/100 Mbit/sec ETHERNET, between all controllers and the new OWS in the building operator's office.
.4 Field control devices.
.5 Software complete with full documentation for software and equipment.
.6 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.
.7 Acceptance tests, technical support during commissioning, full documentation.
.8 Wiring interface co-ordination of equipment supplied by others.
.9 Miscellaneous work as specified in these sections and as indicated.

1.6 METRIC REFERENCES

.1 Conform to CAN/CSA-Z234.1.
.2 Provide required adapters between Metric and Imperial components.

1.7 STANDARDS COMPLIANCE

.1 All equipment and material to be from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.8 EMCS CONTRACTOR QUALIFICATIONS

.1 EMCS contractor to:

- .1 Have local office within Alberta for at least 5 years, staffed by trained personnel capable of providing instruction, routine maintenance, emergency service on systems,
- .2 Provide record of successful installations performed by Contractor submitting tender of experience with similar computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Provide proof that system proposed is native Bacnet, in compliance with ANSI/ASHRAE standard 135, latest edition.
- .5 The following bidder is required.
  - .1 Controls and Equipment (Delta) – ESC Automation.

1.9 SYSTEM DESIGN RESPONSIBILITY

.1 Design and provide all conduit and wiring linking all elements of system, including future capability.

.2 Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by Departmental Representative prior to installation.

.3 Location of controllers to be approved by Departmental Representative prior to installation.

.4 Provide utility power to new control components.

.5 EMCS is to provide single user interface to all control points covered by this contract.

1.10 LANGUAGE OPERATING REQUIREMENTS

.1 Operator to interface to system in English.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. All other information to be in English.

.3 Operating system executive: primary hardware-to-software interface (specified as part of hardware purchase) with associated documentation to be in English.

.4 System manager software: to include system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency. These functions to be in English.

.5 EMCS operator: include, in English:

- .1 All input and output commands and messages from operator-initiated functions and/or field related changes and/or alarms as defined in CDL's or assigned limits (i.e. all commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

1.11 MATERIALS DELIVERY SCHEDULE

.1 Provide Departmental Representative with "Materials Delivery Schedule" within 2 weeks after award of Contract.

PART 2 - PRODUCTS

2.1 LOCKABLE PANELS

.1 Panel to be NEMA rated to suit environmental requirements.

.2 To have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

2.2 CODE COMPLIANCE

.1 DDC panels must be listed products having UL 864 certification for use in smoke control systems.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 PAINTING

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint all unfinished equipment installed indoors to CEMA 2Y.1.

.5 Perform painting to standards and workmanship specified in section 09 91 00

End of Section

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

1.2 DESIGN REQUIREMENTS

.1 Preliminary Design Review

.1 Within five (5) working days after tender closing and before contract award, submit preliminary design document for review by Departmental Representative, containing following contractor and systems information:

.1 Location of local office.

.2 Description and location of installing and servicing technical staff.

.3 Location and qualifications of programming design and programming support staff.

.4 List of spare parts.

.5 Location of spare parts stock.

.6 Names of sub-contractors and site-specific key personnel.

.7 Sketch of site-specific system architecture.

.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.9 Descriptive brochures.

.10 Sample CDL and graphics (systems schematics).

.11 Response time for each type of command and report.

.12 Item-by-item statement of compliance.

1.3 SHOP DRAWINGS

.1 Shop Drawings to consist of three (3) hard copies and one (1) soft copy of design documents, shop drawings, product data and software.

.2 Hard copy to be completely indexed and co-ordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.3 Soft copy to be in Autocad (2007) and MS Word (2010), structured using menu format for easy loading and retrieval on OWS.

.4 Preliminary Shop Drawing Review

.1 Submit preliminary shop drawings within 20 working days of award of contract.

.2 Include:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, specification, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including communications protocol, signal levels, pressures where new EMCS ties into existing control equipment.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare capacity between control centre, field controllers and systems being controlled.

.7 Complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque.

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.5 Detail Shop Drawing Review

.1 Submit detailed shop drawings within 25 working days after award of contract and before start of installation.

.2 Include:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Complete Point Name Lists.

.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types), signal range.

.6 Software and programming details associated with each point.

.7 Manufacturer's recommended installation instructions and procedures.

.8 All, signal levels, pressures where new system ties into existing control equipment.

.3 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.4 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain all specified energy optimization programs.

.5 Listing and example of reports.

.6 Listing of time schedules.

.7 Detailed to-scale drawing of control room showing location of equipment and operator work space.

.8 Type and size of memory with statement of spare capacity.

.9 Full description of software programs provided.

.10 Sample of "Operating Instructions Manual" to be used for training purposes.

.11 Outline of proposed start-up and verification procedures. See also Section 25 01 11 - EMCS: Start-up and Check Out.

.12 Communication protocol, media and network speed.

.13 Full details of communications, networks and data transfer rates.

.14 No partial submissions will be accepted or reviewed.

End of Section

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to requirements of Section 01 78 00 - Closeout Submittals, supplemented and modified by requirements specified in this section.

.2 Project records and O&M manuals specified in this section are to be completely separate entity from those specified in Section 01 78 00 - Closeout Submittals.

1.2 ACRONYMS

.1 Acronyms: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 FINAL CONTROL DIAGRAMS

.1 Provide before acceptance in both hard and soft copy.

.2 Show:

- .1 Changes to contract documents as well as addenda and contract extras.
- .2 Changes to interface wiring.
- .3 Major routing of conduit and control air lines.
- .4 Signal levels, setpoints, reset curves, schedules.

.3 Where possible, bind with specified Operating and Maintenance Manuals.

.4 Provide listing of alarm messages.

.5 Provide soft copy of updated drawings on system and soft copy back-up.

.6 Provide 1 non-fading "As-Built" copy showing control and/or adjustment procedures. Seal in plastic laminate in rigid metal bound loose leaf.

1.4 LANGUAGE

.1 Provide record documents as-built drawings Operation and Maintenance manual in English.

1.5 O&M MANUALS

.1 O&M Manuals (both hard and soft copy) to be custom designed and contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this section.

.2 Provide 2 soft copies and 2 hard copies in hard-back, 50 mm 3 ring, D-ring binders.

- .1 Binders to be 2/3 maximum full.
- .2 Provide index to full volume in each binder.
- .3 Identify contents of each manual on cover and spine.
- .4 Include names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .5 Provide Table of Contents in each manual. Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

.3 Furnish 1 complete set of hard and soft copies prior to system or equipment tests. Furnish remainder upon acceptance.

.4 Include complete coverage in concise language readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.5 Functional description to include:

- .1 Functional description of theory of operation.
- .2 Design philosophy.
- .3 Specific functions of design philosophy and system.
- .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces, requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

.6 System operation to include:

.1 Operation of computer peripherals, input and output formats.

.2 Emergency, alarm and failure recovery.

.3 Step-by-step instructions for start-up, back-up equipment operation, execution of all systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.7 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus any linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing all Controller common parameters and functions.

.8 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, Controller interface firmware's, plus diagnostics and repair/replacement of system hardware.

.9 Test procedures and reports: record implementation, description of test procedures. Provide for measurement or observation of results.

.10 System configuration document:

.1 Basic system design and configuration.

.2 Provisions and procedures for planning, implementing, recording hardware and software modifications required during installation, test and operating lifetime of system.

.3 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.4 Full documentation of new system configurations.

.11 PROM programmer and test equipment manual: include full documentation on PROM's including as minimum PROM locations in system, stock number, Programmer/PROM unique considerations.

.12 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

End of Section

PART 1 - GENERAL

1.1 GENERAL

.1 Provide identification for all control items..

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.1-1998, The Canadian Electrical Code, Part I.

1.3 SUBMITTALS

.1 Submit for approval samples of nameplates, identification tags and list of proposed wording.

PART 2 - PRODUCTS

2.1 LANGUAGE

.1 Provide nameplates and identification tapes and tags in English..

2.2 NAMEPLATES FOR PANELS

.1 Identify faces with laminated plastic nameplates.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: 7 mm minimum high, black.

.4 Inscriptions: machine engraved to identify function and, where applicable, fail-safe position.

.5 Nameplates: plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.6 Provide type panel directories at each panel identifying all inputs and outputs to face panel.

2.3 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: 5 mm minimum high produced from laser printer in black.

.4 Data to include: point name, schematic designation number, model, capillary length, size, range, set point, other pertinent data, function, fail-safe position.

.5 Companion cabinet: identify interior components using plastic enclosed cards.

2.4 NAMEPLATES FOR ROOM SENSORS

.1 Interior: identify by stick-on labels.

.2 Exterior: identify point name on face of cover using engraved plastic laminate nameplates.

.3 Sizes: to suit.

.4 Lettering: to suit. Clearly legible.

2.5 WARNING SIGNS

.1 Equipment (e.g. motors, starters) under remote automatic control: provide orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" or equivalent to Departmental Representative's approval.

2.6 NAMEPLATES FOR WIRING

.1 Provide numbered tape markings on wiring at panels, junction boxes, splitters, cabinets, outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify at each panel.

2.7 NAMEPLATES FOR CONDUIT

.1 Colour code all EMCS conduit.

.2 Locate coding on conduits, in exposed and concealed locations including removable suspended ceilings, tunnels, shafts, on both sides of walls, floors, and at 15 m intervals.

.3 Coding: use plastic tape or paint, 25 mm wide, fluorescent orange. Confirm colour with Departmental Representative during "Preliminary Design Review".

2.8 CONTROL PANELDIRECTORIES

.1 For each panel, provide typed list of input and output points. Post inside panel.

.2 Provide for Departmental Representative's approval prior to posting.

PART 3 - EXECUTION

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing legends to reflect changes made during work.

End of Section

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 07 84 00: Firestopping

.2 Section 23 05 00: Mechanical, General Requirements.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

- .1 ANSI/ASME B16.22-1989, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
- .2 ANSI C2-1990, National Electrical Safety Code.
- .3 ANSI/NFPA 70-1990, National Electrical Code.

.2 Canadian Standards Association (CSA)

- .1 CSA C22.1-98, Canadian Electrical Code, Part 1.
- .2 CAN/CSA C22.3 No.1-M87, Overhead Systems.

1.3 SYSTEM DESCRIPTION

.1 Electrical:

- .1 Provide power wiring from existing power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
- .2 Hard wiring between field control devices and EMCS field panels.

1.4 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

- .1 Continuously direct and monitor all work.
- .2 Attend site meetings.

PART 2 - PRODUCTS

2.1 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation.

2.2 WIRING

.1 As per requirements of Division 26 and 27. All wiring in Hydrogen Inflation Room and Hydrogen Generation Room (Hogen) to be done in accordance with CEC Z006 Section 18-100 (Installation in Class I Division 1 and 2, Group B Locations). Reference Division 26 for room classifications.

.2 For 70V and above copper conductor with chemically cross- linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 All wiring is to be in conduit, and surface mounted.

.4 Sizes:

- .1 120V Power supply: to match or exceed breaker, size #12 minimum.
- .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
- .3 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
- .4 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. Wiring must be continuous without joints.
- .5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:

.1 Terminate all wires with screw terminal type connectors. Connectors to be suitable for wire size, and number of terminations.

2.3 CONDUIT

.1 As per requirements of Division 26 and 27.

.2 Conduit to be surface mounted.

.3 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 45.

.4 Junction and pull boxes: welded steel.

.1 Surface mounting cast FS: screw-on flat covers.

.2 Flush mounting: covers with 25 mm minimum extension all round.

.5 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.6 Outlet boxes: 100 mm minimum, square.

.7 Conduit boxes, fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.8 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.9 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.4 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

.3 Cover plates and blank plates: finish to match other plates in area.

2.5 STARTERS, CONTROL DEVICES

.1 Across-the-line magnetic starters: By Div. 26 and 27.

.2 Starter diagrams:

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.

.3 Auxiliary Control Devices:

.1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.

.2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

.3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.

.4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

2.6 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:
  .1 50 mm diameter and smaller: one-hole steel straps.
  .2 Larger than 50 mm diameter: two-hole steel straps.
.3 Suspended support systems:
  .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
.2 Electrical installation in Hydrogen Inflation Room and Hydrogen Generation Room to be done in accordance with CEC requirements for room classification. Reference Division 26 for room classifications.

3.2 SUPPORTS

.1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:
  .1 Divisions 26, 27, this specification.
  .2 CSA 22.1 Canadian Electrical Code.
  .3 ANSI/NFPA 70.
  .4 ANSI C2.
.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
.3 Do underground installation to CAN/CSA C22.3 No.7, except where otherwise specified.
.4 Conform to manufacturer's recommendations for storage, handling and installation.
.5 Check factory connections and joints. Tighten where necessary to ensure continuity.
.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
.9 Install conduits, and sleeves prior to pouring of concrete.
.10 Holes through exterior wall and roofs: flash and make weatherproof.
.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Conduit to be surface mounted. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in starters to Div. 26 and 27.

.17 Install bonding conductor for 120 volt and above in conduit.

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Departmental Representative with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed. Utilize terminal type connectors (crimped eyelets), bare wire connections are not acceptable.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 WIRING DEVICES, COVER PLATES

.1 Receptacles:
- .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Cover plates:
  - .1 Install suitable common cover plate where wiring devices are grouped.
  - .2 Use flush type cover plates only on flush type outlet boxes.

3.7 STARTERS, CONTROL DEVICES

.1 Identify each wire, terminal for external connections with permanent number marking identical to diagram.

.2 Performance Verification:
- .1 Operate switches and controls to verify functioning.
- .2 Perform start and stop sequences of contactors and relays.
- .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.8 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.9 TESTS

.1 General:
- .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Commissioning.
- .2 Give 14 days written notice of intention to test.
- .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
- .4 Conceal work only after tests satisfactorily completed.
- .5 Report results of tests to Departmental Representative in writing.
- .6 Preliminary tests:
  - .1 Conduct as directed to verify compliance with specified requirements.
  - .2 Make needed changes, adjustments, replacements.
  - .3 Insulation resistance tests:
    - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
    - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

3.10 IDENTIFICATION

.1 Refer to Section 25 05 54 - EMCS: Identification.

End of Section

PART 1 - GENERAL

1.1 ACRONYMS

.1 Acronyms used in this section include see Section 25 05 01 - EMCS: General Requirements.

1.2 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU).

.2 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.3 Allow for future expansion of network, with selection of networking technology and communication protocols.

.4 LAN to be capable of communicating with BACnet LAN/WAN network directly.

1.3 OWS/MCU PANEL SUPPORT

.1 MCU and OWS's to reside directly on LAN so that communications may be executed directly between work-stations and controllers on peer-to-peer basis.

1.4 GENERAL NETWORK DESIGN

.1 To include:

.1 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabit per second minimum.

.2 Support of any combination of MCU controllers directly connected to LAN. Each LAN to be capable of supporting at least 50 devices.

.3 Detection and accommodation of single or multiple failures of either MCU panels or network media. To reconfigure itself automatically to allow operational equipment to perform designated functions effectively in event of single or multiple failures.

.4 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications such as office automation.

.5 Network medium to be CAT5 or CAT6 cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

.2 Acceptable technologies: ETHERNET.

PART 2 - PRODUCTS

2.1 COMPONENTS

.1 Provide HUBS, switches and other components as required for a complete operational system.

PART 3 - EXECUTION

3.1 DEMONSTRATIO OF LAN

.1 Demonstrate communication from each OWS to each MCU and LCU via LAN to Departmental Representative.

End of Section

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

.2 Related Sections:

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.3 Section 25 05 03 - EMCS: Project Record Documents.

.4 Section 25 30 01 - EMCS: Building Controllers Family of Controllers.

.5 Section 25 90 01 - EMCS: Sequence of Operation.

1.2 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

.2 Secondary OWS: performs identical user interface functions as primary OWS.

.3 Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.

.4 Remote Auxiliary Touchscreen OWS: performs identical user interface functions as primary OWS.

1.3 OWS SYSTEM DESCRIPTION

.1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.

.2 Primary OWS to include:

.1 Colour report printer.

.2 Remote Internet Modem.

.3 Secondary OWS.

.1 Desk approximately 60cm x 120cm.

.4 Remote auxiliary touchscreen OWS.

.5 Portable Laptop.

1.4 SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

1.5 ENVIRONMENTAL CONDITIONS

.1 OWS to operate in conditions of 10 degrees C to 32 degrees C and 20 % to 90 % non-condensing RH.

1.6 MAINTENANCE

.1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENT

.1 Controls contractor to provide two computers as described in the following sections. One PC shall be situated in the Operations Building to provide the main OWS service. The second PC shall be installed in the Control Room and shall be used as a secondary OWS.

.2 Controls Contractor to provide two laptop computers as described in the following sections. One laptop shall be situated in the Operations Building and provide portable OWS service. The second laptop shall be situated in the Control Room (see Drawing MC1) and shall be used for Hogen system monitoring. Setup of the Hogen monitoring computer shall be the responsibility of the Departmental Representative. All software for this computer shall be provided by the Departmental Representative.

.3 Controls Contractor to provide a touchscreen computer as described in the following sections to be installed in the Control Console in the Control Room to provide OWS service.

2.2 OWS HARDWARE

.1 PC system to include:

.1 Processor: Intel Core i7 Processor operating at minimum clock speed of 3.6 Gigahertz, 4 core, capable of supporting software necessary to perform functions specified in this section.

.2 Internal clock.

.1 Uninterruptible clock: accuracy of plus or minus 5 seconds/month, capable of deriving year / month / day / hour / minute / second.

.2 Rechargeable batteries: to provide minimum 48 h clock operation in event of power failure.

.3 Interfaces for connection to listed peripheral devices including LAN and remote devices.

.2 Power supply unit to accept 120 V 60 Hz source and include line surge and low voltage protection for processor and its peripherals.

.3 Include UPS to provide 5 minutes minimum operation of PC, CRT and communication and peripheral devices; applies to fixed (non-portable) OWSs, touchscreen OWS and peripherals.

2.3 OWS PC COMPONENTS

.1 Primary OWS: IBM PC compatible with the following as minimum:

.1 1TB hard disk drive.

.2 Internal Blu-Ray HD DVD drive capable of 12X BD-R read, 12X BD-R write, 16X DVD-ROM read, 16X DVD+/-R write, CD-R read, CD-R write. Provide 3 BD-RE disks and 10 DVD+RW disks.

.3 16 GB RAM.

.4 Enhanced 101-key keyboard.

.5 Optical wireless wheel mouse with mouse pad. Wheel button to be programmed to act as double left click. Wheel to be programmed for scroll function.

.6 Colour LCD TFT Monitor, minimum screen size 558 mm (22”) (diagonal measurement), minimum 1680x1050 pixel resolution, 600:1 minimum contrast ratio, 160 degree minimum viewing angle.

.7 Video card to have compatible PCIe bus and capable of driving supplied monitor to its maximum resolution including 1680x1050, 1280x1024 and 1024x768 all in 32 bit colour as well as IBM SVGA and VGA in 16 bit colour.

.8 External hard drive with USB 2.0 interface, minimum 100g shock rating, 1TB capacity. Provide necessary software to facilitate system backup and recovery from this device.

.9 Ethernet LAN adapter to connect to local Ethernet Network.

.10 Communications software and interface as required to allow for remote internet access to the system. Coordinate with Departmental Representative for existing internet service.

.2 Secondary OWS to perform identical user interface functions as primary OWS: IBM PC compatible PC equivalent to primary OWS.

.3 Portable OWS: IBM compatible personal laptop computer, with following as minimum:

.1 Intel Core i5 processor, duo core, minimum clock speed 2.5 GHz.

.2 640 GB hard disk drive.

.3 Internal 8X dual layer DVD+/-RW, CD-R RW drive

.4 4 GB RAM.
.5 Two USB 2 and one USB 3 ports.
.6 One multi-card slot (SD, SD mini).
.7 Enhanced 101-key keyboard.
.8 USB wireless wheel mouse with mouse pad. Wheel button to be programmed to act as double left click. Wheel to be programmed for scroll function.
.9 Colour LCD Monitor, minimum screen size 356 mm (14") (diagonal measurement).
.10 Display to be capable of 180 degree range of motion such that display and body can be made co-planar.
.11 Ethernet LAN adapter to connect to local Ethernet Network.
.12 Communications software and interface as required to allow for remote internet access to system.
.13 Software, hardware and interface as required to allow for direct connections to all MCUs, LCUs or TCUs (portable OWS only).
.14 Operating system: same as primary OWS and include licensed OWS software as installed on primary OWS.

.4 Remote Auxiliary Touchscreen OWS: locate in Control Room in Control Console as indicated on mechanical drawings and system architecture diagram with the following as minimum:
.1 OWS to perform identical user interface functions as primary OWS with the following minimum requirements:
.2 Colour monitor: 178 mm (7" diagonal) high resolution, 800 x 480 (WVGA), 16bit color.
.3 Software and hardware interface to connect to EMCS LAN.

2.4 PRINTERS

.1 Report printer: Include following features:
.1 Colour laser printer.
.2 Accommodate 8.5 X 11" and 8.5 X 14" paper.
.3 Minimum 1200 by 1200 dpi resolution.
.4 Minimum 16 MB RAM, expandable to minimum 72 MB RAM.
.5 Minimum 18 pages per minute print speed.
.2 Include one box of 8.5 X 11" paper.

2.5 OPERATING SYSTEM (OS) OR EXECUTIVE

.1 OS to support complement of hardware terminals and software programs specified.
.2 OS to be true multitasking operating environment.
.1 MS DOS or PC DOS based software platforms not permitted.
.3 OWS software to operate in "Windows" based operating environment: Windows 8, 7 or Unix "X' Windows based system.

2.6 OWS CONTROL SOFTWARE

.1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.
.2 Time Synchronization Module.
.1 System to provide Time Synchronization of real-time clocks in controllers.
.2 System to perform this feature on regular scheduled basis and on operator request.
.3 User Display Interface Module.
.1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.

.2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.

.4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:

.1 Operator Log-in from user interface device.

.2 Communication messages: errors, failures and recovery.

.3 Event notifications and alarms by category.

.4 Record of operator initiated commands.

.5 General Event Log:

.1 Hold minimum of 4 months information and be readily accessible to operator.

.2 Able to be archived as necessary to prevent loss of information.

.6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:

.1 Automatic logging of digital alarms and change of status messages.

.2 Automatic logging of analog alarms.

.3 System changes: alarm limits, set-points, alarm lockouts.

.4 Display specific point values, states as selected.

.5 Provide reports as requested and on scheduled basis when required.

.6 Display graphics as requested, and on alarm receptions (user's option).

.7 Display list of points within system.

.8 Display list of systems within building.

.9 Direct output of information to selected peripheral device.

.10 On-line changes:

.1 Alarm limits.

.2 Setpoints.

.3 Deadbands.

.4 Control and change of state changes.

.5 Time, day, month, year.

.6 Control loop configuration changes for controller-based CDLs.

.7 Control loop tuning changes.

.8 Schedule changes.

.9 Changes, additions, or deletions, of points, graphics, for installed and future systems.

.11 According to assigned user privileges (password definition) following functions are to be supported:

.1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.

.2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.

.12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

.7 Internet access for off site OWSs.

.1 Operators at off-site OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.

.8 Message Handling Module - and Error Messages: to provide message handling for following conditions:

.1 Message and alarm buffering to prevent loss of information.

.2 Error detection correction and retransmission to guarantee data integrity.

.3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.

.4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.

.9 Access Control Module.

.1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:

.1 Guest: no password data access and display only.

.2 Operator Level: full operational commands including automatic override.

.3 Technician: data base modifications.

.4 Programmer: data base generation.

.5 Highest Level : system administration - password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.

.1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time- stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.

.2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.

.3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

.4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.

.11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.

.1 Reports to include time, day, month, year, report title, operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in such reports.

.4 Sort output by area, system, as minimum.

.3 Periodic/automatic report:

.1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting.

Run time to accumulate until reset individually by operator.

.4 Summary of run time alarms:

include point name, run time to date, alarm limit.

.5 Summary of start/stop schedules: include start/stop times and days, point name.

.6 Motor status summary.

.4 Report types:

.1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:

.2 Points in accessible from this OWS (total connected for this location), multiple "areas".

.3 Area (points and systems in Area).

.4 Area, system (points in system).

.5 System (points by system type).

.6 System point (points by system and point object type).

.7 Area point (points by system and point object type).

.8 Point (points by point object type).

.5 Summary report: printout or display of point objet data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.

.6 Include preformatted reports as listed in Event/Alarm Module.

.12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.

.2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.

.3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.

.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.

.2 Delete graphic picture.

.3 Call up and cancel display of graphic picture.

.4 Define symbols.

.5 Position and size symbols.

.6 Define background screens.

.7 Define connecting lines, curves.

.8 Locate, orient, size descriptive text.

.9 Define, display colours of elements.

.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.

.8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative Engineer Consultant. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and , flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. Departmental Representative Engineer Consultant to provide CAD floor layouts. Provide display of TCU VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.

.9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.

.10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English and/or French language.

.13 Event/Alarm Module : displays in window alarms as received and stored in General Event Log.

.1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.

.3 Alarm reports.

.1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

.2 Analog alarm limit summary: include point name, alarm limits, deviation limits.

.3 Summary of alarm messages: include associated point name, alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:

.1 Critical - 5 seconds.

.2 Cautionary - 10 seconds.

.3 Maintenance - 10 seconds.

.6 Display alarm messages in English and French.

.7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
  .1 Controller not responding - where possible delineate between controller and communication line failure.
  .2 Controller responding - return to normal.
  .3 Controller communications bad - high error rate or loss of communication.
  .4 Controller communications normal - return to normal.

.10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module.
  .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.
  .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
  .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.

.15 CDL Generator and Modifier Module.
  .1 CDL Generator module to permit generation and modification of CDLs.
  .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
  .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
  .4 Module to permit testing of code before downloading to building controllers.

2.7 ADDITIONAL UTILITY SOFTWARE

.1 Supply and install on primary OWS, following CAD software products by Autodesk Inc. and include:
  .1 AutoCAD LT latest version.
  .2 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.
  .3 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.
  .4 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Departmental Representative Engineer Consultant.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

.1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment.
  .1 Install tamper locks on breakers of circuit panels.
  .2 Refer to UPS requirements stated under OWS Hardware in PART 2.

End of Section

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.
.2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
.3 Section 25 05 03 - EMCS: Project Records Documents.
.4 Section 25 10 01 - EMCS: Local Area Network (LAN).
.5 Section 25 30 02 - EMCS: Field Control Devices.
.6 Section 25 90 01 - EMCS: Sequence of Operation.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)
  .1 C22.2 No.205-M1983(R1992), Signal Equipment.
.2 Institute of Electrical and Electronics Engineers
  .1 IEEE C37.90.1-84, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.3 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Records Documents.

1.4 ACRONYMS

.1 Acronyms used in this section include: see Section 25 05 01 - EMCS: General Requirements.

1.5 SUBMITTALS

.1 In accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process submit product data sheets for each product item proposed for this project.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 General: A network of Controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
  .1 Provide sufficient Controllers to meet intents and requirements of this section.
  .2 Controllers quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
.2 Controllers to be stand-alone intelligent Control Unit. Controllers to:
  .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
  .2 Incorporate communication interface port for communication to Local Controller's LAN to exchange information with other Controllers.
  .3 Be capable of interfacing with operator interface device. Operator interface device to be at the panel, complete with LCD display, and keyboard for operator input and system navigation.
  .4 Interface with field sensors via input output termination board to be part of Controllers or located remotely.
  .5 Execute its logic and control (direct digital or closed loop process) having primary inputs (input or outputs which have direct interaction with logic processing) connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other processor. Secondary input used for reset such as outdoor air temperature to be located in other Controller(s).

2.2 BASIC FUNCTIONAL REQUIREMENTS

.1 To include:

- .1 Scanning of AIs and DIs connected inputs for detection of change of value and processing the detection of alarm conditions.
- .2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.
- .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
- .4 Control of systems as described in sequence of operations.
- .5 Execution of optimization routines as listed in this section.

.2 Field Termination and Interface Devices.

- .1 To conform to CSA C22.2 No.205.
- .2 To electronically interface sensors and control devices to processor unit.
- .3 To include, but not be limited to, following:
  - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
  - .2 Power supplies for operation of logics devices and associated field equipment.
  - .3 Lockable wall cabinet with tamper alarm (unless housed in processor unit cabinet).
  - .4 Required communications equipment and wiring (if remote units).
  - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
  - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
  - .7 Wiring terminations shall use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
  - .1 Convert analog signals to digital format with 12 bit analog-to-digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 - 20 mA;
    - .2 0 - 10 V DC.
    - .3 Meet IEEE 472 surge with stand capability.
    - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
  - .3 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment to:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 - 20 mA.
    - .2 0 - 10 V DC.
    - .3 Meet IEEE 472 surge withstand capability.
- .6 DI interface equipment to:
  - .1 Be able to reliably detect contact change of sensed field contact and feed condition to controller logic processor.
  - .2 Meet IEEE 472 surge withstand capability.
  - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment to:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.3 Controller's and associated hardware and software to operate in conditions of 0°C to 44°C and 20% to 90% non-condensing RH.

.4 Controllers (MCU, LCU) to be mounted in wall mounted cabinet with hinged, keyed-alike locked door. Provide for conduit entrance from top, bottom or sides of panel. ECUs to be mounted in equipment enclosures and TCU's in ceiling space. Mounting details to be as approved by the Departmental Representative for ceiling mounting.

.5 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.6 Provide surge and low voltage protection for interconnecting wiring connections.

2.3 MASTER CONTROL UNIT (MCU)

.1 Primary function of MCU is to provide co-ordination and supervision of subordinate devices. Supervisory role shall include coordination of subordinate devices in the execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices. Include support for BACnet.

.3 MCU shall have local I/O capacity as follows;

.1 To have at least 16 I/O points of which minimum to be 2AO, 6AI, 4DI, 4DO.

.2 LCU's to be added to support system functions as indicated in I/O Summary List.

.3 MCU to have 25 % spare input and 25 % output point capacity without addition of cards, terminals, etc.

.4 Central Processor Unit (CPU)

.1 Processor to consist of at minimum a 16 bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving month/day/hour/minute/second, with rechargeable batteries for minimum 72 hr operation in event of power failure.

.5 Local Operator Terminal (OT)

.1 OT to:

.1 Have integral access/display panel.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs additions and modifications.

.3 Simultaneously display minimum of 16 points with full English and French identification to allow operator to view single screen dynamic displays depicting entire mechanical systems.

.2 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop setpoints.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.
.11 Enter/modify analog warning limits.
.12 Enter/modify analog alarm limits.
.13 Enter/modify analog differentials.

.3 OT to provide access to real and calculated points in controller to which it is connected or to any other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and any other controller in network.

.4 Operator access to OTs to the same as OWS user password. Password changes to automatically be downloaded to controllers on network.

.5 OT to provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.6 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.4 LOCAL CONTROL UNIT (LCU)

.1 Design to provide control functions for typical HVAC or Hydronic systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points of one Building System to be connected to one controller as listed in I/O Summary designations.

.4 To comprise of microprocessor capable of supporting necessary software and hardware to meet specified requirements. As per MCU requirements (section 2.4.4) above with the following additions:

.1 Include as minimum 2 interface ports for connection local computer terminal.

.2 Design so that shorts, opens or grounds on any input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

.7 LCU to have 25% spare input and 25% output point capacity without addition of cards, terminals, etc.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', ‘system’ or point group, an entire 'area', or entire network on printer or OWS as selected by operator. Display analog values digitally to 1 place of decimals with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

.2 Refer also to Section 25 05 01 - EMCS General Requirements.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PWGSC point naming convention. Each point name to include; an identifier field for "area", "system", "point" which has at minimum a 25 character string entry, and, point identifier expansion fields which at minimum support 32 character strings for each "system" and "point" identifier. System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.2 Upon operator's request, system to present condition of any single point, system, area, or connected points on system to OWS or remote printer as selected by operator. Display analog values digitally to (1) place of decimals with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. Updates to be change-of-value (COV)-driven or if polled not to exceed 4 second intervals for points displayed.

.3 Refer also to Section 25 05 01 - EMCS: General Requirements.

PART 3 - EXECUTION

3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

.1 Install Controllers in secure enclosures as indicated or as directed by Departmental Representative.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in an emergency and co-ordinating mode.

End of Section

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Section 25 05 03 - EMCS: Project Records Documents.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C12.7-1993, Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-1978(R1987), Requirements for Instrument Transformers.

.2 National Electrical Manufacturer's Association (NEMA)

.1 NEMA 1

.2 NEMA 12

1.3 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Include:

.1 Information as specified for each device.

.2 Manufacturer's detailed installation instructions.

.3 Pre-Installation Tests

.1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 CLOSEOUT SUBMITTALS

.1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 25 05 03 - EMCS: Project Records Documents.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32°C with 10-90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters to be unaffected by external transmitters (eg. walkie talkies).

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in EEMAC 12 enclosures.

.8 Devices to be installed in user occupied space must not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Hogen (Hydrogen Generation Room) and Inflation Room classified as specified in Division 26. All devices used/installed in these rooms must meet the rating requirements of these classifications.

2.2 AIR FLOW SENSOR (Af)

.1 Requirements: Output signal: 4 - 20mA linear into 500 ohm maximum load.
.2 Calibrated span: not to exceed 125% of duct velocity pressure at maximum flow.
.3 Accuracy: 0.4% of span.
.4 Repeatability: within 0.1% of output.
.5 Linearity: within 0.5% of span.
.6 Deadband or hysteresis: 0.1% of span.
.7 External exposed zero and span adjustment.
.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.
.9 Sensor to be suitable for installation in room's classification specified in Division 26.

2.3 CURRENT TRANSDUCER (Ct)

.1 Purpose: measure line current and produce proportional signal in one of following ranges:
  .1 4-20 mA DC.
  .2 0-1 volt DC.
  .3 0-10 volts DC.
  .4 0-20 volts DC.
.2 Frequency insensitive from 10 - 80 hz.
.3 Accuracy to 0.5% full scale.
.4 Zero and span adjustments. Field adjustable range to suit motor applications.
.5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.4 DAMPER ACTUATORS (De)

.1 Damper Actuators:
  .1 Push-pull proportional type as indicated.
  .2 Spring return for "fail-safe" in normally open or normally closed position as indicated.
  .3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).
  .4 Power requirements: 5 VA maximum at 26 V AV.
  .5 Operating range: 0 - 20 V DC.
  .6 Acceptable materials: Belimo.
  .7 Damper actuators located in Hydrogen Generation Room to be complete with Belimo ZS-260 explosion proof housing. Housing to be rated for operation in classified space. Reference Division 26 for room classification.

2.5 CONTROL DAMPERS

.1 See Section 23 33 15.

2.6 FLAME SENSOR (Fi)

.1 Copper free aluminum construction. Minimum operating temperature -40C.
.2 Digitally stepped analog output 4 to 20mA for connection to EMCS.
.3 Normally Open fire relay output to be hard wired to shut down inflation valves and Hogen unit.
.4 Complete with three infrared sensors, 120 degree field of view, external reflectors are not acceptable.
.5 CSA to meet room classification. Reference Division 26 for room classification.
.6 Acceptable materials - Honeywell Fire Sentry SS4-AUV.

2.7 ELECTRIC HEATING COIL (Hc)

.1 Provide analog output to control heating coil from 0% to 100%. Coordinate with coil supplier for control interface.

2.8 HYDROGEN SENSOR TRANSMITTER (Hi)

.1 H2 sensor - remote, sensor mounting lower detectable limit; 300 ppm, maximum 15 second response time, minimum -40C operating temperature, accuracy - +/-150 ppm, C/W collecting cone and fault contact.

.2 Transmitter - LMZ5 aluminium alloy construction 5 coat marine finish paint, -40C minimum operating temperature 4 to 20 ma output, fault warning detection, CSA: Class 1, Division 1, Group B.

.3 Acceptable materials - Honeywell XNX (transmitter), Honeywell MPD-CB1 (sensor), Honeywell 02000-A-1642 (collecting cone), Honeywell 1226A0354 (gassing point assembly).

2.9 EXTERIOR AUDIBLE ALARM (Hn)

.1 24V DC, CSA certified, Nema 4X enclosure.

.2 18 ga aluminum construction with neoprene gaskets between the trim ring and horn.

.3 110 dBa at 1m.

.4 -54C minimum operating temperature.

2.10 INTERIOR AUDIBLE ALARM (Hn)

.1 24V, 85 db (at 1m) audible alarm.

.2 Incorporate into stack lights.

2.11 EXTERIOR ALARM LIGHTS (Le)

.1 24V DC LED light surface mounting

.2 Low operating temperature -35C.

.3 80mm diameter, 140mm height.

.4 See drawings for quantity and lens colour requirements.

.5 Standard of acceptance; Federal Signal LP3TL.

2.12 STACK LIGHTS (Li)

.1 Socket-mount LED lamps, 24V.

.2 For light and audible alarm operational requirements refer to sequence of operation.

.3 See drawings for colour requirements.

.4 Minimum light diameter 50mm.

2.13 EMERGENCY STOP BUTTON (Pb)

.1 Foolproof twist release, 22.5 diameter, 24V.

.2 Once the button is pressed, it shall remain engaged until manually released with a twist motion.

2.14 EMERGENCY DISCHARGE BUTTON (Pb)

.1 Push button 22.5 mm minimum diameter red colour, foolproof twist release.

.2 Provide c/w cover to prevent accidental discharge.

.3 Once the button is pressed, it shall remain engaged until manually released with a twist motion.

2.15 HYDROGEN DISPENSING BUTTON (Pb)

.1 Illuminated standby, flush shape, mounting type; level with bezel, green lens colour.

2.16 ELECTRICAL RELAY DRY CONTACT (Rc)

.1 Provide a digital input to monitor the status of the dry contact.

.2 Provide all relays as required to interface to the relay dry contact.

2.17 SOLID STATE RELAYS (Rv)

.1 Requirements: To match voltage and load requirements.

2.18 TEMPERATURE SENSORS (Ts, Td)

.1 General:
  .1 10K OHM thermistor.
.2 Sensors:
  .1 Room type: wall mounting, adjustable temperatures set point. Element 10-50 mm long with ceramic tube or equivalent protection.
  .2 General purpose duct type: suitable for insertion into ducts at any angle, insertion length 460 mm or as indicated.
  .3 Sensor in Hydrogen Generation Room to be rated for operation in classified space as specified in Division 26. Sensor in Inflation Room to be rated for operation in classified space as specified in Division 26.

2.19 SMOKE SENSOR (Sm)

.1 Minimum operating temperature -40C.
.2 Photo electric type.
.3 Output: digital.
.4 Normally Open contact to be hard wired to shut down inflation valves and Hogen unit.
.5 CSA to meet room classification. Reference Division 26 for room classification.
.6 Device in control room shall not be classified.

2.20 SWITCH (Sw)

.1 Provide an override two position switch. Switch to be at minimum 30 mm in diameter. Installed on front of control panel.
.2 Provide all relays as required to monitor the status of the switch in the override position.
.3 Provide lamecoid labels as outlined in the Point Database Schedule.

2.21 PANELS

.1 Either free-standing or wall mounted cabinets with hinged and key-locked front door.
.2 To be modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by Departmental Representative without adding additional cabinets.
.3 Panels to be lockable with same key.

2.22 CONTROL CONSOLE (CONTROL ROOM)

.1 14 ga steel body, door, lid. Smooth continuously welded seams, solid sides and back, solid doors (2) on front. Sloped console top approximate 1200 x 650mm.
.2 Flush mount opening for operator touch screen.
.3 Mounting for placement of portable notebook laptop.
.4 Finish beige powder coat.
.5 CSA certified, Nema 12 enclosure.
.6 Standard of acceptance; Hammond Enclosures Series 2000.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.2 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.

.3 Support field-mounted transmitters, sensors on pipe stands or channel brackets.

.4 Install wall mounted devices on plywood panel properly attached to wall.

3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).

.3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.4 Identify wiring and conduit clearly.

3.4 FIELD MOUNTED TRANSMITTERS AND SENSORS

.1 Support properly on pipe stands or channel brackets.

.2 Install wall mounted devices on plywood panel attached properly to wall.

3.5 IDENTIFICATION

.1 Identify field devices properly.

.2 Refer to Section 25 05 54 - EMCS: Identification.

3.6 TESTING

.1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Departmental Representative for approval. Departmental Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.

3.7 HYDROGEN SENSOR

.1 Install per manufacturer's recommendations.

.2 Refer to drawings for sensor locations and mounting heights.

3.8 FLAME SENSOR

.1 Install per manufacturer's recommendations.

3.9 STACK LIGHTS

.1 Install per manufacturer's recommendations.

3.10 EXTERIOR ALARM LIGHTS

.1 Install per manufacturer's recommendations.

3.11 EXTERIOR AUDIBLE ALARM

.1 Install per manufacturer's recommendations.

End of Section

PART 1 - GENERAL

1.1 GENERAL

.1 All set points are to be operator adjustable from the graphics display interface in either the Operations Building or Control Room. Set points for the alarm lower flammability limit (LFL) levels will be password protected so they can only be adjusted by system administrators. The date and time and description of all alarms occurrences as well as the date and time of the reset shall be logged by the DDC system, and shall be accessible from the operator workstations.

.2 Provide control graphics to display system operation. Graphics to match with other Balloon Launch sites and shall generally consist of the following screens at minimum:

- .1 General Information and Alarms
- .2 Control Room Information and Ventilation
- .3 Inflation Room Information
- .4 Hogen Room Information and Ventilation
- .5 Hogen Unit Information and Control

.3 Under normal operating conditions the green exterior light and the green stack lights in the Control Room/the Operation Building shall be illuminated continuously. The only times that the green lights shall not be illuminated are when there is an alarm situation (see alarm sequences for warning light requirements) or if Hogen unit is in operation (in this situation the green lights shall flash on and off).

1.2 HOGEN ROOM VENTILATION

.1 The Hogen room is equipped with two parallel ducted exhaust fans, motorized fresh air, exhaust air and recirculation air dampers.

.2 When the control system detects the Hogen (hydrogen generator) unit is in operation, the control system shall start the lead exhaust fan and open the fresh air, exhaust air, recirculation air dampers to provide 47 l/s of fresh air to the space.

.3 If the lead exhaust fan does not start when commanded then the control system shall start the lag exhaust fan. Also, if the lead exhaust fan does not start when commanded (as detected at the airflow sensor) then an alarm message shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.4 If the lag fan fails to start, then refer to Alarm Sequence #6.

1.3 HOGEN ROOM TEMPERATURE CONTROL

.1 If the temperature of the Hogen room is above set point and the Hogen unit is not in operation then the lead exhaust fan shall be started and the fresh air / exhaust air / recirculation air dampers shall be modulated to maintain the space temperature at setpoint.

.2 Once the space temperature set point is reached the fan shall stop and the fresh air/exhaust air dampers shall be closed.

.3 If the Hogen unit is in operation and the space temperature is above set point then the lag exhaust fan shall be started. The fresh air / exhaust air / recirculation air dampers shall be modulated to maintain the space temperature at setpoint AND maintain the minimum fresh air flow to the space. If the Hogen unit is still in operation and the space temperature setpoint is reached, the lag fan shall stop.

.4 If the space temperature exceeds the set point temperature by more than 3°C, an alarm message shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.5 If the space temperature in the Hogen room drops below setpoint, the electric heaters shall be engaged by the control system. When the room reaches setpoint temperature, the heaters shall be shut off.

.6 If the space temperature falls more than 3°C below setpoint temperature, an alarm message shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.7 If the Hogen room temperature drops below 8°C then refer to Alarm Sequence #5.

.8 The minimum space temperature set point for the room shall be 15°C.

1.4 CONTROL ROOM TEMPERATURE CONTROL

.1 The space temperature in the Control room shall be maintained via one ventilation unit and one space electric heater.

.2 When the light switch is ON (CTRL_OCC), the EMCS shall start the ventilation unit and modulate the electric heating coil as required to maintain 20°C supply air temperature.

.3 If the space temperature falls more than 1°C below setpoint temperature, the electric heating coil shall be commanded to 100%. If the space temperature reaches setpoint, the electric heating coil shall modulate to maintain 20°C supply air temperature.

.4 If the heating coil is on for more than 5 minutes, and the temperature is below setpoint, the electric space heater shall be commanded ON. Once the space temperature reaches 0.5° below setoint, the space heater shall be commanded OFF.

.5 When the room is unoccupied (lights are off), the electric space heater shall be commanded ON and OFF to maintain the space temperature at 12°C (operator adjustable).

1.5 HYDROGEN DISPENSING

.1 The hydrogen dispensing circuit shall be made active from the Control Room control console operator touch screen. When the circuit is active:

- .1 The white segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 1 seconds on and 1 second off.
- .2 The hydrogen master dispensing valve shall open, however, the secondary hydrogen dispensing valve shall remain closed.
- .3 When the dispensing circuit is active the hydrogen dispensing button light shall be illuminated.

.2 Once the hydrogen dispensing circuit is made active the hydrogen dispensing button will be made active (this is to be indicated at the operator work stations and control console touch screen).

- .1 When the active dispensing button is pressed the secondary hydrogen dispensing valve shall open and hydrogen shall flow to the balloon.
- .2 When the active dispensing button is pressed the white stack light segments shall be illuminated continuously.
- .3 When the dispensing button is released the secondary valve shall close and the white stack light segments shall flash 1 second on and 1 second off.

.3 See Alarm Control Sequences for conditions that will over ride hydrogen dispensing valve operation.

1.6 HOGEN GENERATOR PRODUCING HYDROGEN

.1 While the Hogen generator is in hydrogen production mode:

- .1 The green segments of the stack warning alarm lights (located in the Control Room and the Operations Building) and the exterior green light shall flash at a rate of 1 seconds on and 1 second off.
- .2 The ventilation system shall operate per sequence 1.2 Hogen Room Ventilation Sequence.

1.7 FIRE ALARM AND OVERRIDE

.1 The operator shall be able to disable the fire alarm reporting by placing the switch on the enclosure of the EMCS panel in the override position.

.2 When the switch is in the override position, the EMCS shall enable the Override outputs to the fire alarm system. Both override outputs shall be commanded in unison. (This will signal to the fire alarm system a “trouble” signal for the two fire inputs from the EMCS and the fire alarm will register but not react.)

.3 If a fire is detected in the Hogen room, the EMCS shall enable the hogen fire output to the fire alarm system.

.4 If a fire is detected in the Inflation room, the EMCS shall enable the Inflation fire output to the fire alarm system.

.5 Refer to Division 26 for installation details.

1.8 ALARM CONTROL SEQUENCE #1

.1 Inflation Room Combustible Gas Detector: When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 20% of the lower flammability limit (LFL) then:

- .1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console touch screen (Control Room).
- .2 The yellow segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 2 seconds on and 1 second off
- .3 The audible alarms, located at each of the light stacks shall produce an intermittent tone of 2 seconds on and 1 second off.
- .3 The yellow alarm light on the exterior of the building shall also flash at a rate of 2 seconds on and 1 second off.
- .4 The control system shall fully close both the main hydrogen dispensing valve and the secondary dispensing valve and stop the HOGEN unit.
- .5 The visual alarms shall remain on and the hydrogen-dispensing valve shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 20%.
- .6 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.2 When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 50% of the lower flammability limit (LFL) then

- .1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console touch screen (Control Room).
- .2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.5 seconds on and 0.5 second off.
- .3 The audible alarm, locate at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 second off.
- .4 The red alarm light on the exterior of the building shall flash at a rate of 0.5 seconds on and 0.5 second off.
- .5 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.
- .6 The control system shall fully close the master and secondary hydrogen dispensing valves.
- .7 The visual alarms shall remain on and the hydrogen-dispensing valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 50%.
- .8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.3 When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 70% of the lower flammability limit (LFL) then:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console touch screen (Control Room).

.2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.3 seconds on and 0.3 second off.

.3 The audible alarm, located at each of the light stacks shall produce a constant tone.

.4 The red alarm light on the exterior of the building shall flash at a rate of 0.3 seconds on and 0.3 second off.

.5 The audible alarm shall produce a constant tone.

.4 If the Inflation Room combustible gas detector detects a fault condition then:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console touch screen (Control Room).

.2 The yellow segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.5 seconds on and 0.5 second off.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 second off.

.4 The yellow alarm light on the exterior of the building shall flash at a rate of 0.5 seconds on and 0.5 second off.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The visual alarms shall remain on and the hydrogen-dispensing valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, gas sensor fault status is corrected.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.9 ALARM CONTROL SEQUENCE #2

.1 Hogen (generator) Room Combustible Gas Detector: When the Hogen Room combustible gas detector detects a hydrogen concentration greater than 20% of the lower flammability limit (LFL) then:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The yellow segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 2 seconds on and 1 second off.

.3 The audible alarm, locate at each of the light stacks shall produce an intermittent tone of 2 seconds on and 1 second off.

.4 The yellow alarm light on the exterior of the building shall also flash at a rate of 2 seconds on and 1 second off.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The HOGEN generator shall be powered down by the DDC.

.7 Exhaust fans EF1 and EF2 shall run with dampers at full exhaust until the LFL level falls below 20%.

.8 Heated wall vent shall be disabled until alarm clears and is acknowledged.

.9 The visual alarms shall remain on, the master/secondary hydrogen dispensing valves shall remain closed and the Hogen generator shall remain off until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 20%.

.10 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.2 When the Hogen Room combustible gas detector detects a hydrogen concentration greater than 50% of the lower flammability limit (LFL) then:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
.2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.5 seconds on and 0.5 second off.
.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 second off.
.4 The red alarm light on the exterior of the building shall flash at a rate of 0.5 seconds on and 0.5 second off.
.5 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.
.6 The control system shall fully close the master hydrogen dispensing valve (**INFLN_H2VLV1**) and the secondary hydrogen dispensing valve (**INFLN_H2VLV2**).
.7 The HOGEN generator shall be powered down by the DDC.
.8 The visual alarms shall remain on, the master/secondary hydrogen dispensing valves shall remain closed and the Hogen generator shall remain off until the alarm has been acknowledged at the operator graphics interface and the LFL level is below 50%.
.9 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.3 When the Hogen Room combustible gas detector detects a hydrogen concentration greater than 70% of the lower flammability limit (LFL) then:
.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
.2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.3 seconds on and 0.3 second off.
.3 The audible alarm, locate at each of the light stacks shall produce a constant tone.
.4 The red alarm light on the exterior of the building shall flash at a rate of 0.3 seconds on and 0.3 second off.
.5 The audible alarm on the exterior of the building shall produce a constant tone.
.6 The visual alarms shall remain on and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 70%.
.7 The audible alarm shall stop once the alarm has been acknowledged at the operator graphics interface.

.4 If the Hogen Room combustible gas detector detects a fault condition then:
.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
.2 The yellow segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash at a rate of 0.5 seconds on and 0.5 second off.
.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 second off.
.4 The yellow alarm light on the exterior of the building shall flash at a rate of 0.5 seconds on and 0.5 second off.
.5 The DDC system shall power down the Hogen unit.
.6 The control system shall fully close the master hydrogen valve (**INFLN_H2VLV1**) and the hydrogen dispensing valve (**INFLN_H2VLV2**).
.7 The visual alarms shall remain on and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the gas sensor fault status is corrected.
.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.10 ALARM CONTROL SEQUENCE #3

.1 Fire detection in Hogen Room: When the infrared (IR) flame detector (**HOGEN_FIRE**) detects a fire or smoke in the Hogen Room:

- .1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
- .2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.
- .3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.
- .4 The red alarm light on the exterior of the building shall illuminate continuously.
- .5 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.
- .6 The EMCS shall power down the Hogen unit.
- .7 If a fire is detected, an alarm shall be sent to the fire alarm panel (**FA_HOGEN**).
- .8 The control system shall fully close the master hydrogen valve (**INFLN_H2VLV1**) and the hydrogen dispensing valve (**INFLN_H2VLV2**).
- .9 The exhaust fans EF1 and EF2 shall be commanded OFF and the dampers closed.
- .10 The Hogen heaters shall be commanded OFF. The heaters to reset automatically when the alarm input is off.
- .11 The digital output from the flame detector shall be hard wired such that if a fire is detected the hydrogen valves (**INFL_H2VLV1** and **INFL_H2VLV2**) close and the Hogen unit is stopped.
- .12 The visual alarms shall remain on, the hydrogen valves shall remain closed, the Hogen unit off and exhaust fans off until the alarm has been acknowledged at the operator graphics interface, and the IR sensor no longer detects a fire or smoke.
- .13 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.11 ALARM CONTROL SEQUENCE #4

.1 Fire detection in Inflation Room: When the infrared (IR) flame detector (**INFL_FIRE**) detects a fire or smoke in the Inflation Room:

- .1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
- .2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.
- .3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.
- .4 The red alarm light on the exterior of the building shall illuminate continuously.
- .5 The audible alarm on the exterior of the building shall produce a an intermittent tone of 0.3 seconds on and 0.3 seconds off.
- .6 If fire is detected, an alarm shall be sent to the fire alarm panel (**FA_INFL**).
- .7 The control system shall fully close the master hydrogen valve (**INFLN_H2VLV1**) and the hydrogen dispensing valve (**INFLN_H2VLV2**).
- .8 The EMCS shall power down the Hogen unit.
- .9 The digital output from the flame detector shall be hard wired such that if a fire is detected the hydrogen valves (**INFL_H2VLV1** and **INFL_H2VLV2**) close and the Hogen unit stopped.
- .10 The Control Room heaters shall be commanded OFF. The heaters to reset automatically when the alarm input is off.
- .11 The visual alarms shall remain on and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the IR sensor no longer detects a fire or smoke.

.12 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.12 ALARM CONTROL SEQUENCE #5

.1 Hogen Room Temperature below 8°C: If the Hogen room temperature sensor detects a room temperature below 8°C:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The blue segments of the stack warning alarm lights (located in the Control Room and the Operations Building) and the exterior blue light shall illuminate continuously.

1.13 ALARM CONTROL SEQUENCE #6

.1 Hogen Room Ventilation Flow Restriction: If the flow station located in the ventilation duct does not detect airflow flow while the Hogen unit is in production mode:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The blue and white segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 1 second on and 1 second off.

.4 The EMCS shall power down the Hogen unit.

.5 The visual alarms shall remain on, and the Hogen unit off until the alarm has been acknowledged at the operator graphics interface, and the proper airflow is detected for a minimum test period of 2minutes.

.6 The audible alarm shall stop once the alarm has been acknowledged at the operator graphics interface.

1.14 ALARM CONTROL SEQUENCE #7

.1 Hogen Generator Fault: If a fault in the Hogen generator is detected:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The yellow and white segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.

.3 The yellow and white exterior warning alarm lights shall also illuminate continuously.

.4 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 1 second on and 1 second off.

1.15 ALARM CONTROL SEQUENCE #8

.1 Heated Wall Vent Low Temperature: If the sensor monitoring the heated wall vent temperature detects a temperature of less than 2°C:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The yellow and blue segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.

.3 The yellow and blue exterior warning alarm lights shall also illuminate continuously.

.4 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 1 second on and 1 second off.

1.16 ALARM CONTROL SEQUENCE #9

.1 Emergency Stop Button: When the emergency stop button, located in the Control Room control panel or the Operations Building or at the operator work stations (in the Operations Building and Control Room) is pressed:

- .1 The Hogen Generator shall power down (hard wired by Controls).
- .2 The master and secondary hydrogen dispensing valves (**INFLN_H2VLV1**, **INFLN_H2VLV2**) shall close (hard wired by Controls).
- .3 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
- .4 All colour segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.
- .5 All warning alarm lights on the exterior of the building shall illuminate continuously.
- .6 The audible alarm, located at each of the stack lights, shall produce a constant tone.
- .7 The audible and visual alarms shall remain on, the hydrogen valves shall remain closed, and the Hogen unit shall remain off until the stop button has been reset. If the shutdown was initiated by a push button, it shall be reset manually by twisting the emergency stop button. If the system was shutdown via the EMCS, it shall be reset at the operator work station.

1.17 ALARM CONTROL SEQUENCE #10

.1 Emergency Hydrogen Discharge: When the emergency hydrogen discharge button, located at the Operations Building is pressed:

- .1 The emergency hydrogen discharge valve (**INFLN_EMGVLV**) located at the hydrogen storage tank shall open (hard wired by Controls).
- .2 The master and secondary dispensing valves (**INFLN_H2VLV1**, **INFLN_H2VLV2**) shall close and the Hogen unit stopped (hard wired by Controls).
- .3 An alarm message shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
- .4 All colour segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall flash intermittently at a rate of 1 second on and 1 second off.
- .5 All warning alarm lights on the exterior of the building shall flash intermittently at a rate of 1 second on and 1 second off.
- .6 The audible alarm, located at each of the stack lights, shall produce an intermittent tone of 1 second on and 1 second off.
- .7 The audible and visual alarms shall remain on, the hydrogen valves shall remain closed, and the emergency discharge valve shall remain open until the discharge button has been reset manually by twisting the emergency discharge button.

1.18 ALARM CONTROL SEQUENCE #11

.1 Hydrogen Leak Detection: When the hydrogen flow switch detects a leak (flow switch senses flow when the valves **INFLN_H2VLV1** and **INFLN_H2VLV2** are commanded closed):

- .1 An alarm message shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).
- .2 The red and white color segments of the stack lights (located in the Control Room and the Operations Building) as well as the red and white exterior lights shall be illuminated continuously.
- .3 The audible alarm located at each stack light shall produce an intermittent tone of 2 seconds on and 1 second off.
- .4 The EMCS shall close the master and secondary hydrogen dispensing valves (**INFLN_H2VLV1**, **INFLN_H2VLV2**) and shall stop the Hogen unit.

.5 The visual alarms shall remain on and the hydrogen valves closed until the alarm has been acknowledged at the operator graphics interface, and there is no longer any flow detected for a minimum test period of 2minutes.

.6 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.19 ALARM CONTROL SEQUENCE #12

.1 Smoke detection in Control Room: When the smoke detector (**CTRL_SMOKE**) detects smoke in the Control Room:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.

.4 The red alarm light on the exterior of the building shall illuminate continuously.

.5 The audible alarm on the exterior of the building shall produce a an intermittent tone of 0.3 seconds on and 0.3 seconds off.

.6 The control system shall fully close the master hydrogen valve (**INFLN_H2VLV1**) and the hydrogen dispensing valve (**INFLN_H2VLV2**).

.7 The EMCS shall power down the Hogen unit.

.8 The smoke detector shall be hard wired such that if smoke is detected hydrogen valves (**INFL_H2VLV1** and **INFL_H2VLV2**) close and the Hogen unit stopped.

.9 The Control Room heaters shall be commanded OFF. The heaters to reset automatically when the alarm input is off.

.10 The visual alarms shall remain on and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the sensor no longer detects smoke.

.11 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.20 ALARM CONTROL SEQUENCE #13

.1 Smoke detection in Hogen Room: When the smoke detector detects smoke in the Hogen Room:

.1 An alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

.2 The red segments of the stack warning alarm lights (located in the Control Room and the Operations Building) shall illuminate continuously.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.

.4 The red alarm light on the exterior of the building shall illuminate continuously.

.5 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.3 seconds on and 0.3 seconds off.

.6 The EMCS shall power down the Hogen unit.

.7 The control system shall fully close the master hydrogen valve (**INFLN_H2VLV1**) and the hydrogen dispensing valve (**INFLN_H2VLV2**).

.8 The exhaust fans EF1 and EF2 shall be commanded OFF and the dampers closed.

.9 The Hogen heaters shall be commanded OFF. The heaters to reset automatically when the alarm input is off.

.10 The smoke detector shall be hard wired such that if a fire is detected the hydrogen valves (**INFL_H2VLV1** and **INFL_H2VLV2**) close and the Hogen unit is stopped.

.11 The visual alarms shall remain on, the hydrogen valves shall remain closed, the Hogen unit off and exhaust fans off until the alarm has been acknowledged at the operator graphics interface, and the IR sensor no longer detects a fire or smoke.

.12 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

1.21 FIRE ALARM OVERRIDE ALARM

.1 When the fire alarm override selector switch is in the override position after 4:00pm, an alarm warning shall be sent to the operator work stations (Operations Building and Control Room) and the control console operator touch screen (Control Room).

End of Section