PART 1 - GENERAL

The requirements of this Section apply to the Siemens Building Technology Division Building Automation System (BAS). Included are the design and provision of a direct digital control (DDC) system to provide the required sequences of operation specified for mechanical systems. Controls shall be integrated into the existing Siemens Building Technology DDC system by connecting to the nearest DDC control panel.

1.01 DESIGN CRITERIA

A. Drawings and Specifications:

1. Communication Network: Show routing and extension of existing communication network. Coordinate with electrical to provide DDC conduits.
2. Variable Frequency Drives (VFD): Variable Frequency Drives shall be provided for variable volume applications. Coordinate with electrical for location, service access, installation and connection.
3. Occupancy sensors shall be investigated for use to reduce outside air ventilation requirements during lower occupancy (with prior approval from F&I).
4. Provide control diagrams, point list and operating sequences for each system.
5. Dynamic Color Graphics shall be provided for systems at operator workstation.
6. Indicate control valves, DDC control panel, and variable frequency drives locations with service access requirements.
7. Specify Point-to-Point Test plan, Acceptance Criteria and commissioning requirements.
8. Point names shall utilize Port of Seattle conventions and be assigned at or before the 30% submittal to reference Mechanical Equipment identification numbers obtained from the Central Plant Personnel. Refer to General Provisions “Design Submittal Guidelines” and “Mechanical Equipment Identification Systems” as well as Appendix C.
9. Final As Builts of all DDC documentation shall be provided as part of O&M manuals. Final DDC programming, dynamic color graphics on operator

workstation and as-builts provided must be in agreement (point names, equipment identification etc.).

10. Field labeling of all major DDC components shall be provided. (Control Valves, DDC Panels, Network Junction boxes, VFD's, etc.) Refer as applicable to General Provisions "Mechanical Equipment Identification Systems". For DDC network wiring panels and boxes label with Building Level Network (BLN) or Field Level Network (FLN) information.

B. Design:

1. No more than two adjacent rooms, each with the same usage may be connected to the same terminal box with a common control.
2. Primary Air handling units, heat exchangers, etc. control valves and damper actuators shall be pneumatic. Terminal unit control devices, control valve and damper actuator shall be electronic. Pressure independent control valve actuators shall be furnished under this section for factory installation.
3. Provide independent DDC controller for each air-handling unit, terminal unit, chillers, boilers, main heating and cooling systems. Provide two spare points of each type (AI, AO, DI, DO) at each controller (except at terminal unit).
4. Provide flow meters for chilled water mains, steam, condensate, and hot water hydronic mains.
5. Provide tenant metering monitoring and recording as required by project, this could include domestic hot and cold water and natural gas.
6. Provide space temperature sensor for each zone (local adjustment not allowed) - mount close to the return/exhaust grille location and approximately five feet above the floor.

PART 2 – PRODUCTS

2.01 SEQUENCE OF OPERATIONS

A. Sequence of Operations shall be indicated on drawings.

B. The DDC system shall schedule each system or zone independently to support SeaTac International Airport – airlines operating schedule.

C. Operating schedules shall be defined by the Owner.

D. Sequence of operations shall be edited to suit project requirements.

E. Typical Variable Volume Terminal Box:

1. The DDC system shall schedule air handling unit warm up/cool down, occupied and unoccupied modes of operation. Return fan shall be software interlocked to run with supply fan running. Upon failure of the supply fan, associated return fan shall be disabled.
2. Upon air handling unit shutdown, the following occurs:
   a. Supply Fan/Return Fan: Disabled.
   b. Outside and Exhaust Air Damper: Closed (Spring Return Closed).
   c. Return Air Damper: Open (Spring Return Open).
   d. Cooling Coil Valve: Closed (Spring Return Closed).
   e. Heating Coil Valve: Under Control (Fail Open).
   f. Interlocked Exhaust Fans: Disabled.
3. Warm up Mode: Air handling unit shall be optimally started to establish occupied space temperature set point prior to occupancy. Economizer dampers shall remain in full re-circulation and interlocked exhaust fans shall remain off during warm up mode.
4. Occupied Mode: Occupied mode shall be based on a time-of-day schedule program. Air handing unit shall be started if not running for continuous operation during the occupied mode. Outside air damper shall be positioned to outside air ventilation requirements. Interlocked Exhaust fan shall be started for continuous operation.
5. Outdoor Air Ventilation: DDC system monitors outside air measuring unit and modulates outside air damper to maintain ventilation airflow requirements.
6. Outside Air Ventilation Reset Control Option: DDC system shall monitor space carbon dioxide (CO2) level(s) and reset outside air ventilation air cfm set point in accordance with highest zone CO2 levels as follows:

Maximum Space CO2 Level	Minimum outside air ventilation cfm
700 PPM and Below	50 percent of design minimum
1000 PPM and above	100 percent of design minimum

F. Temperature Controls:

1. Air Handling Unit: DDC system shall monitor discharge air temperature and modulate economizer dampers, heating coil valve, cooling coil valve in sequence to maintain discharge air temperature set point.
2. On call for cooling, economizer dampers shall be modulated form minimum to 100 percent outside air. On further call for cooling, cooling coil valve is modulated open. If the outside air temperature exceeds the return air temperature, dampers shall be positioned to minimum.
3. On call for heating, economizer dampers shall remain at minimum and heating coil valve is modulated open.
4. Supply Fan Volume Control: DDC system shall monitor supply air duct static pressure(s) and regulates supply fan Variable Frequency Drive (VFD) to maintain minimum supply air duct static pressure set point.
5. Return Fan Volume Control: DDC system shall monitor total supply and return air flows and regulates return fan Variable Frequency Drive (VFD) to maintain differential airflow set point. During warm-up mode, differential set point shall be zero.
6. Unoccupied Mode: Unoccupied mode shall be based on a time-of-day schedule program. Air handling unit shall be disabled and remain off during the unoccupied mode.
7. DDC system shall monitor space temperature(s) and reset discharge air temperature set point in accordance with warmest temperature zone conditions as follows:

Warmest Zone Temperature	Discharge Air Temperature Set Point
75 degrees F	55-60 degrees F
68 degrees F	80-85 degrees F

8. Safeties: Safeties device shutdown shall be hardwired and independent of DDC system controls (except for monitoring):
   a. If the coil leaving air temperature drops below 35 degrees F, the freeze protection thermostat shall shut down air handling unit.

b. If smoke is detected, Duct smoke detector(s) through fire alarm system shuts down air handling unit.
c. If the supply duct static pressure exceeds set points, the high limit differential pressure switch shall shut down the air-handling unit.
d. If the supply duct static pressure exceeds set points, the high limit differential pressure switch shall shut down the air-handling unit.

9. Typical VAV Fan Powered Terminal Unit: (These are not desired at SeaTac airport) submit request to AV/F&I for approval before designing.
   a. VAV fan powered terminal unit operating modes (warm-up, occupied and unoccupied modes) shall be similar with associated air handling unit.
   b. Warm-up Mode: Fan and temperature controls shall be activated to establish occupied space temperature set point.
   c. Occupied Mode (Series Terminal Units): Terminal Unit fan shall be activated if not running to operate continuously during the occupied mode. On call for cooling, primary air damper shall be modulated form minimum to maximum design airflow. On call for heating, heating coil valve is modulated open with primary air damper at minimum design airflow.
   d. Occupied Mode (Parallel Terminal Units): On call for cooling, primary air damper shall be modulated form minimum to maximum design airflow. On call for heating, fan shall be started and upon further call for heating, heating coil valve is modulated open. Primary air damper shall be at minimum design airflow during the heating mode.
   e. Unoccupied Mode: Terminal unit shall be disabled. DDC monitors space temperature and drop in space temperature below 55 degrees F, terminal unit controls shall be activated to operate under the heating mode. Terminal unit continues to operate until the space temperature exceeds 60 degrees F.
10. Typical Single Duct VAV Terminal Unit (VAV and CV):
    a. VAV terminal unit operating modes (warm-up, occupied and unoccupied modes) shall be similar to associated air handling unit.
    b. Warm-up Mode: Temperature controls shall be activated to establish occupied space temperature set point.
    c. Occupied Mode: On call for cooling, primary air damper shall be modulated form minimum to maximum design airflow. On call for

heating, heating coil valve is modulated open with primary air damper at minimum design airflow.

d. Unoccupied Mode: Terminal unit shall be disabled.

11. Typical Exhaust Fan (General Exhaust, Toilet Rooms):
    a. Exhaust fan operating modes (warm-up, occupied and unoccupied modes) shall be similar to associated air handling unit.
    b. Warm-up Mode: Exhaust fan remains off.
    c. Occupied Mode: Exhaust fan shall be started and runs continuously during the occupied mode.
    d. Unoccupied Mode: Exhaust fan remains off.
12. Typical Supply Fan or Exhaust Fan (Room Control): DDC system monitors space temperature and rise in space temperature to 80 degrees F, outside air damper shall be opened. Upon further rise in space temperature to 85 degrees F, fan shall be started. Fan remains operational with damper opened until the space temperature drops to 75 degrees F.
13. Typical Unit Heater: DDC system monitors space temperature, upon drop to 60 degrees F, unit heater fan is started, and heating coil valve is opened. Unit heater remains operational until the space temperature exceeds 65 degrees F.
14. Typical Fan Coil:
    a. Intermittent Operation: DDC system monitors space temperature, rise in space temperature to 85 degrees F, supply fan is started, and cooling coil valve is modulated opened. Fan Coil remains operational until the space temperature drops below 70 degrees F.
    b. Electrical Power Centers (Continuous Operation: DDC system enables supply fan for continuous operation and modulates cooling coil valve to maintain space temperature set point.
15. Typical Hydronic Pumping: DDC system will enable designated lead pump for continuous operations. Upon failure of operating pump, failed pump shall be disabled and standby pump shall be activated. DDC system shall rotate lead pump based on equal run-time calculations.
16. Typical Variable Flow Application: DDC system monitors differential pressure sensor(s) and regulates pump variable frequency drive (VFD) to maintain minimum differential pressure set point.

17. Typical Tertiary Chilled Water Pumping: DDC system monitors SCWR return water temperature and modulates pressure independent flow control valve to maintain return water temperature set point. Return water temperature set point shall be 14 to 16 degrees above summer or winter chilled water supply temperature.
18. Typical Steam to Water Heat Exchanger: DDC system monitors hot water supply temperature and modulates steam valves in 1/3 and 2/3 capacity sequence to maintain 180 degrees F hot water supply temperature set point. On call for heating, 1/3 steam capacity valve is modulated open. On further call for heating, 2/3 steam capacity valve is modulated open. Steam valves are closed (spring return closed) with heating water pump off.
19. Typical Domestic Water System: DDC system enables/disables hot water re-circulation pump per owner's operating schedule.

2.02 DDC POINT LIST

A. Point List shall be indicated on drawings.

B. Point List shall be edited to suit project requirements.

C. As a minimum, provide the following DDC points for monitoring and control. Provide additional points as required to accomplish the sequence of operation.

1. Abbreviations:

A	Indoor Air Quality Sensor
AHU	Air Handling Unit
AI	Analog Input
AO	Analog Output
AMU	Air Measurement Unit
AUX	Auxiliary Device or Contract
CR	Control Relay
CS	Current Sensing Relay
CT	Current Sensor/Transmitter
DDC	Direct Digital Control
DI	Digital Input
DPH	Differential Pressure Switch- High
DPL	Differential Pressure Switch- Low
DPT	Differential Pressure Sensor/Transmitter
DO	Digital Output

FCV	Flow Control Valve
FM	Flow Meter
FPT	Freeze Protection Thermostat
FS	Flow Switch
H	Humidity Sensor (Space)
ICV	Isolation Control Valve
LSH	Level Switch - High
LSL	Level Switch - Low
LT	Level Transmitter
MOD	Modulating Damper
NC	Normally Closed
NO	Normally Open
PSH	Pressure Switch - High
PSL	Pressure Switch - Low
PT	Pressure Sensor/Transmitter
RH	Relative Humidity Sensor/Transmitter
SD	Smoke Detector (Duct)
T	Temperature Sensor (Space)
TBV	Tower Bypass Valve
TS	Temperature Sensor (Pipe or Duct)
TCV	Temperature Control Valve
VFD	Variable Frequency Drive

2. Point List: The following points list identifies DDC System points for specific equipment identified on the drawings. Provide sensors or switch devices indicated or connect to auxiliary contacts provided by electrical or equipment manufacturer as required. Provide additional points as necessary to accomplish Sequence of Operation.

a. Typical Air Handling Unit (Variable Volume Application):

Description	Type	Devices
Supply Fan VFD Enable/Disable	DO	CR/VFD
Supply Fan VFD Speed Control	AO	VFD
Supply Fan VFD (Frequency)	AI	VFD
Supply Fan VFD (Amps)	AI	VFD
Supply Fan VFD (Status)	DI	VFD
Return Fan VFD Enable/Disable	DO	CR/VFD
Return Fan VFD Speed Control	AO	VFD
Return Fan VFD (Frequency)	AI	VFD
Return Fan VFD (Amps)	AI	VFD
Return Fan VFD (Status)	DI	VFD
Typical Supply Air Flow (cfm)	AI	AMU
Typical Return Air Flow (cfm)	AI	AMU
Outside Air Flow (cfm)	AI	AMU
Supply Air Differential Pressure	AI	DPS
Space Differential Pressure	AI	DPS
Supply Air Temperature	AI	TS
Return Air Temperature	AI	TS
Mixed Air Temperature	AI	TS
OSA/RA/EA Dampers	AO	MOD
Heating Control Valve	AO	TCV
Cooling Coil Valve	AO	TCV
Freeze Protection Thermostat	DI	AUX
Typical Smoke Detector Status	DI	AUX
Typical Filter Differential Pressure Switch	DI	DPH
Supply Duct Differential Pressure Switch	DI	DPH
Return Duct Differential Pressure Switch	DI	DPL

b. Typical VAV Unit:

Description	Type	Devices
Discharge Air Temperature	AI	TS
Primary Air Damper Control	AO	MOD
Primary Airflow	AI	DPS
Fan Control	DO	CR
*Heating Coil Valve	DO	TCV
*Cooling Coil Valve	DO	TCV
** Indoor Air Quality Sensor	AI	A

* Floating Point Control

** Provide for indoor air quality control application.

c. Typical Fan (Exhaust Fan, Supply fan):

Description	Type	Devices
Space Temperature	AI	T
Fan Start/Stop	DO	CR
Fan Status	AI	CT

d. Typical Unit Heater:

Description	Type	Devices
Space Temperature	AI	T
Fan Start/Stop	DO	CR
* Heating Coil Valve	DO	TCV

* Floating Point Control

e. Typical Fan Coil Unit: (Not Used without special permission)

Description	Type	Devices
Space Temperature	AI	T
Discharge Air Temperature	AI	TS
Fan Start/Stop	DO	CR
Cooling Coil Valve	AO	TCV
Filter Differential Pressure Switch	DI	DPH

f. Miscellaneous (HVAC):

Description	Type	Devices
Control Damper (2 position)	DO	MOD
Control Damper Position (open/close)	DI	AUX
Typical Zone Fire/Smoke Dampers Status	DI	AUX

g. Typical Hydronic Pumping:

Description	Type	Devices
Typical Pump VFD Enable/Disable	DO	VFD
Typical Pump VFD Speed Control	AO	VFD
Typical Pump VFD (Frequency)	AI	VFD
Typical Pump VFD (Amps)	AI	VFD
Typical Pump VFD (Status)	DI	VFD
Supply Flow (gpm)	AI	FM
Supply/Return Differential Pressure	AI	DPS
Isolation Control Valve (if required)	DO	ICV

h. Typical Tertiary Chilled Water Pumping:

Description	Type	Devices
SCWS Flow (gpm)	AI	FM
SCWS Temperature	AI	TS
SCWR Temperature	AI	TS
SCWS/SCWR Differential Pressure	AI	DPS
CHWR Return Water Control Valve	AO	TCV
CHWR Flow (gpm)	AI	FM
CHWS Temperature	AI	TS
CHWR Temperature	AI	TS

i. Typical Chiller:

Description	Type	Devices
Chiller Enable/Disable	DO	CR
Chiller Alarm	DI	AUX
Chiller Temperature Reset	AO	AUX
Evaporator Flow (gpm)	AI	FM
Condenser Flow (gpm)	AI	FM
Chilled Water Supply Temperature	AI	TS
Chilled Water Return Temperature	AI	TS
Condenser Water Supply Temperature	AI	TS
Condenser Water Return Temperature	AI	TS
Evaporator Isolation Control Valve	DO	ICV
Evaporator Isolation Control Valve	DO	ICV

j. Typical Cooling Tower:

Description	Type	Devices
Condenser Water Supply Flow	AI	FM
Condenser Water Return Flow	AI	FM
Condenser Water Supply Temperature	AI	TS
Condenser Water Return Temperature	AI	TS
Tower Flow Control Valve	AO	FCV
Tower Bypass Valve	AO	TBV
Tower Fan VFD Enable/Disable	DO	VFD
Tower Fan Speed Control	AO	VFD
Tower Fan VFD (Frequency)	AI	VFD
Tower Fan VFD (Amps)	AI	VFD
Tower Fan VFD (Status)	DI	VFD
Sump Level	AI	LS
Sump Level Control (make-up water)	DO	Solenoid
Filtration System Enable/Disable	DO	CR

k. Typical Cold Storage:

Description	Type	Devices
Cold Storage Enable/Disable	DO	CR
Cold Storage System Alarm	DI	AUX
Cold Storage Temperature Reset	AO	AUX
Evaporator Flow (gpm)	AI	FM
Cold Storage Water Supply Temperature	AI	TS
Cold Storage Water Return Temperature	AI	TS
Cold Storage Isolation Control Valve	DO	ICV

l. Typical Steam to Water Heat Exchanger:

Description	Type	Devices
Steam Control Valve (1/3 Capacity)	AO	TCV
Steam Control Valve (2/3 Capacity)	AO	TCV
Heating Water Supply Temperature	AI	TS
Heating Water Return Temperature	AI	TS

m. Typical Condensate Pumping:

Description	Type	Devices
Enable/Disable (fail enabled)	DO	CR
Typical Condensate Pump Run Status	AI	CT
Condensate Flow	AI	FM
Receiver High Level	DI	LS

n. Miscellaneous (Main Steam and Condensate):

Description	Type	Devices
Steam Pressure (HPS)	AI	PT
Steam Pressure (MPS)	AI	PT
Steam Pressure (LPS)	AI	PT
Main Branch Steam Flow (lbs/hr)	AI	FM

2.03 MANUFACTURER

Direct Digital Control Technology with components as manufactured by and installed by local office of Siemens, Building Technologies Division.

2.04 BASIC DDC SYSTEM

The Direct Digital Control (DDC) System shall be fully integrated and installed as a complete package of controls and instrumentation. The system shall include, but not limited to, all computer software and hardware, operator input/output devices, sensors and controls required for complete operation. All wiring, installation, supervision and labor, including calibration, checkout, commissioning, adjustments, and operator training necessary shall be provided for a complete and fully operating system. This system is currently installed and operating at SeaTac International Airport and any new or renovated spaces that are within the "campus" perimeter shall be integrated into the system using Siemens DDC components and programming.

2.05 DDC PANELS AND CONTROLLERS

Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Modular in design and consisting of processor board with programmable RAM memory, power supplies, and input/output modules.

2.06 DDC PANEL AND CONTROLLER SOFTWARE

All necessary software to form a complete operating system shall be provided. The software programs shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

2.07 VARIABLE FREQUENCY DRIVES

Manufacturers: See 238107

2.08 FLOW METERS

A. Manufacturers: Spirax-Sarco, Hyspan, Rosemount.

B. Water: Electromagnetic flow meter, (example) Spirax-Sarco EMCO Model 3100 sensor with either remote or unit mounted signal converter.

C. Steam: Insertion Turbine type, (example) Spirax-Sarco EMCO Model TMP600 with G2 rotor.

D. Condensate: Electromagnetic flow meter, (example) Spirax-Sarco EMCO Model 1100 sensor with either remote signal converter.

2.09 AIR MEASURING UNITS

A. Manufacturers: Ebtron, Air Monitor or equal.

B. Ebtron GT116 Series or Air Monitor "VOLU-probe VS" air measuring units.

2.10 CONTROL DAMPERS

A. Manufacturers: Ruskin, American Warming, T.A. Morrison.

B. AMCA Certified, low leakage, airfoil blades, concealed linkages with blade and jamb seals. Leakage shall be less than 5.2 cfm at 4.0 w.g. pressure difference (based on 48"x48" damper).

2.11 SYSTEM DEFINITION

The Building Automation System (BAS) operates through one standalone backbone (Appendix C typical, but not complete) separate from any other Port of Seattle communication system. The BAS controls and operates HVAC functions within the airport using Direct Digital Control (DDC).

A. DDC is defined as the control of heating, ventilation, and air conditioning controls within the airport. Within these systems is the infrastructure of main

support equipment necessary to facilitate operations of thermal comfort. Basically, the infrastructure includes chiller operations, boiler operations, pumping stations, and their ancillary operating equipment. The response team associated with this equipment is under the operating engineers.

PART 3 - EXECUTION

3.01 ROLES AND RESPONSIBILITIES

A. Operating Engineers: Operating Engineers are responsible for the operation of the central plant operations and upkeep of HVAC systems throughout the airport under the guidance of the Facilities and Infrastructure (AV/F&I) group. Operators responsible for the Building Automation system shall be trained in the operation of the front end, trending to identify performance of the system, commands for overriding system functions to meet current specific needs of the customers. The operators shall be trained in the diagnostics associated with all HVAC operation including system failure resolution and system component replacement.

B. System Administrator: The system administrator for system security, operation of backbone maintenance will be by manufacturer's representative. System administrator is responsible for point naming architecture, system conformance, and working with the SeaTac construction representatives and outside consultants with the Port of Seattle in proper layout of system additions and deletions.

3.02 USER ACCOUNTS / ACCESS PRIVILEGES

A. Access Levels: Access levels are the rights that users are granted to access groups, Insight applications, and field panel functions. Access levels are slightly different between Insight and BLN accounts.

B. Insight accounts have the following four access levels:
   1. No Access.
   2. Read Only.
   3. Command.
   4. Configure/Edit.

C. Building Level Network (BLN) accounts which include the Modular Building Controllers have the following four access levels:
   1. No Access.
   2. Read Only.
   3. Command.
   4. Edit.

D. A system administrator will assign the appropriate levels based on the input from the Owner (AV/F&I). The tables below explain Insight and BLN access levels and what each access level means when assigned to an access group, Insight application, or field panel function.

Insight Accounts Access Level	**Access Groups**	**Insight Applications**
No Access	Users cannot see the objects in the access group	Users cannot see the application
Read Only	Users can only view the objects in the access group	Users can only view the value or status of objects
Command	Users can command the value or status of objects, as well as view them	Users can command the value or status of objects, as well as view them
Configure/Edit	Users can configure objects, as well as command and view them	Users can add and delete objects, as well as command and view them

BLN Accounts Access Level	**Access Groups**	**Field Panel Functions**
No Access	Users cannot see the objects in the access group	Users cannot see the function
Read Only	N/A	Users can only view the value or status of objects
Command	N/A	Users can command the value or status of objects, as well as view them
Configure/Edit	Users can configure objects, as well as command and view them	Users can add and delete objects, as well as command and view them

Examples:

User A				
HVAC Operators	Read Only	Access Group 1	_____	Point 1
				Point 2
				Etc.
	Command	Access Group 2	_____	Point 3
				Point 4
				Etc.

(NOTE: The APOGEE Siemens DDC System is in the process of replacement by the DESIGO Siemens DDC System which will differ in some respects from some of the nomenclature above.)

END OF SECTION