DESIGN STANDARDS

for

GOVERNMENT FACILITIES

PROPERTY
MANAGEMENT AGENCY

Government of Yukon

G. GENERAL DESIGN OBJECTIVES

The primary objective of the Yukon Government is to produce buildings that satisfy the **functional needs** of the client department and users for the minimum **capital cost** consistent with lowest **life cycle costs**. Considerations must be given to **energy efficiency, occupant health and comfort, environmental impact, and reliability**, **durability, and local materials and workforce**. The design is to express a modest, simple, respectable statue of publicly funded facilities..

G.1 FUNCTIONAL NEEDS

Client departments, building advisory committees, and people who will use and access the facility must be involved in providing information for functional planning of the facility. Public funding dictates prudent design of buildings on program requirements, space needs analyses and client justification that avoids wasted space.

SIMPLICITY AND EFFICIENCY

In terms of concepts all building design should strive to:

- produce the minimum gross area necessary to accommodate the stated program
- minimize the enclosed volume and building perimeter required to accommodate the program
- enable renovation or expansion as simply as possible with minimal cost and without major disruption to building.

In terms of detailed development, the building design should:

- be kept simple to improve the ease and speed of erection in a limited construction season and to offer greater opportunity for employment of local skills
- incorporate materials and methods which will permit quality construction under adverse environmental conditions in a limited construction season
- ensure O&M manuals and procedures contain all required information and can be easily understood, and adequate training is provided for maintenance personnel.

G.2 LIFE CYCLE COSTS

"An economic assessment of competing design alternatives, considering all significant costs of ownership over the economic life of a building" *Hanscomb*

Wherever alternative designs are considered, the alternative representing the lowest life cycle cost is to be selected. Wherever alternatives are shown, the alternative with the lowest capital cost is to be selected. For comparative purposes a 20-year design life is to be used. In some circumstances other considerations may overrule: where direct benefits to the community will be realized (i.e. incorporating locally available materials); or where a product preference is stated in these standards.

G.3 ENERGY EFFICIENCY

Minimizing the energy consumption of public buildings is of critical importance in the Yukon where energy costs are extremely high. Energy efficiency means that buildings should consume a minimum amount of energy for heating, cooling and electrical loads, and that construction and finishing materials have low embodied energy.

Energy efficiency does not mean sacrificing the comfort level of occupants.

*see G6 Codes and Regulations for comments on the upcoming National Energy Code

Recommendations for energy efficiency have been integrated in the applicable sections of the Standards and Guidelines. (i.e.: heating and ventilation, lighting, building envelope…)

G.4 RELIABILITY AND DURABILITY

All building systems must be rugged enough to withstand the climate conditions (including weather, people vehicles…) to which they are exposed without the need for frequent or specialized repairs or maintenance. All systems must be reliable in the winter conditions of the Yukon. Standby and backup equipment and installations that facilitate quick repairs are an essential characteristic of our building systems. Mechanical systems especially should be simple, reliable, and require minimum maintenance.

G.5 OCCUPANT HEALTH AND COMFORT

Many materials used to construct, finish and furnish offices continue to release contaminants into the building air long after construction is complete. The most common air contaminants are urea formaldehyde and volatile organic compounds; these are found in some particleboard, carpets, fabric, paints, and adhesives. These contaminants, along with poorly designed heating and ventilation systems can combine to create numerous problems. All equipment, systems and material must be reviewed in the design process for their long-term effect on occupant health and comfort.

G.6 ENVIRONMENTAL IMPACT

Commercial construction and operation can have many negative impacts on the natural environment: ozone depletion due to the use of CFCs and HCFCs: depletion of virgin and non-renewable resources: air, water, and soil pollution from the manufacture of construction materials: and waste disposal problems at landfill sites. Many negative impacts can be avoided or minimized through careful specification of building materials and environmentally appropriate building design. The use of recycled and reused materials; the avoidance of products from unique or non-renewable sources; the elimination of materials that involve toxic manufacturing and pollution; and sending minimal waste to the landfill are all objectives that must be addressed.

G.7 OTHER DESIGN CONSIDERATIONS

7.1 LOCAL RESOURCES

Design and Construction projects provide important opportunities for communities to become involved in their own development.

7.2 LABOUR

To facilitate maximum local involvement, materials and methods used in the construction of Yukon buildings should be suitable for broad application. This will develop skills and identify training to be undertaken which could be applied to future projects. Specialized products, systems and/or installations should be carefully considered.

7.3 EQUIPMENT

The use of local equipment can benefit the community, and minimize construction costs. Building design and construction methods should attempt to take advantage of these opportunities.

7.4 SUPPLIERS & MANUFACTURERS

Specifications should not unduly restrict local suppliers, and consideration should be given to incorporating any locally available products in new buildings.

7.5 OPERATION AND MAINTENANCE

Building maintenance is generally the responsibility of the Facilities Management section of Property Management Agency. However, proper design has to consider the maintenance and operational costs of the facility. Project Managers must ensure that Facilities Management is involved **early** in the process to review the design and submit comments.

7.6 STANDARDIZATION

Standardization should always be an objective of design, in an effort to simplify construction and maintenance of buildings. It is especially critical with additions and renovations of buildings to ensure continuity of building design, systems and equipment.

7.7 ARCHITECTURAL STYLE

New buildings should fit into the site unobtrusively, with the massing and finishes related to the context of the community. Although this can be a justifiable design approach, it is nearly impossible to achieve in all situations. It should be recognized then, that other approaches are also valid, as long as the design successfully addresses the following:

- Building orientation is critical (Solar loads, wind patterns, micro-climate etc.)
- the design must communicate the function of the building
- colours, materials, and forms are selected to support and enhance other design decisions
- massing is consistent with function, context, and climate conditions.
- whether it blends in, contrasts with or dominates a site, the relationship of the building to the site should be consistent with its function and local requirements
- whether it is private, public, friendly or decorous, the relationship of the building to the street should be consistent with the function and local requirements
- whether they contrast with or are similar to adjacent buildings the relationship between buildings should be clear and consistent with the building and it's functions. Presentation of the "building" to be appropriate in the communities eyes.

Finally, the design of Yukon buildings must be stylistically appropriate, and incorporate the objectives of these standards.

7.8 OTHER RELATED DOCUMENTS

During the design phase of any project several documents are usually produced, each with a specific objective - the distinctions between them however can be confusing. These "Design Standards" (DS) are meant to document "performance criteria, preferred materials or methods, and logistical considerations" (as noted in the foreword to this document). They should not be confused with other related documents such as functional programs, specifications or design documents. The following are provided as <u>examples</u> of the distinctions that can be made between the documents:

<u>Document</u>	<u>Example of Contents</u>
Functional Program	a coffee maker and small appliances such as a toaster and microwave oven will be used
Submission Requirements	provide consumption estimates for heating and electricity
DS	energy consumption targets
Specifications	flooring to be 4.5 mm thick Mondoflex by Mondo Rubber
DS	sports flooring may be either PVC, rubber or wood (sprung)

The interrelationship of all of these design considerations is as important to understand as the distinction between them: complete functional/program information is required before the correct technical requirement is applied, right material specified, adequate documentation submitted, and installation completed satisfactorily.

G8 CODES AND REGULATIONS

8.1 NATIONAL BUILDING CODE OF CANADA

The l995 version of the National Building Code of Canada has been adopted without change in the Yukon. The Authority having jurisdiction is the Community and Transportation Services, Public Safety Section of Yukon Government. Public safety has offices Dawson City, Watson Lake and Whitehorse. The City of Whitehorse, Building Inspections Department, has authority within Whitehorse city limits.

The National Energy Code

The 1996 National Energy Code is expected to be issued later in 1996. It is anticipated that that code will not be adopted by the Yukon. The Energy Code will include both prescriptive and performance requirements. Upon publication of the Energy Code, authorized software, including a construction and energy cost data base, will be made available to allow an evaluation of the performance of proposed designs. Designers and project managers are therefore encouraged to become familiar with the Energy Code, as it will be referenced in these Standards.

8.2 MUNICIPAL BYLAWS

8.2.1 Municipal Bylaws and Ordinances

All municipal bylaws and ordinances must be observed in the design and construction of facilities for the Yukon.

8.2.2 Municipal Bylaws

The Yukon Government administers municipal bylaws for all Communities except Whitehorse and Dawson City.

8.2.3 Draft Rules

The Yukon Government has initiated some DRAFT rules on how to deal with hazardous chemicals, storage tanks (new and old), and contaminated sites. (June 96)

8.3 DESIGN PROFESSIONALS

Engineering

The Association of Professional Engineers, regulates the practice of Engineering in the Yukon Territory, under the authority of the Engineering Professions Act - Yukon registration is required.

Architecture

The practice of Architecture in the Yukon is currently unregulated. Registration in a recognized provincial association may be requested for specific projects.

8.4 SI METRIC REQUIREMENTS

All new construction for the Yukon must be designed and dimensioned in SI metric units: the actual materials may be designated in metric or imperial, and soft conversion to metric is acceptable.

** Note that this requirement may be relaxed when these standards are applied to renovation projects and where the original documents are in imperial measures: either metric or imperial may be used in this case. See notes re: “Application of Standards” in foreword to this document.*

Soft conversion

Physical dimensions remain unchanged. Products are converted to the nearest metric unit.
i.e. a 3'-0" wide window (nominal) becomes a 900mm wide window (actual size).

Hard Conversion

Physical dimensions are changed and products converted to metric. i.e. a 3'-0"wide window (nominal) is changed slightly in size to become 914mm wide window (actual size).

L. SITEWORK DESIGN STANDARDS

Sitework includes all work required to:

- prepare site for building foundations
- grade site to promote drainage away from the foundation and direct spring run-off to a suitable drainage course
- provide access to the site and building for staff, visitors, service and emergency vehicles and (pedestrian and vehicular traffic) “Barrier Free Considerations”
- create outdoor activity areas such as playgrounds
- create suitable settings for buildings through landscaping
- provide services such as: water, sewer, septic, power, communications, T.V., storm sewers (above or below ground)
- accommodate snow removal
- allow for future expansion of facilities

L1 CODES AND REGULATIONS

Water and sewer; storm see section M1.1
Garbage removal: refer to local municipality
Parking: refer to local municipality
Fuel delivery: refer to local distributor
Power: see section E 1.1
Telephone: see section E 1.1
T.V.

L2 GENERAL DESIGN CONSIDERATIONS

<u>Schedule</u>
On some projects there is a very limited period of time when site work can be done. Buildings are often completed before the sitework can be finished, meaning that interim or temporary installations must be put in place until the next construction season. Project schedules must include adequate time to perform all sitework.

<u>Local Equipment</u>
Sitework should be designed to ensure work can be completed using existing local equipment and operators where possible. Local equipment for hauling, spreading and compacting fill is often limited, it is important that this be taken into consideration during design so that the desired results are possible to achieve. It is generally desirable to ensure that local contractors using local materials, not only to benefit the local economy, but to minimize costs as well can complete fill and grading work.

<u>Snow Clearing</u>
The presence of snow and the need to clear portions of a site are normal conditions in all Yukon communities. Any aspect of a site, which does not function well when covered in snow, does not function well most of the time.

<u>Spring run-off</u>
In most Yukon communities the spring melt occurs suddenly so that the winter's accumulation of snow and ice is quickly transformed into considerable amounts of water. Quick freeze thaws (often 3 or 4 in a few days) reek havoc on roofs, roads, drainage systems and ground surfaces or in some instances sheets of ice. It is not uncommon to see ice creeping near a downspout or scupper - and actually crawl down the siding of the building to the ground (20' or more), as the ice thaws and freezes. This water must be directed away from the building and into acceptable drainage courses to avoid damage or flooding.

A. ARCHITECTURAL DESIGN STANDARDS

A1 CODES AND REGULATIONS

See G6 Codes and Regulations

Documents, other than noted in G 6, referenced in this section include:

AWMAC Standards

A2 BUILDING ENVELOPE

The outer shell of a building separates occupants from the outdoor climate. In the Yukon temperature range, on average, from -45° C in the winter to +30° C in the summer, with recorded hourly wind pressures ranging from 0.32 to 1.59 kPa. Although most of the Yukon is located above the 60th parallel, there are some dramatic climatic variations within the Yukon, which must be recognized in design and construction. In particular a distinction is usually made between areas above and below the treeline where typical snow drifting patterns; wind and seasonal temperatures differ significantly. Temperatures can fluctuate from -20°c to above zero in a matter of a few hours, anywhere in the Yukon, expanding and contracting materials, fasteners, and sealants.

Careful detailing is required to ensure airtight, energy efficient building assemblies. Minimum acceptable values noted in these standards, must be met unless it can be shown that reduced values will provide savings over the life cycle of the building. The requirements in this section are given in addition to, or as a clarification of NBC and the National Energy Code, latest addition.

2.1 AIR MOVEMENT, WATER AND VAPOUR PROTECTION

More than a layman's understanding of air and vapour barriers is required of designers, and constructors of Yukon buildings. The requirements of the National Building Code are not always clear, or sufficiently defined, and further reading or study is suggested. A suggested reading list is included in Appendix D.

Requirements	Rationale
2.1.1 Control of Rain and Snow Penetration In addition to the requirements of NBC, entry of snow into the assembly must be frustrated by means of snow screens (building paper, filters, or baffles).	*In the Yukon wind driven snow can be of equal, if not greater, concern than rain.*
In applying the requirements of NBC, it should be assumed there is always a likelihood of some penetration of exterior cladding by rain or snow. Therefore drainage or venting to allow vapour or water to escape to the outside must be provided.	*The provision of drainage is considered a precautionary measure that can be provided in conjunction with the requirements of NBC. In addition to drainage of rainwater or melted water sublimation of snow to vapour may also be expected*
2.1.2 Control of Ground water See notes concerning site drainage around granular foundation pads in L 4.2 Site Grading.	*NBC requirement does not recognize open crawlspaces or consider the effect of extreme spring run-off conditions common in the Yukon.*
Any drainage connection or opening must not violate the integrity of the ground cover in an enclosed crawlspace.	*The ground cover serves a dual two-way function, both as an air leakage barrier and as a water/vapour barrier. See crawlspaces in A2.3.5*

2.1.3 Control of Condensation within the Envelope Assembly

All building envelopes must be designed to provide:

Clarification of NBC requirements for controlling vapour diffusion and air leakage. These requirements state that condensation must be prevented from building up in the assembly where it will damage materials. However, it is clear, when read in conjunction with other articles, that the intent is not to prevent water vapour from entering the assembly, but to:

a) one vapour diffusion barrier (vapour barrier) conforming to CGSB 51.33M or 51.34M and is a minimum 0.15mm (6 mil) thick. Vapour diffusion barriers are to be overlapped and sealed with sealant (see 2.1.6 (4)). Perimeter joints, cracks and around open rings is to be sealed. CSA approved foam gaskets or equivalent to be used on all exterior wall electric outlets.

· minimize the passage of vapour into the assembly through diffusion or air leakage

b) one air leakage barrier (air barrier) conforming to A2.1.4 of this document.

c) a means of venting the assembly to the outside

· Ensure any vapour that does pass through the vapour barrier is not trapped in the assembly. Vapour that migrates to the exterior may build up as frost over the winter months, then drain or evaporate during the summer when it melts

d) a means of draining to the outside any condensation that may enter the assembly

2.1.4 Air leakage rates

The maximum acceptable air leakage rate per unit area of air barrier system is:

The NBC requires all buildings to meet acceptable air leakage rates. The IRC (Institute for Research in Canada, a part of the National Research Council of Canada) has suggested these air leakage rates. Theoretically, this amount of air leakage will not introduce more vapour into an envelope assembly than can be "managed" on an annual cycle. (see 2.1.3)

a) 0.1 l/sec/m2 @ 75 Pa for all buildings with a normal indoor relative humidity between 27-55%.

This will typically apply to schools, community halls, health centres, libraries or offices.

b) 0.05 1 l/sec/m2 @ 75 Pa for all buildings with a normal indoor relative humidity above 55%.

This will typically apply to residential occupancies including group homes, student residences or long term care facilities.

2.1.5 Rainscreen Principle

Building envelopes are to be designed in accordance with the 'rainscreen principle' (pressure equalization theory):

A minimum 19 mm air space to be provided between the insulation and the exterior cladding

Divide all cavities behind the exterior cladding into compartments (zones of equal pressure) no more than one storey in height, and at 6 m intervals along the facade except at corners where compartments should be no more than 2.4 metres wide

Providing appropriate compartmentation, which nevertheless must incorporate openings to provide the drainage required by NBC, can considerably reduce air movement behind the exterior cladding.

2.1.6 Materials and Assembly

1) <u>Vapour Diffusion Barriers</u> Materials, or the assembly of materials making up the vapour diffusion barrier (vapour barrier) must be:	*See A 2.1.3 "Control of Condensation within the Envelope Assembly"*
a) **durable**	*to last the life of the building*
b) **impermeable**	*to meet the requirements of the NBC and reference standard CAN/CGSB 51.33 or 51.34*
c) **continuous** pay special attention to joints, corners and penetrations	*to ensure the integrity of the building envelope*
d) **compatible** with other building components	*differences in creep behaviour, elastic movement, thermal expansion, shrinkage, moisture changes etc. could result in the loss of continuity, impermeability or durability of vapour barrier*
e) **location with assembly**	*Towards the warm side of the 1/3 – 2/3 insulation rule of thumb.*
The building envelope must be designed so that multiple vapour barriers are avoided: any material with a low permeance rating which is located on the low pressure side of the insulation cavity, must be installed in such a way that vapour can migrate to the exterior.	*To meet requirements described in A2.1.3 above. Materials with low vapour permeance, such as plywood sheathing, can act as a barrier to vapour that has passed into the assembly. The vapour must be allowed to migrate to the exterior by open joints between sheets, or by perforating the material.*
2) <u>Air leakage barriers</u> Materials, or the assembly of materials making up the air leakage barrier must be:	*Clarification of NBC*
a) **durable**	*To last the life of the building*
b) **impermeable**	*To minimize the movement of air (infiltration or exfiltration) so as to minimize heat loss and vapour migration into the building envelope assembly.*
Acceptable leakage rates for the complete air barrier system are noted in A 2.1.4. and the air leakage rates of some common building materials and assemblies can be found in Appendix D.	
Materials employed in the construction of air leakage barrier must have air permeance values no more than 1/10th of the air leakage rate allowable for the complete air barrier system.	*Measuring the performance of the building envelope is problematic. However the materials themselves can be easily tested: these values have been suggested by the NRC in the expectation that once installed, the air leakage rate of the entire air barrier system will be below values noted in A 2.1.4 (taking materials, joints, and penetrations into consideration).*

c) **continuous**
pay special attention to joints, corners and penetrations

To ensure the integrity of the building envelope

d) **rigid and strong**
to withstand both positive and negative air pressures, including wind in accordance with NBC 4.1.8, and designed to transfer such pressures to the structural framing while undergoing minimal deflection.

If not rigid and strong the material would be easily displaced by the air pressures acting on it - the movement can then cause the material to tear at attachment points, or the joints to fail. The structural performance of many common materials and assemblies can be found in "Structural Requirements for Air Barriers" CMHC report No. 30133.OR1.

e) **compatible**
with other building components

see Appendix D for listing of the air leakage rates of common building materials

Differences in creep behaviour, elastic movement, thermal expansion, shrinkage, moisture changes etc. could result in the loss of continuity, impermeability or durability of the air leakage barrier

3) <u>Location of Air Leakage and Vapour diffusion barriers</u>

a) Coincident air/vapour barriers located on the outside of structural framing are preferred. In such designs the vapour barrier material may be applied to the outside of the air leakage barrier.

By locating the AV barrier (and thus the insulation) on the exterior of structural framing, rather than on the interior the following can be achieved:
· the potential for structural damage due to condensation is virtually eliminated
· interior finishes can be applied directly to structural framing (no need for additional strapping to protect AV barrier)
penetration of AV barrier by mechanical and electrical systems is reduced to those elements that must exit the building
· with fewer penetrations and use of rigid air leakage barrier materials, a good quality installation is simpler to achieve

b) Coincident air/vapour barriers located on the inside of structural framing are acceptable, except as noted in A 2.6.3. In such designs, vapour barrier material must be applied to the warm (in) side of the air leakage barrier.

Common practice. Although this assembly meets the NBC requirements for vapour protection, it requires that a number of precautions be taken including:
· plumbing and electrical wiring routes in exterior floors, walls and roofs must be carefully detailed to minimize AV barrier penetrations
· interior strapping or other means of attaching finish materials is provided to accommodate electrical wiring and outlets without the need for air/vapour barrier penetration

4) <u>Sealants</u>
Sealants used as part of the air leakage barrier system of the exterior wall assembly must be:
- serviceable to -40C in their fully cured state.
- possible to apply under conditions to be encountered during application

Silicone or one component elastomeric type that meets the above criteria is acceptable. Acrylic and solvent curing types are not acceptable. Acoustical sealant is acceptable for sealing the vapour diffusion barrier.

The performance of sealants is dependent on choosing the correct sealant for the substrate as well as application under acceptable conditions and service conditions.

Construction typically occurs during cool or cold temperatures in the Yukon. Silicone and elastomeric sealants are available that can be applied at sub-zero temperatures and remain serviceable at temperatures down to -40□; most *other sealants cannot be property applied at sub-zero temperatures and lose their ability to fulfil functional requirements at cold temperatures.*

2.2 THERMAL RESISTANCE

The thermal resistance of the building envelope serves two important functions: to minimize energy consumption through heat loss; and to prevent moisture condensation on the interior skin of the building envelope. The National Energy Code latest edition sets maximum allowable overall heat transmittance of buildings for different regions of the country. The Code identifies zones within the Yukon and provides data on the performance of common building assemblies in an appendix. Computer software is available to complete cost/benefit analysis using costs applicable to each identified zone. Alternatively "prescriptive" alternatives and "trade offs" can be used to meet Energy Code requirements. Energy modelling is common to our building phases.

Requirement	Rationale
2.2.1 Minimum Values The RSI value of exterior assemblies is: Floors: RSI 7.0 Walls: RSI 4.9 Roofs: RSI 7.0 In buildings or portions of buildings not interiored for typical comfort conditions, thermal resistance values may be lower. Refer to project briefs.	*An acceptable overall level of thermal resistance is to be achieved regardless of the type and placement of the insulation in the assembly.* *For unheated buildings or minimally heated buildings, such as ice arenas and parking garages, insulation requirements may be non-existent or governed by non-thermal considerations.*
2.2.2 Location of Insulation All insulation is to be located on the cold side of the vapour diffusion barrier. In accordance with A2.1.6(3) then:	
a) where the air vapour barrier is located on the exterior side of the structural framing rigid foamed plastic insulation must be used. The type must be suited to moisture and UV conditions anticipated. (See 2.1.6)	*Insulation applied to the exterior of the building structure provides a uniform insulating value over the entire building envelope area and eliminates thermal bridging.*
b) where the AV barrier is located on the interior of structural framing, glass fibre batt insulation may be used in the structural framing space. (A layer of insulated sheathing should be used in addition to the insulated structural cavities see A2.2.3.).	*Glass fibre batt insulation is less expensive than rigid foamed plastics. However the overall thermal resistance of the assembly is reduced by the structural members, and should be minimized by using insulating sheathing. It is also difficult to provide a uniform level of insulation at the junctions of the floor and wall, and wall and roof as it is difficult to create structural cavities at these points: the insulating sheathing is often the only means of insulation such junctions.*

2.2.3 Continuity of Insulation

Thermal bridging must be recognised and minimized in the building envelope design.

a) where insulation is installed outside the structural framing it must be installed in 2 layers at right angles; 2 layers of girts or strapping installed at right angles or with the outer layer of girts screw fastened through the lower layer of insulation into structural framing

to reduce thermal bridging through girths or strapping

b) Where insulation is installed within structural framing, a layer of insulating sheathing is to be provided on the exterior of the framing or exterior structural sheathing

to reduce thermal bridging through structural members (this is common practice in the Yukon).

2.3 BUILDING ENVELOPE – FLOORS

Requirement	Rationale
As some of Yukon buildings are elevated, floors assemblies may have an exterior surface. In locations where a typical basement or slab foundation is possible the National Building Code requirements suffice. Insulation requirements under slabs on grade will often be dictated by consideration of permafrost preservation.	

2.3.1 Air Movement, Water and Vapour Protection

All requirements of section A 2.1 apply to building envelope floors.

Clarifies criteria to be used in evaluating floor assemblies with respect to NBC requirements

Building envelope floors subject to differentials in temperature, water vapour pressure or air pressure require air leakage barriers and vapour diffusion barriers meeting the requirements outlined in sections A 2.1.3 and 2.1.4.

Floors over unheated crawlspaces are in all areas of the Yukon. Such conditions present potential opportunities for air leakage, snow infiltration and vapour diffusion not normally associated with floors

2.3.2 Thermal Resistance

see A2.2.1

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2.3.3 Materials and Assembly

(1) Air/Vapour Barrier – see A2.1.6

A false floor should be considered wherever insulation is located within the structural framing of the floor and the comfort of users is a consideration, or where required to accommodate plumbing.

This assembly can result in a cold floor, due to thermal bridging through the floor joists, a false floor is suggested for residential and institutional facilities such as group homes, and elementary schools. Offices or assembly spaces would not normally require a false floor for reasons of comfort. Warm air "movement" within this space is essential to keep service piping and the floor itself from getting cold.

(2) Sealants - see A2.1.6(4)

(3) Insulation see A2.2.2 and A2.2.3

(4) Ventilation and Drainage
Please note the requirements of A 2.1.1 and A2.1.3. A weather barrier and battens covering the spaced joints of exposed floor soffits can achieve both.

Materials considered to satisfy these requirements include sheet materials of plywood, exterior grade particle and oriented strand board suitably battened at the joints, and corrosion protected ribbed sheet metal with lapped mechanically fastened joints.

b) Do not use pressure treated materials for floor soffits unless continually high moisture levels are anticipated.

The dry climate of the Yukon generally makes the use of pressure treated materials unnecessary - the extra cost is not warranted.

2.3.4 Thermal Break

A thermal break must be provided between the heated building and foundations. See Section S3.

To minimize heat loss from building to frozen soils, and to prevent cold spots due to thermal bridging in the building envelop.

2.3.5 Basements and Crawlspaces

(1) Unheated crawlspaces
Substantial wire mesh must be used to screen off open crawlspaces below buildings.

To discourage uncontrolled access by animals and people, while allowing ventilation to prevent degradation of frozen soils by heat loss from building.

(2) Heated or semi-heated crawlspaces
Any enclosed crawlspace must be treated as a separately enveloped space; that is perimeter walls, floor and ceiling assemblies (i.e. floor assembly above) must fulfil the functions of the air/vapour barrier and conform to all requirements section A 2.1 of this document

The temperature of a heated or semi-heated crawlspace is often kept in a much lower range than that of the building above in order to minimize energy consumption as well as heat loss to frozen ground. Such difference in environmental conditions of the crawlspace could result in air/vapour leakage or condensation and therefore requires its appropriate separation from the remainder of the building.

(3) Drainage of Crawlspaces
A graded slope of 2% (minimum) to sump points is required of all crawlspace floors. Any drainage connection or opening must not violate the integrity of the ground cover in a crawlspace.

Exceeds NBC to ensure that the possibility of water accumulating is always considered and a means of drainage ensured. This is to recognize spring run-off.

(4) Utilidettes
For those portions of a building where services are consolidated in the floor system because of occupancy or program requirements, provide a heated suspended utility space.

To consolidate building services and to encourage the minimization of suspended utility space, by providing only partial suspended utility space and to provide service access to utilidettes below building.

Such buildings would include schools, group homes, health centres, and smaller buildings with extensive drainage requirements.

2.4 BUILDING ENVELOPE - WALLS

Walls typically make up the greatest exterior surface of a building. They are also typically interrupted by a large number of openings and penetrations in the form of doors, windows, mechanical chimneys and hoods, and electrical services. Particular attention must be paid to the design of the air barrier system in wall assemblies to ensure its continuity at all openings, penetrations, and junctions with the floor and roof assemblies.

Requirement	Rationale
2.4.1 Air Movement, Water and Vapour Protection	
All requirements of A 2.1 with the exception of A2.1.2 apply to building envelope wall assemblies.	*Clarifies criteria to be used in evaluating wall assemblies with respect to NBC requirements.*
All walls subject to differentials in temperature, water vapour pressure or air pressure require air leakage barriers and vapour diffusion barriers meeting all requirements outlined in Section A 2.1.3 and A2.1.4	*Although this applies primarily to exterior walls, walls that subdivide buildings may also be subject to these forces. - for example community arenas, or office/warehouse and office/firehall facilities*
2.4.2 Thermal Resistance – see A2.2.1	
2.4.3 Materials and Assembly	
(1) Air/Vapour Barrier see A2.1.6(3)	*Note that continuity of the AV barrier must be provided though it may be difficult to achieve where roof or floor AV barriers are located on a different plane from that selected for the walls*
(2) Sealants – see A2.1.6(4)	
(3) Insulation – see A2.2.2 and A2.2.3	
(4) Drainage and Ventilation Compartmentation requirements do not preclude the need to drain water to the outside. Wall assemblies are expected to incorporate horizontal interruptions and openings at suitable locations and intervals, enabling discharge in a 'cascade' like manner. See A2.1.5	*To meet NBC requirements including application of the rainscreen principle.*

2.5 EXTERIOR WALL FINISHES

These "standards" do not specify where specific materials are to be used: rather, if and when the designer selects materials, they should conform to the requirements noted here. Maintenance, appearance, performance, ease of repair and availability are all considerations.

Requirement	Rationale
2.5.1 General All siding to be installed so that the requirements of A2.1.5 "Rainscreen" are met.	*Air pressure equalization compartments can be created using strapping applied to support the siding.*
Siding patterns and edge joints should allow easy replacement at areas susceptible to damage.	*Examples of areas proven susceptible to frequent damage include the lower portion of exterior walls of schools and arenas, areas around stairs and landings, corners of garages,*

loading docks etc.

2.5.2 Wood

- Board and batten, lap joint, tongue & groove, channel or drop siding is acceptable.

Although requires regular maintenance, it is easily applied and repaired, and a variety of colours and patterns can be used.

- Spruce or cedar siding is acceptable, and siding may be air-dried or kiln dried.

Local materials are always preferred; there is now an operating kiln in Haines Junction.

- A semi-transparent stained finish is preferred, and solid colour stains acceptable. Paint finishes for exterior wood should be limited to fascia and trim.

Commonly used with acceptable performance

- Pre-finished plywood siding, such as "Ranchwall", minimum 15.5 mm thick is an acceptable siding material.

- Cement bonded particleboard may be considered for areas of exterior finish proven to be susceptible to damage (accidental or deliberate).

- Medium Density Overlaid is not acceptable as an exterior finish.

Nailing

- ·1 nail only at each support is adequate for wood siding boards under 140mm in width

number of nails not stated in NBC

- ·2 nails at each support required for wood siding over 140mm in width.

Profile: select from standard
Colours: to be selected from manufacturer's standard colours

Fasteners: concealed fasteners preferred

When installed on prefabricated structure, siding to be factory pre-punched to match factory pre-punched holes in structural members.

Typically used with prefabricated metal buildings such as recreational facilities or service buildings. Metal siding is susceptible to damage from impact, and repairs are not easily undertaken by local maintainers, the damage is often left unprepared. Wood siding should be considered at areas most susceptible to damage, such as entranceways.

The extra cost of custom profiles or colours is generally not warranted for public buildings, and delivery time is often increased.

Aluminium siding is not acceptable for Yukon facilities.

*Very susceptible to damage from impact.*2.5.4

2.5.4 Vinyl Siding

Not acceptable for Yukon facilities.

Expansion and contraction in varying temperatures causes warping, and vinyl also becomes very brittle in cold temperatures, and most susceptible to vandalism.

2.5.5 Stucco Finish

Generally not acceptable for use on Yukon buildings.

Easily damaged on impact and materials are generally unavailable for repairs. Wicks moisture at the base of building and deteriorates rapidly

2.6 BUILDING ENVELOPE – ROOFS

Requirements	Rationale
2.6.1 Air Movement, Water and Vapour Protection	
All requirements of A 2.1 with the exception of A 2.1.2 apply to roof assemblies.	*Clarifies criteria to be used in evaluating roof assemblies with respect to NBC requirements.*
All roofs are subject to differentials in temperature, water vapour pressure and air pressure, and as such require air leakage barriers and vapour diffusion barriers meeting all requirements outlined in section A 2.1.3 and A 2.1.4	*Clarifies criteria to be used in evaluating AV barriers with respect to NBC requirements.*
2.6.2 Thermal Resistance – see A2.2.1	
2.6.3 Assembly and Materials	
(1) AV Barriers	
a) Coincident air/vapour barriers located on the outside of structural framing only are to be considered for all buildings located above the treeline. Protected, fully adhered membranes must be used.	*Condensation within the roof assembly has caused structural damage to a number of roofs across the Yukon: locating the structural roof inside of the AV barrier is a reliable means of avoiding this problem. Venting roof assemblies above the treeline is problematic as vents allow snow infiltration.* *With the membrane fully adhered to a structural backing, the assembly can meet as the air/vapour barrier requirements and any damage to the membrane will not allow moisture to travel between the membrane and the backing*
. b) The location of the A/V barrier on the interior of roof framing may be considered only for small buildings. Great care must be taken to ensure a continuous air/vapour barrier, and a means of venting the assembly that will minimize snow infiltration.	*The use of more expensive insulation and vapour barrier materials becomes necessary when the AV barrier is located on the exterior of the roof framing. This additional cost may not always be justifiable for smaller buildings located below the treeline where a ventilated roof system can perform satisfactorily.*
(2) Sealants – see A 2.1.6(4)	
(3) Insulation – see A 2.2.2 and 2.2.3	
(4) Ventilation and Drainage a) The requirements of NBC are not deemed applicable for roofing assemblies where the AV barrier is located above structural joist or rafter spaces and rigid insulation is used.	*The ventilation requirements of NBC are applicable where assemblies may be adversely affected by condensation as described in NBC. The potential for condensation to occur is essentially eliminated when an AV barrier meeting the requirements of this document is provided. Even if any condensation were to occur the amount of moisture would be extremely small since virtually all air has been*

displaced, nor would it adversely affect the insulation or roof structure.

b) Wherever fibreglass insulation is used in a roof assembly the requirements of NBC must be met.

It is important that adequate ventilation be provided where glassfiber insulation is used as its insulation value is adversely affected by condensation. Given that it is difficult to avoid snow infiltration through required ventilation openings, wetting of the insulation and roof assembly occurs as soon as conditions allow infiltrated snow to melt.

(5) Roofing

Areas above the tree-line are typically very windy. Shingles can be blown off and are difficult to replace. Asphalt shingles are readily available, generally less expensive and present a lower fire hazard than wood shingles.

a) Shingles:
Asphalt shingles are acceptable for use in areas below the tree-line only.
Wood shingles are not acceptable

The intense heat of summer will cause wood to warp, cup, and generally distort in shape

. b) Modified Bitumen Membrane:
The 2 ply torched on MBM roof system is acceptable for all Yukon buildings.

The 2 ply torched on MBM membrane has proven to be suitable for installation at sub-zero temperatures, and has performed well to date. Repairs are relatively simple to perform

c) EDPM or Rubber Roofing: Loose-laid membranes are not acceptable for use on Yukon buildings.

These loose laid membranes can allow moisture to travel between the membrane and the backing making it difficult to trace leaks.

d) Metal Roofing:
Acceptable for all Yukon buildings.

This type of roofing has caused considerable controversy and difficulties on Yukon buildings.

Use ice guards

Safety

2.6.4 Flat Roofs

All roofs must have a minimum slope of 4% (1:25).

To ensure positive drainage and avoid ice damming.

2.6.5 Roof Massing

Organize roof massing in a way that avoids snow catching.

To prevent the occurrence of extensive snowdrifting which may cause excessive roof loading.

2.6.6 Parapet Walls

Avoid the use of parapet walls.

Creates an obstruction where snowdrifts will form, adding to roof load

2.6.7 Eaves

(1) Eave Projections
Projections of a building beyond the line of the air/vapour barrier must not compromise the objective of an airtight assembly.

Where the AV barrier is located outside the structural framing eave projects must be supported by separate independent framing members

While eaves provide one of the simplest ways to divert rain and meltwater away from walls, windows, doors and the building perimeter, careful detailing is necessary to maintain the integrity of the building assembly and to avoid ice damming. Depending on the roof assembly, the integrity of the building envelope may be compromised if the structure is extended to provide eave projections. The additional cost and effort required to meet this requirement makes minimizing of eave projections desirable

. Minimal eave projections ranging from 100

Minimal eaves are considered adequate above to 200mm are preferred in regions of the Yukon above the treeline, and larger projections ranging from 200 to 300 mm are acceptable in regions below the treeline.

the treeline in any case, where rain and meltwater runoff is less severe than below the treeline.

(2) Eavestroughs
Generally to be avoided.
Where necessary, detail appropriately with strength

Ice build up renders them ineffective, as well as damaging them during spring melt.

2.6.8 Access

Where roof traffic is anticipated, the finish at access routes must be slip-proof and durable.

Access to the roof may be required for cleaning and maintenance of roof equipment.

A3 DOORS AND WINDOWS

Doors and windows can be a significant source of heat loss and of air infiltration, but are of course a necessary element of the building envelope despite these undesirable attributes. Although door and window quality has improved considerably over the past years, the manufacturing industry produces products for the North American market, not for the extreme conditions of the Yukon. Careful evaluation of such products as to their suitability for use in the Yukon is expected.

3.1 EXTERIOR DOORS AND FRAMES

Several problems are commonly experienced with exterior doors: significant heat loss is inevitable as doors are not currently available with insulation values over 2.0 RSI. Air infiltration is also inevitable as an absolute seal is impossible to achieve; and shifting can occur from even slight building movement (unavoidable in buildings not continuously supported on foundation walls) resulting in doors that are difficult to close properly.

	Requirements	Rationale
3.1.1	Doors All exterior doors to be insulated metal, minimum RSI 1.30.	*Solid wood doors cannot achieve this minimal level of insulation and are susceptible to warping.*
	Do not use a second, "storm door" at entrances. Vestibules or windbreaks should provide additional protection.	*Any vapour leaking past the inner door freezes on second outside door and storm doors are typically manufactured for residential application and do not withstand the heavy use encountered in public buildings*
3.1.2	**Overhead Doors** All overhead doors are to be metal with replaceable panels. Use manufacturer's standard gauges doors unless there is a particular danger of damage from people or equipment: where that is the case use 16-ga. metal.	*Removable panels allow for replacement of portions of the door if they are damaged. 16 ga. metal OH doors are special order items meaning longer delivery times and higher costs. The additional weight of doors also puts added stress on hardware. Typical uses for OH doors include arenas, firehalls, and garages.*
	Overhead doors in insulated walls shall have a high thermal resistance selected from manufacturers' standard products.	*Insulated doors are required in insulated walls. Thermal resistance ratings in excess of those available from manufacturers are unnecessary. Custom doors are not required.*
3.1.3	**Frames** Minimum 16-gauge steel pressed metal frames only to be used for all exterior doors.	*Extra strength required, as doors are susceptible to damage from heavy use typical for public buildings.*
	All exterior doorframes must incorporate a thermal break. However, the manufacturer should reinforce thermally broken frames when they are to be installed in high traffic public use facilities, or other facilities that are subject to break-ins.	*The thermal break although desirable because of the extreme cold experienced in the Yukon weakens the frame where strength is required by hinges and latching hardware. This has been especially problematic in schools*
	Wood frames may be considered where security will not be compromised.	*Wood frames are thermally less conductive than steel frames; however, they are not as strong as steel and their use should be limited to continuously occupied facilities (typically residential) where break-ins are not common.*

Removable astragal bars should not be used with double doors unless a three point latching device is provided

Removable astragal bars can twist out of plane and allow easy forced entry when combined with single point (rim device) latching

3.1.4 Sealants – see A2.1.6(4)

3.1.5 Glazing in Doors and Sidelights

Sidelight frames should be independent of doorframes.

Permits replacement of doorframes without replacement of the window.

Laminated glazing is required for the exterior pane of glazing in doors and all sidelights.

See NBC. Typically used for schools, community halls, health centres, court facilities, libraries, and airport terminals

3.1.6 Vestibules

Provide vestibules at all main entries or other high traffic entrances.

Moderates and limits cold winter air entering building

3.2 INTERIOR DOORS AND FRAMES

Refer to AWMAC, Part 3 - Wood Doors

<u>Requirements</u> | <u>Rationale</u>

3.2.1 Doors

All wood interior doors to be solid core wood. Paint Grade birch veneer plywood face acceptable for paint finish, "Select White" required for clear finish.

Hollow core doors are too susceptible to damage in public use facilities, including residential use facilities.

3.2.2 Frames

Interior doorframes may be wood or metal. Metal frames to be expandable/removable type.

As suited to the application.

3.2.3 Bi-fold doors

To be used only in residential facilities where there are fewer than 10 occupants.

Sliding mechanisms too susceptible to damage from heavy use

3.2.4 Glazing

The use of glass in the lower portion of doors (i.e. below 600mm above the finished floor) is discouraged. Where glass must be used in the lower section of doors it must be reinforced or laminated.

Although glass can be important for visibility, the lower portion of door is vulnerable to damage and abuse

3.3 DOOR HARDWARE

After construction maintenance personnel are often called on to correct or repair door hardware. As these repairs often require immediate attention, replacement parts should be stocked locally. Heavy public use requires reliable, durable and easily repaired hardware.

<u>Requirements</u> | <u>Rationale</u>

3.3.1 Preferred Products

The preferred manufacturers in each region are listed below:

<u>Locksets</u>

Schlage, Corbin, Weiser, Russwin

Other hardware
Panic Hardware - VonDuprin
Dead Bolts - Weiser

Maintainer preference where Regional keying system in place. Parts are available locally.

3.3.2 Overhead door openers
Manual operation by chain hoist preferred. Automatic door openers acceptable only where they are essential to facility operation

Automatic overhead doors require more on-going maintenance and are more susceptible to problems than a manual door. The additional cost is not usually justifiable large size doors and security situations are exceptions.

3.3.3 Power Door Operators

3.3.4 Latching
At least two points and preferably three point latching should be considered for all exterior doors. Surface bolts combined with a rim device are recommended.

Although more expensive initially than single point latching, three-point latching provides higher security doors and a more airtight seal: forced entries are a recurring problem in public buildings.

A properly sloped threshold plate is required where threshold recesses used.

Recesses tend to become blocked by ice.

3.3.5 Keying
Keying for all buildings to be maintained by clients is to be done to the clients keying system. Clients can advise.

This allows buildings to be keyed separately for security reasons, but allows Regional maintainers to cut keys and provide submaster keys where required

3.4 WINDOWS

The number and size of windows must be limited in northern building envelopes, given the extreme climate and because of the potential for vandalism of public buildings. Views and natural light must be carefully considered when selecting and locating windows.

Requirements | Rationale

3.4.1 Window Frame
Insulated frame PVC or vinyl frames are preferred. Metal windows with thermal break frame, or protected wood windows are acceptable.

Easy maintenance as there is no need to refinish, and the potential for damage to windows by condensation is eliminated.

3.4.2 Sealants - see A2.1.6(4)

3.4.3 Location in wall assembly
Windows are to be located in the wall assembly such that the interior of the frame is located on the warm side of the insulation. The window frame should straddle the plane of the air/vapour barrier.

Although setting windows at exterior wall creates a wide interior ledge, airflow over the glass is reduced and this can allow condensation or frost to build up inside the window. This placement will also allow air/vapour barrier continuity through the window frame without offset.

3.4.4 Operation

All operating windows should be casement or awning type with rugged hinges, handles and camlocks, and be designed so that they will not be blocked by accumulations of snow or ice on sill plates. Awning vents located in the top 1/3 of the window frame are preferred and awning vents in the lower 1/3 discouraged.

Best seal of all opening window types. Awning vents in lower 1/3 of frame are more likely to allow wind, dust and snow to blow in. Also, ventilators in lower portions of windows are less secure and ready intrusion points.

Refer to M 8.1 where windows with an operable panel are provided.

3.4.5 Glazing

All windows must have minimum double glazed sealed units with low "E" coating <u>or</u> triple glazed sealed units.

Insulation values currently available.

A single glazed removable sulsash of polycarbonate plastic or laminated or tempered glass on the exterior face of the wall is to be used to protect fixed units where deemed necessary.

Wherever recurring vandalism is identified, as a potential problem protection of glazing should be provided. See notes in NBC. Typically used for schools where windows subject to vandalism.

Shutters or demountable panels may be used to protect windows.

Should be considered for all seasonal use facilities where vandalism is a potential problem. This may include schools when shut down for the summer.

3.4.6 Skylights

Unless shown to provide significant dividends, and unless means are provided to control condensation, skylights are not to be used in Yukon facilities. i.e. the benefit of overhead daylight must be available for significant portion of the year.

An example where the use of skylights would be inappropriate would include a school in Old Crow, where the benefits of daylight would occur primarily when the facility was not in use.

When skylights are approved for use in Yukon facilities, several key design features must be included:

1) a steep slope is required for drainage i.e. 3:12 to 6:12
2) skylight units must be placed on raised upstands above the roof plane a minimum of 200mm to allow for drainage and flashing
3) adequate ventilation must be provided across the interior of the skylight to minimize condensation, and width of condensation gutters must be increased (from standard widths)
4) all skylights must be equipped with a means of shading or diffusing sunlight that is easily operable by facility users

Past experience with skylights in the Yukon has been mixed. Skylights (including translucent structural panels) provided a number of facilities with light in areas where windows were not possible. Although it is acknowledged that the quality of overhead natural lighting is superior to side lighting from windows, the problems experienced with skylights cannot be ignored. Condensation has caused damage to interior furnishings and property, and discomfort to users; users often complain of overheating and glare; and extensive roof damage has occurred as a result of poorly sealed skylight units

3.4.7 Clerestory windows

Not to be used unless shown to provide significant dividends and snow build up on adjacent roof will not render them ineffective during the winter months.

As for skylights, the use of clerestory windows is discouraged unless the designer recognizes potential problems, and devises a means of eliminating or reducing them

A4 INTERIOR CONSTRUCTION AND FINISHES

Durability and simplicity are desirable qualities in Yukon buildings. This applies to interior construction and finishes as it does to all buildings systems. Generally colour schemes and careful placement of building elements must be relied upon to create attractive and pleasing interiors: the range of appropriate materials and architectural details is limited. The occasional special use facility or high profile project may, of course, call for more elaborate or adventurous treatment. **Increased concern about volatile organic compounds in recent years should encourage all architects and interior designers to become familiar with and to utilize new products which reduce hazards introduced into buildings by interior finish materials.**

4.1 FLOORS

Although a large number of floor finishes have been used in Yukon buildings over the years, only a few have gained overall acceptance by users, O&M staff contractors and designers. This section notes standards for different types of commonly used flooring materials, and indicates preferences for some specific uses.

	Requirements	Rationale
4.1.1	**Resilient Flooring** (1) Marbolized linoleum This is the preferred flooring for most Yukon facilities.	*Linoleum has proven durability, good range or colours, and is easy to maintain. Compared to vinyl composite tiles, linoleum is only slightly more expensive to install, requires much less maintenance, and is far more durable. there are now linoleum products is not suitable for wet areas such as shower rooms... it is also less toxic than most other flooring.*
	Heavy traffic areas: Minimum 2.5 mm thickness with welded seams	*Typical high traffic areas would include all public lobbies and corridors, and throughout health centres.*
	Medium traffic areas: minimum 1.8 mm lino with welded seams	*Typical medium traffic areas would include seasonal use facilities, private offices are few Yukon facilities where traffic would be deemed consistently light*
	Light traffic areas: minimum 1.8 mm lino with welded seams	*There are few Yukon facilities that would be considered to have light traffic.*
	(2) Sheet Vinyl 2mm thick, monogeneous composition, colour and pattern detail throughout thickness of product. Use marbolized or granite patterns and welded seams. Do not use cushioned flooring.	*Typically used in shower rooms where floors may remain wet for several hours, or for residential uses where only small areas required. Welded seams are required to provide a durable, watertight seam. Products with surface colours and patterns should not be selected because they show wear too readily in public facilities with medium to heavy traffic. Patterns are preferred because they can hide dirt more easily than plain colours. Cushioned flooring is prohibited because it can be easily damaged/punctured by furniture.*

Heavy-duty vinyl sports flooring with polyurethane surface, suitable for surface painted lines and slip resistance.

Typically used in community or school gymnasia

(3) Vinyl Composite Tiles
2.5 mm-minimum thickness, colour and pattern detail throughout the thickness of the tile. Use marbolized or granite patterns.

Because VCT's are easily installed using local labour, they are especially appropriate where small quantities do not warrant the expense of bringing in a flooring sub-contractor.

Do not use vinyl composite tiles in cold porches or unheated rooms. Typically acceptable only in light traffic areas in smaller buildings.

Typical uses would include smaller buildings such as offices in maintenance garages or firehalls, Renewable Resource offices or summer use staff quarters. Tile shrinkage in cold temperatures makes them a poor choice for cold areas

. (4) Rubber Flooring
Rubber flooring is generally unacceptable for use in Yukon buildings.

Rubber flooring used in public or residential buildings has been found to be difficult to clean, and expensive to install. There is no inherent advantage that makes rubber flooring a better choice than linoleum or vinyl where resilient flooring is called for in Yukon facilities.

Rubber sports flooring suitable for surface painted lines is acceptable for use in community or school gymnasiums.

Rubber flooring is suitable for sports activities, but also allows for community events without requiring people to remove footwear: unlike the more traditional wood sports floor, rubber flooring is resistant to damage from sand or mud tracked in by footwear.

Vulcanised rubber skate flooring is acceptable for use in limited areas of community arenas.

Typically installed only between ice surface and areas where skates are put on or removed.

(5) Cork Flooring
Generally unacceptable in Yukon buildings.

Difficult to maintain, and expensive to install. There is no inherent advantage that makes cork flooring a good choice for any particular use in a Yukon facility.

4.1.2 Wood flooring
Generally not acceptable for use in Yukon buildings, (including gymnasiums).

Capital, installation and maintenance costs are high. Wood floors in gymnasiums require protective coverings when used for community events, which is inconvenient for users: where protective coverings are not used floors are easily damaged.

4.1.3 Ceramic Tiles
Generally not acceptable for use in Yukon buildings. Where it can be shown that the advantages might outweigh the disadvantages, tiles may be proposed and considered.

Although it is recognized that ceramic tiles are low maintenance, easy to clean, and very durable, capital costs are high in the Yukon (especially due to transportation costs). There is also a high risk of breakage in transit. Flexible wood structures, typical of most Yukon facilities, are not the best substrate for ceramic tiles. Installation requires skilled tradespeople and repairs require special attention by maintainers.

Examples of where ceramic tiles may be appropriate would include specialized facilities *such as laboratories or hospital operating rooms. Other cases might include showers or change rooms in communities with road access where lower transportation costs prevail.*

4.1.4 Roll Carpeting

Roll carpeting only is to be considered for use in Yukon buildings.

Typically used in classrooms, libraries, office areas, courtrooms etc. Do not use in entranceways, lobbies, kitchens, and bathrooms or on stairs, except in some residential applications.

(1) Properties

Yarn: nylon preferred.

Durability, appearance and cost of nylon loop have been found to be most suited to Yukon buildings.

Pile: loop only - do not use cut pile.

Hard wearing & easier to maintain than cut pile

Density: minimum 12.0 kilotex

Density is the standard measure of carpet "wearability" not weight (i.e. 28 oz. or 32 oz.).

Static control: carpets must be rated under 3.0 kV

The dry cold climate of the Yukon promotes static build-up, which can be uncomfortable to users, and damage electronic equipment. Higher rating may be required where there is a greater concentration of electronic equipment.

Colours: use patterned carpets only in medium colour ranges Do not use solid colours, with the exception of accent borders.

Doesn't show wear or dirt as easily as solid colours.

(2) Installation

direct glue down preferred. Do not use underlay except for limited residential lounge areas.

Gives a tight, low surface carpet that does not shift or stretch under heavy traffic. Although underlay can be more comfortable for residential lounge areas, it is not suitable for use in most Yukon Government facilities.

(3) Warranty of Carpeting

Heavy Traffic areas: minimum 15-year warranty required. Typically includes schools or colleges, airports, or public corridors in multi-unit housing.

Medium Traffic areas: minimum 10-year warranty required. Typically includes community offices, student hostels or group homes.

Light Traffic areas: minimum 10-year warranty required.

The manufacturer's warranty is probably the best indication of its durability. Warranties typically cover wear, anti-static performance, and zippering, edge ravel or other seam defects. Warranties do not cover damage by burns, tears, pulls, cuts, use of improper cleaning agents, or inadequate protection from castored chairs.

Using less durable carpeting will generally result in higher life-cycle costs because of the high cost of shipping materials to the Yukon.

4.1.5 Carpet Tiles

Generally not acceptable for use in Yukon buildings.

When carpet tiles first came out, they seemed to be a great idea - although more expensive than rolls, it was thought that the rotation of worn or stained tiles could extend the overall life of the carpet. However, carpet tiles have been found to lift easily, joints wear and become accentuated over time, and finally, tiles are not rotated as part of routine maintenance.

4.1.6 Epoxy Floor Finishes

should be used only where continuously wet conditions will be encountered in fairly large areas.

Careful application is required, and it is difficult to keep maintenance materials in stock.

Shower rooms in correctional centres are an example of where epoxy flooring may be considered

4.1.7 Floor Paint

where suitable, should be non-skid finish, and applied to marine or exterior grade plywood.

Suitable for low traffic, non-public areas where protection from water, dirt or spilled oil is required

Typically used for mechanical room floor finish Entries. Colouring concrete during concrete pour is more ideal.

4.1.8 Granular or Sand Floors

When arenas are located in areas of permafrost, or on sites where subsurface conditions will trap melted water:

a) a liner must be installed below the ice surface

b) a means of removing meltwater must be provided

Floors under the ice surface in arenas have typically been left as compacted granular or sand fill. Allowing meltwater to seep through the granular or sand floor can result in damage to the foundation system: degradation of permafrost by meltwater changes the soil bearing capacity; increased moisture in the soil can increase frost heaving forces.

4.1.9 Baseboards

Wood baseboards preferred.

Integral baseboards are required for wet areas.

Vinyl, rubber or any resilient cove baseboards are not acceptable other than in low-use areas of a facility, such as a storage or mechanical room.

Resilient cove/baseboards detach easily from walls requiring on-going maintenance.

4.1.10 Entrance mats and grilles

Do not incorporate recess for mats or grills at entries.

Difficult construction detail. Rely on frequent cleaning instead.

4.1.11 Local Materials

Where a suitable local material is available, and work will contribute to local economy, that material may be considered. Local materials suitable for flooring could include stone or wood.

Can provide opportunities for local employment and skill development, as well as resulting in a more distinctive community building.

4.2 WALLS

Interior walls surfaces are both very visible and susceptible to abuse in public buildings. Regular maintenance involves cleaning, patching and refinishing. Walls need to be reinforced where they are likely to be kicked, hit, bumped or carved, washable, and easily repaired and refinished by local maintainers with materials that can be easily stored.

	Requirements	Rationale
4.2.1	**Framing of non load bearing walls** Wood or steel studs are acceptable for all interior non load-bearing walls.	*The use of steel studs simplifies work of electrical and mechanical trades, is relatively simple to install and are reusable when renovations are undertaken. In many situations however, wood framing may be preferable where it is consistent with other framing to be undertaken.*
4.2.2	**Demountable Wall Systems** Acceptable for use in office areas only.	*Demountable systems can allow flexibility, however typically some acoustic separation is required, and built-in place walls generally perform better at lesser cost.*
4.2.3	**Mechanical Room Walls** 1) Heat transfer The preferred means of reducing heat transfer from mechanical rooms to occupied rooms is to avoid locating them adjacent to one another. Where this cannot be avoided the interior walls separating the rooms must be insulated. Coordinate with acoustic separation requirements below.	*Overheating of rooms adjacent to mechanical rooms is a common problem in larger public buildings such as schools or health centres.*
	2) Acoustic Isolation The preferred means of acoustically isolating mechanical rooms from occupied spaces is to avoid locating them adjacent to one another. Where this cannot be avoided walls, floors, and ceilings of mechanical rooms must be rated to STC 50. In general, create sound barriers by using mass (i.e.: double layer of drywall) rather than fibreglass insulation.	*Noise from mechanical rooms disturbs users of adjacent spaces in many existing buildings.*
4.2.4	**Gypsum Board** Gypsum board is the preferred wall finish in most Yukon facilities.	*An industry standard providing good fire resistance and a smooth easily finished surface.*
4.2.5	**Plywood backing or higher impact drywall** Gypsum board finishes must be backed by, or replaced by, plywood in vestibules and washrooms. Group homes require an even greater degree of attention.	*These areas are subject to damage (i.e. .from doors or abuse from users) that gypsum board cannot withstand*

4.2.6	**Birch plywood** Acceptable walls finish where durability is important. Use select grade for clear finish, or paint grade for a painted finish.	*Provides a very durable wall finish. Also consider that less skill required for installation than for drywall.* *Typically used in gymnasiums, change rooms, garages and arenas.*
4.2.7	**Wood panelling** T&G board finish acceptable. Architectural veneer panelling to be limited to areas where skilled tradespeople are available.	*Cost and skill required for installation limit the use of high quality veneer panelling. Poor quality (in terms of durability and appearance) make prefinished panelling unacceptable*
4.2.8	**Metal Wall Liner Panels** Where metal liner panels are used as an interior wall finish, such panels are to be factory preformed steel sheet, minimum 0.6 mm (24 gauge) base metal thickness, zinc coated, prefinished on the exposed face.	*Typically used with pre-engineered metal buildings for the interior finish of garages and firehalls.*

4.3 CEILINGS

Although generally inaccessible to occupants, ceilings do need to be able to withstand abuse in many circumstances (schools, gymnasiums, arenas, and correctional facilities) and may be subject to periodic cleaning (health facilities, kitchens). The effects of ceiling heights, shapes and materials on acoustic and lighting design must also be considered.

	Requirements	Rationale
4.3.1	**Drywall** In-situ seamless construction such as gypsum board is generally preferred.	*Industry standard*
4.3.2	**Exposed Roof Decks** An acceptable ceiling finish where T&G board or some metal products deck is used.	*. Typically used in gymnasiums and school classroom, but may be considered wherever roof assembly allows decking to be exposed (see A 2.6) and such a finish is appropriate.*
4.3.3	**"T-bar" suspension grid** Lay-in boards acceptable only where large open areas need to be covered and where ceiling finish is not an integral part of envelope design.	*Tiles can provide a practical finish concealing ducts and wiring, and providing some sound absorption, but are difficult to fit neatly into small spaces. In most cases the deck or sheathing of the roof assembly provides an acceptable ceiling finish as noted above.*
	Do not use suspended ceilings with lay-in boards in public use areas where the ceiling is less than 2.5m high. Where ceiling space is used as a tile w/a sealed finish on B/S.	*Susceptible to damage*
	Tiles must be painted or sealed on all sides.	*Where ceiling used as return air plenum.*
4.3.4	**Textured Ceiling Finishes** Not acceptable for use in Yukon facilities.	*Easily damaged, and difficult to repaint, or repair.*

4.3.5 Metal liner ceiling panels

Where metal liner panels are used as an interior ceiling finish, panels to be factory preformed steel sheet, minimum 0.6 mm (24 gauge) base metal thickness, zinc coated, prefinished on visible face.

Typically used with pre-engineered metal buildings as an interior finish for garages and firehalls

4.4 PAINTING AND WALL COVERINGS

Requirement	Rationale

4.4.1 Water Based Paints

This guideline is number ECP-07-89 in a series designed to minimize the pollution generated by the use and disposal of the myriad of goods which Canadians enjoy. The Environmental Choice Program is a major element in a continuing effort to improve and/or maintain the quality of the natural environment.

Reducing volatile organic compound emissions will improve air quality and thereby contribute to the reduction of the impact on global warming and ozone depletion

Interpretation:

1. In the following guideline:

“Aromatics hydrocarbons” means organic substances that have a benzene ring in their molecular structure

“Flash point” is the minimum temperature of a liquid at which the vapours given off are sufficient to form a flammable mixture with air when exposed to an open flame in accordance with the American Society for Testing and Materials (ASTM) test method D93-80 (Pensky –Martens Closed Tester) or ASTM test method D3278-82 (Seta).

“Governmental means Canadian federal, provincial and local governments.

“Halogenated solvent” means any organic solvent containing halogens including fluorine, chlorine, bromine and iodine.

“Volatile organic compound” means any organic compound which has a vapour pressure more that 13.3 Pa at 25°C in accordance with ASTM test method D3960-89

“Water based” means paints that use water as the primary solvent/diluent component.

(c) not be formulated or manufactured with mercury or mercury compounds or be tinted with pigments or lead, cadmium, chromium VI and their oxides;

Have a flash point of 61.0°C or greater,

(d) not contain volatile organic compounds (VOC’s) in excess of 250 g./L;

(e) not be formulated or manufactured with aromatic hydrocarbons, and

(f) be accompanied by information describing proper disposal methods.

4. The calculation of volatile organic compounds in section 3(e) shall:

(a) exclude water; and

(b) exclude tinting colorant added at the point of sale.

5. **VERIFICATION**

To verify a claim that a product meets the criteria listed in the guideline, the Canadian Standards Association will require access, as is their normal practice, to relevant quality control and production records and the right to access to production facilities on an unannounced basis.

Requirement | Rationale

4.4.2 Water Based Paints

This guideline is number ECP-12-89 in a series designed to minimize the pollution generated by the use and disposal of the myriad of goods which Canadians enjoy.

Based on a review of currently available product life cycle information, the project category requirements will produce a net environmental benefit or improvement. Reducing volatile organic compound emissions will improve air quality and thereby contribute to the reduction of the impact on global warming, ground level ozone (smog information) and stratospheric ozone depletion. Reducing the release of toxic chemicals will help protect the environment and reduce possible adverse health effects.

“Flash Point” means the minimum temperature of a liquid at which the vapours given off are sufficient to form a flammable mixture with air when exposed to an open flame in accordance with ASTM test method D93-80 (Pensky-Martens Closed Tester) or ASTM test method D3278-82 (Seta).

“Governmental” means Canadian Federal, provincial and local governments.

“Halogenated solvent” means any organic solvent containing halogens including fluorine, chlorine, bromine and iodine.

“Solvent based” means paints and coatings that use an organic solvent as the primary volatile component.

“Volatile organic compound” means any organic compound, which has a vapour pressure more than .01 mm Hg at 25 C in accordance with ASTM test method D3960-89.

In Canada, standards for paints are published by the Canadian General Standards Board (CGSB) and the Bureau de normalisation du Quebec (BNQ).

4. The calculation of volatile organic compounds in section 3(d) shall:
   (a) include any solvent used for diluting as directed by the formulator or manufacturer, and
   (b) exclude any tinting colourant added at the point of sale.

5. VERIFICATION

To verify a claim that a product meets the criteria listed in the guideline, the Canadian Standards Association will require access, as is their normal practice, to relevant quality control and production records and the right of access to production facilities on an unannounced basis.

6. A signed statement of the Chief Executive Officer or the equivalent officer of the manufacturer shall attest to compliance with section 2(b). The Canadian Standards Association shall be advised in writing immediately by the applicant of any non-compliance that may occur during the term of the license. On the occurrence of any non-compliance, the applicant may appeal the termination of the license to the Environmental

Choice Board.

7. **LICENSING CONDITIONS**

The EcoLogo may appear on the wholesale or retail packaging or on the product itself, provided that the product meets the requirements outlined in this guideline.

Requirements	Rationale
4.4.3 Acrylic/Latex Paints Water based paints acrylic latex are preferred for use in all Yukon facilities.	*Environmental and health concerns have encouraged manufacturers to develop water based paints that can now compete with oil based paints for durability. Painting tradespeople are also beginning to stipulate the use of water based products because of health concerns. Minimizing the availability of harmful products (including solvents) is also an important concern in many Yukon communities. A recent survey of maintenance staff revealed that acrylic latex paints are now used to repaint most Yukon buildings*
4.4.4 Alkyd Paints Oil based paints are acceptable for use in Yukon facilities only where the risk of freezing is very high because of a lack of heated storage area, or limited shipping options.	*Although able to withstand freezing during shipping and storage, oil based paints must be shipped as hazardous materials. VOC emissions and the need to use and store solvents for cleaning also make this an undesirable option*
4.4.5 Special Coatings to be used only where it is applied to a reinforced drywall, plywood or concrete surface. As noted above, water based products are preferred.	*The purpose of special coatings is generally to provide a very damage resistant finish, and so the substrate should be equally resistant*
4.4.6 Vinyl wall coverings Recommended only for : · visible public areas where appearance is important and painted wall finishes would show wear quickly · areas where posters, notices etc. will be affixed to walls	*Although durable, vinyl wall coverings can be damaged by impact; they are expensive; installation requires more skill than painting; and textured surfaces can be difficult to clean once soiled.* *more durable surface than painted drywall* *Tape or tacks can be used on vinyl wall surfaces with less visible damage than would occur on a painted surface*
Where used in corridors it should be installed so that the lower portion of the wall (up to about 1.2m) can be replaced independently.	
Avoid using vinyl wall coverings where frequent cleaning will be required, such as above countertops	*The textured surface can be difficult to clean.*

A5 FINISH CARPENTRY

For this reason, as well as for cost considerations, the extent of finish carpentry in Yukon buildings is usually limited and plain: complex details are generally not achievable on site and should not be demanded. AWMAC Standards are to be used exclusively in specifying architectural woodwork.

5.1 CABINETS AND SHELVING

Refer to AWMAC Quality Standards for Architectural Woodwork, Part 2 "Casework", Part 1 "Quality Grades & Material Standards", Part 6 "Installation", and Part 5 "Factory Finishing"

Requirements	Rationale
5.1.1 Casework Custom grade casework, including drawers, shelving, doors and edge banding as described in Part 2.	*AWMAC establishes only two grades: custom, and premium. Premium would rarely be necessary in a Yukon building*
Cabinet Doors Plywood doors are acceptable if they do not exceed 450(w) x 1200 (h) in size.	*Large plywood doors often warp*
Hollow core doors or composite boards are both acceptable	
5.1.2 Clear Finish (1) Materials Where a clear finish to be used, birch veneer hardwood plywood is preferred. To be Select White or Red, as described in Part 1, Section 8	*Reasonable appearance and cost*
(2) Matching Book matching preferred. Slip matching acceptable. Random matching not acceptable.	
5.1.3 Paint Finish Where a paint finish is to be used, Paint Grade plywood as described in Part 1, Section 8 is acceptable.	*Smooth surface important, but wood grain appearance is not.*
5.1.4 Hardware finish: brushed metal or plastic coated preferred cabinet hinges: concealed hinges preferred drawer slides: ball bearing type preferred cabinet door and drawer pulls: simple design preferred	*Good quality, durable and simple hardware best suited to public use buildings where long life is expected*

5.1.5 Shelving

Requirements	Rationale
The use of premanufactured shelving systems is preferred to custom millwork for most public buildings particularly in libraries, resource centres, and storage rooms. Metal storage shelving should be considered as an alternative to built-in shelving where appearance is not critical.	*Premanufactured shelving is generally less expensive than custom millwork and provides users with more flexible furnishings*
(1) <u>Supports</u> Generally to be supported on metal standards for adjustable shelf brackets.	*To give users some flexibility*
(2) <u>Materials and Finishes</u> a) Clear finish birch plywood or plastic laminate finish c/w hardwood edge banding preferred in all public or visible locations.	*Visible shelving typically required in schools, community offices, health care centres, and public reception areas.*
b) Plastic, plexiglass or glass shelving to be limited to display cabinets	*Display shelving has limited application in schools or community centres, but would more often be found in visitor centres, cultural centres or museums. Because glass or clear plastics need to be kept very clean, and are subject to scratching or breakage their use should be minimized*
c) Melamine or painted shelves acceptable for storage rooms or low visibility locations	*A less expensive alternative to clear finishes where appearances are not as important. Typically acceptable for storage rooms, garages or firehalls, or seasonal use buildings*

<u>Notes and recommendations</u>**:** special attention must be paid to acclimatising wood prior to installation because of the extremely dry climate.

5.2 COUNTERTOPS

These can be a major visual element in rooms making the choice of colours and patterns important. Refer to AWMAC, Part 2, Section 7 and Part 1, Section 11

<u>Requirements</u>	<u>Rationale</u>
5.2.1 Countertops	
Self-edge type, with back splash and side splash sections site installed and sealed using transparent silicone sealant. Hardwood edge may be appropriate in some applications. Do not use post-formed countertops	*Experience has shown post formed countertops are often damaged in transit.*

5.2.2 Plastic Laminate

General Purpose Grade, complete with backing sheets, velour or suede finish. Texture patterns preferred in all high use areas. Solid colours acceptable only in low use areas. Do not use wood grain laminates

Typical high use areas include kitchens and washrooms of all public use or residential buildings, library counters, visitor centre information counters and classrooms. Low use areas, where solid colours are acceptable would typically include office reception counters, courtrooms, seasonal use buildings and staff washrooms

5.2.3 Chemical Resistance

Where chemical resistance required laboratory Grade plastic laminate or countertop linoleum to be used.

Typically required in school science labs, health centres examination rooms and film development rooms, and Renewable Resource labs

5.3 MISCELLANEOUS FINISH CARPENTRY

Refer to AWMAC Part 4 "Frames, Panelling and Specialities", Part 1 "Quality Grades and Material Standards" and Part 6 "Installation".

<u>Requirements</u> / <u>Rationale</u>

5.3.1 Grade

Custom Grade as described in Part 4, AWMAC standards.

Typically use clear fir, oak, birch, or maple.

Fir, oak, birch, maple are hard enough to withstand scratching or denting, whereas pine is soft and susceptible to damage from everyday activities.

Use pine, poplar and other soft woods only in appropriate circumstances

5.3.2 Coat Racks

Ensure spacing and size of pegs adequate for heavy winter parkas, coveralls etc.

Typically provided in schools, community offices, and group homes.

5.3.3 Radiation covers

Premanufactured metal radiation cabinets are preferred for most public buildings. Wood cabinets/covers are acceptable only for low use if a simple means of removing sections to allow cleaning of fins and access to valves is provided: covers that require dismantling to access valves are not acceptable. Wood radiation cabinets /covers are not normally acceptable for use in high use facilities such as arenas and schools.

Higher initial cost than standard metal cabinets. The design of wood cabinets in past installations has made it impossible to clean the fins without dismantling woodwork. Experience shows that a lot of garbage and debris is dropped into radiation cabinets making accessibility for cleaning essential.

A6 SPECIALTIES

6.1 WASHROOM ACCESSORIES

Durability and vandal resistance is important, as washroom accessories are often subject to abuse, including scratched or applied graffiti. Accessories should be surface mounted or free standing for ease of installation.

6.1.1	**Shower Surrounds** Fibreglass or PVC with integral grab-bar system or ability to attached standard grab bars required. Do not use ceramic tiles, or prefinished board.	*Easily cleaned, easy to install, durable surface*
6.1.2	**Toilet Partitions** Standard manufacture plastic laminate or baked enamel finishes partitions to be used. Do not construct on site with plywood.	*Typically required in all public washrooms, so durability and ease of cleaning are important. Site-built partitions generally cannot withstand heavy use and become a maintenance problem for cleaning and repairs.*
6.1.3	**Washroom Accessories** Preferred washroom accessories manufactured by: Bobrick Twin Cee Frost Metal Watrous Sales	*Have proven to be an acceptable standard for public buildings* .
6.1.4	**Backing** Backing must be installed for all furniture, equipment and hardware to be mounted on walls.	*Secure, safe and vandal-resistant installation*

6.2 SIGNS

Although standards for construction Project Signs, and interior signs for Yukon offices have been in use since 1982, to date there have been no interior or exterior sign standards adopted for other Yukon buildings. The following requirements describe sign types and styles currently in use and acceptable until such time a more formal standard is established.

	Requirements	Rationale
6.2.1	**Language** Signs provided to help user and visitor orientation to be integrated signs in English, local dialect(s) and international graphic symbols as appropriate. Local language requirements will be as outlined in Project Sign standards with translations provided by the Yukon language bureau.	*Yukon Government Language Policy*
6.2.2	**Exterior Signs** Cast bronze letters, individually mounted, 12.7 mm thick, and 200mm high. Syllabics to be in modules of 50mm to a maximum of 200mm. Roman Orthography (English) lettering to be upper case Helvetica.	*Have proven acceptable where used for the past several years.*

6.2.3 Interior Signs

(1) Room Names
Laminated plastic, 3mm thick plates, engraved or subsurface printed lettering and symbols, Colours to be coordinated with building interior, or standard Yukon colours: dark blue (AS1 SC601) on pale grey field (Pantone 400)

Have proven acceptable where used for the past several years.

(2) Directory Boards
Removable inserts preferred. Do not use individually mounted letters.

Simple to install and neater appearance than individually mounted letter systems.

6.3 WINDOW COVERINGS

Commonly included in construction contracts rather than with furnishings. Blinds and blackout curtains can be used to control daylighting admitted into rooms in public use buildings; in residential applications curtains and blinds are provided both the control outdoor lighting and for privacy considerations. Daylight control is particularly important during the summer months when most Yukon communities experience 18 to 24 hours of daylight for 4 months of the year. Bedrooms in residential facilities need to be able to be darkened effectively with curtains or blinds provided, as well as any rooms where photographic slides or other projected images may be used.

Requirements — Rationale

6.3.1 Draperies
Must be machine washable.

Dry cleaning is not available in most communities.

6.3.2 Blinds
Adjustable, vertical blinds preferred. Horizontal acceptable.

Vertical blinds do not collect dust as readily as horizontal blinds.

Perforated plastic or metal preferred. Do not use fabric blinds

Plastic or metal are simple to clean

6.4 APPLIANCES

Commonly included in construction contracts rather than with furnishings.

Requirements — Rationale

6.4.1 Kitchen Appliances
Preferred manufacture of stoves, fridges, freezers and other kitchen appliances should be confirmed with Regional maintainers. Standard sizes and energy efficient models to be selected. Colour to be white

To simplify the number of parts stocked and so maintainers can become familiar with repairs.

6.4.2 Laundry Equipment
Preferred manufacture of washing machines, dryers or other laundry equipment should be confirmed with Regional maintainers. Standard sizes and energy efficient models to be selected. Colour to be white.

To simplify the number of parts kept on hand in the region for repairs

A7 COORDINATION

This section highlights structural, mechanical, electrical, or site considerations, which are particularly affected by, or affect architectural design.

Requirement	Rationale
7.0.1 Mechanical Equipment	
(1) Space Requirements Adequate space must be provided in mechanical rooms for plumbing, heating and ventilation equipment including required clearances and access for maintenance. See notes in section M. Mechanical Design Standards and Guidelines.	*Cramped mechanical rooms with minimal clearances and inadequate access for maintenance have been a common shortcoming of Yukon building designs.*
Space provided in wall and floor assemblies must be able to accommodate plumbing and ducts.	*This can be problematic where long plumbing runs are required and structural floor space is limited.*
(2) Location The location of mechanical equipment, grilles and louvres and servicing points must consider effect on equipment performance and be coordinated with structural systems and architectural finishes.	*The location of equipment should satisfy both requirements: giving one consideration priority over the other is unacceptable.*
(3) Access Control and maintenance of heating and ventilation system requires access to controls and equipment. Access panels may need to be provided in ceilings and walls.	*Fairly frequent access is required, especially when building is newly occupied and operator is becoming familiar with system.*
(4) Windows Heat gain and loss through windows, must be taken into consideration by heating and ventilation system designers.	*Changes to architectural design may not necessarily be passed on to mechanical consultants. When ventilation systems cannot manage heat gains the facility can become very uncomfortable for occupants*
7.0.2 Electrical Equipment (1) Space Requirements Adequate space must be provided for electrical equipment including required clearances and access for maintenance. This may require coordination with mechanical design. See notes in section E. Electrical Design Standards and Guidelines.	*Cramped electrical/mechanical rooms with minimal clearances and inadequate access for maintenance have been a common shortcoming of Yukon building designs*
(2) Access Pull and junction boxes need to be accessible in the event electrical changes are required	*Not frequently required, however unless a means of accessing them is provided, ceilings and walls will have to be patched any time they must be accessed*

7.0.3 Lighting Design

Fixture locations must be coordinated with structural and mechanical elements.

To avoid the need for on-site changes, or obstructed lighting.

Fixtures to be coordinated with decorative or architectural theme.

Fixtures often selected by the electrical designer who may not be familiar with interior design and finishes.

Daylighting zones and electrical lighting zones must be coordinated.

Adequate daylight can make electric lighting redundant at times, however energy savings can only be realized if electric lighting can be controlled in daylight zones

Planted areas
Skills and interest in maintaining vegetation will vary depending on staff and location, but it should be accepted that generally little effort will be put into maintaining planted areas except at higher profile public buildings (i.e. Government Administration building; Law Centre). Planting can play an important role in protecting slopes from erosion and creating shelter from wind and sun, and reducing overall maintenance. Use native planting materials and acknowledge particular microclimates of locations.

L3 ACCESS & ORIENTATION

3.1 PEDESTRIAN ACCESS

Public buildings should be easily identifiable, with clearly visible entrances. All pathways, ramps and stairs leading to entranceways should be easy to keep clear of snow, and be protected from vehicle traffic. Building entries should have roof covered protection wherever possible.

Requirements	Rationale
3.1.1 Walkways Finished walkways are required leading from the edge of the roadway, and all parking areas, to all regularly used building entrances. Surfaces to be well drained and finished with fixed in place NON-SLIP type materials.	*Minimizes mud tracked into buildings during spring and fall. Particularly important for facilities with high public uses such as schools, health centres and community recreation facilities. People will walk through a hedge gap, to establish a straight line to the entry.* ***Don't try to guide foot-traffic in an unnatural direction.***
3.1.2 Ramps and Stairs One path of travel to the building entrance is preferred in lieu of both stairs and a ramp. Wherever possible a ramp with a straight run should be provided so that additional stairs are not required. Where space dictates that a ramp must be “dog-legged,” then a stair is to be provided in addition to the ramp.	*Stairs and ramps have typically been installed independently, though leading to a common landing. This creates two paths of travel. Although this is often unavoidable due to site constraints, it is often simply not considered. A single access route can reduce costs, reduce snow clearing requirements and reduce the perception that providing ramped access is wasteful.*
Wood surfaces are acceptable only where traffic is light, or dictated by historic interests.	*Wood is high maintenance, easily damaged by snow clearing, and has an obvious shorter life span in general.*
Concrete stairs, ramps and walks are acceptable, keeping barrier-free access in mind.	
3.1.3 Snowdrifting Locate entrances where snowdrifts will not normally form. Only if this cannot be achieved should another means of reducing snow accumulation be considered.	*Certain building configurations are also prone to snow accumulation, such as inside corners. Massing of building(s) will deter or contribute to snow drifting both on the ground and at roof levels Refer also to freeze thaw considerations in 2.2*

3.2 VEHICULAR ACCESS

In many communities there are no municipal requirements for parking or service vehicle access to buildings. Where parking for users of Yukon Government buildings is to be provided, exterior outlets may be required; service and emergency vehicles and personnel must have access where required all year round without difficulty i.e. no obstruction by snow, standing water or steep slopes.

Requirements	Rationale
3.2.1 Routes and Parking Vehicle routes and parking areas on site to be clearly marked - using substantial physical barriers, which remain visible in winter, conditions.	*To identify and control vehicle traffic around buildings - to provide some protection for pedestrians, landscaping, underground services slopes of building pads or buildings. Boulders, logs, heavy timber or fencing can all be considered.*
3.2.2 Parking stalls Minimum dimensions for car or truck parking stall: - 2.75 m x 6m. Standard Stall - 2.4 m x 7.3 m Parallel Stall - 4.0 m x 6.0 m Barrier Free	*Standard parking stall dimensions - provided as a minimum for Yukon buildings, especially in communities where no area requirements exist (See City of Whitehorse zoning bylaw)*
3.2.3 Plug-ins see Electrical Standards E 6.3.6	*Also act as visual parking cues in winter.*
3.2.4 Air Intake Louvers & Vehicle Emissions Maintain a very healthy separation in the order of 40's plus.	*To prevent air contamination; safety.*

3.3 SERVICES AND UTILITIES ACCESS

With winter conditions lasting from 6 to 8 months of the year, it is important that building service points are easily accessed by trucks and personnel, and protected from snow and ice build-up. Fuel (primarily heating oil) is delivered exclusively by truck. Power and telephone is generally overhead service.

Requirements	Rationale
• garbage	
• storm sewers	
• U/G water lines	Ensure no vehicle or pedestrian traffic
• U/G septic or sewer lines building maintenance vehicles	Ensure no vehicle or pedestrian traffic
• fuel	
• fire truck lanes	
• food or other deliveries	
• mail	
• snow removal	

3.3.1 Delivery vehicles

Provide adequate space for delivery vehicles to pull completely off main roadway when servicing building.

Keeps service vehicles from blocking traffic. (Note this is a municipal requirement in some communities).

3.3.2 Service connection access

Provide stairs and platforms wherever people must gain access to fill points or connect to services located over 1.5 m from ground level - ladders are not acceptable.

To allow delivery people to connect to building easily and safely.

3.3.3 Fuel Storage Tanks

Provide protection from vehicles large and small (Skidoos).

Protection from damage; safety

3.4 BUILDING ORIENTATION

Building orientation is very important, solar energy penetration and absorption wind patterns and micro climate can have a positive or negative effect, depending on the time of year, and the particular situation. These issues are design specific for each situation and must be considered carefully.

<u>Requirements</u> <u>Rationale</u>

3.4.1 Snowdrifting

Snow drifting around buildings and on roof should be managed through careful siting and design so that problems can be minimized or avoided.

3.4.2 Solar Loading

Solar loading has both positive and negative effects, depending on the time of year; N,S,E or W exposures; and weather conditions. It also has a critical effect on energy consumption in a facility.

L4 FILL AND GRADING

4.1 FILL

Granular materials are obtained in various ways: Where local supplies have been identified, quantities need to be estimated in advance of construction to ensure availability (generally the proceeding summer). Types of fill and layering are to be defined by site specific design recommendations based on Geotechnical investigations by a soils engineer.

Requirements | Rationale

4.1.1 Built up Granular Pads

provide an impermeable liner on slopes of pads which lay in the path of run-off in permafrost areas

to divert water around pad, rather than allowing it to seep under or through it, potentially degrading permafrost

see also S3 Foundations

4.1.2 Excavation

Avoid cutting into existing soils where permafrost is present.

exposes frozen soil causing immediate degradation of permafrost to unknown extremities

see also S3 Foundations

4.2 GRADING

Although frozen for much of the year, building sites can be susceptible to significant damage during spring run-off or as a result of ponding and flooding, and access to the building by users or services can be impeded

Requirements | Rationale

4.2.1 Elevations

All site plans that involve elevations, curb heights, etc must be accurate and have sufficient detail as to leave no doubt as to intention and elevation required.

This is a constant and reoccurring problem on projects, resulting in added costs and disputes.

Must meet requirements of NBCC Part 2 - General Requirements - Section 2.3.

4.2. 2 Rough and Finished grades

minimum 4% slope away from building for the 1st 8 to 10 feet if possible.

Keep water away from foundations.

4.2.3 Retaining walls

Where grade differences cannot be accommodated by slopes of 1:3, maximum, because of site constraints or limited fill materials retaining walls may be considered

Using retaining walls can reduce the total amount of fill required, however is generally a more labour intensive and expensive means of stabilizing slopes

4.2.4 Drainage channels

Drainage channels/paths must be in place on site before spring run-off: this may require temporary installation of swales or berms

Construction schedules can result in winter construction: the building is usually ready for occupancy by spring or early summer, but sitework cannot be completed until mid to late summer

L5 SITE REHABILITATION and LANDSCAPING

A comprehensive landscaping plan must, of course, incorporate requirements noted in sections above (circulation, grading etc.) Landscaping using native, low maintenance grass, flower beds, trees and shrubs is preferred, however this is not always a practical consideration, none the less some care needs to be taken in finishing sites around Yukon buildings for appearance sake as well as public safety and to control erosion.

Requirements	Rationale
5.0.1 Existing vegetation Maintain as much existing vegetation on site as possible and protect from vehicular traffic.	*Protects soil from erosion, insulates permafrost, and generally improves appearance of site. Trees and bushes can provide shelter from wind, trap drifting snow and provide shade in the summer.*
5.0.2 Vegetation - New/Added Any plant material added to the site must be hardy, suitable for the locality and require little or no maintenance - transplanting of local species is encouraged where an acceptable source can be found near the community.	*Growing conditions are too harsh for most plants commonly used elsewhere in Canada. Landscapers have used local shrubs and transplanting of birch aspen and spruce trees in their designs.* *Recommend using local landscape consultant companies for their expertise.*
5.0.3 Soil If soil or topsoil is required, it must be available within the community along with any necessary additives (sand, lime etc.).	*Mixed, prepared topsoil is simply not available in most communities. If required in any quantity costs can be high.*
5.0.4 Playgrounds Soft, sandy surfaces to be provided wherever play structures are installed. Play structures to be constructed primarily of wood, with minimal metal fastenings or fittings. Our climate beckons innovation.	*To provide a safe play area: metal parts become hazardous during extremely cold weather.*

S. STRUCTURAL DESIGN STANDARDS

The structural design of buildings located in the Yukon has to take into consideration several conditions not typically of concern in the rest of Canada. Permafrost is one factor, along with transportation, which does not so much change as limit the structural choices appropriate for the Yukon. Transportation costs can be significant; size and weight restrictions can apply. Increasingly important is the requirement to make every effort to ensure that construction projects provide opportunities for local labour to use or develop construction skills. All of these factors together have led the Yukon to favour wood frame construction for most applications. However, while pre-engineered metal buildings are common, wood timber and steel framing are appropriate in some instances, their use is dependent on other demonstrated benefits or needs.

S1 CODES AND REGULATIONS

National Building Code
National Energy Code

S2 GENERAL DESIGN CONSIDERATIONS

<u>Transportation and Handling</u>
Equipment available to move materials is often limited. It is important that the size and weight of all components (particularly steel) are such that they can be moved to the site and put in place with available equipment. Moving materials to, and on the building site can be more problematic in communities. It is important to know what equipment will be available in the community before design starts.

<u>Schedule</u>
The construction season is much more limited in the Yukon than elsewhere across Canada for obvious reasons: getting buildings closed in before severe winter conditions set in is critical. This means that structural work must proceed quickly and smoothly, and that extra care must be taken to ensure it is also completed correctly in one operation. It is not uncommon for foundation work to be separated from the general construction contract: to allow local contractors or communities to take on the work; or because it must be completed before all construction documents can be ready for tender.

<u>Standardization</u>
An attempt must be made to standardize the size and type of structural elements used in a building and approach the overall buildings in sensible simplistic terms. This will tend to decrease waste and can reduce down time by eliminating the need for materials to be brought in on an emergency basis during construction. Whenever possible simplify framing details and minimize the number of operations required to complete a detail.

<u>Drawings</u>
Drawings must clearly represent all the required elevations, measurements and required information for contractor to perform the work. Refer to *NBCC - Part 2 - General Requirements - Section 2.3.*

S3 FOUNDATIONS

Foundations systems for Yukon buildings are designed for typically light building loads, recognizing the constraints on construction imposed by soils, which are partially, or permanently frozen. Geotechnical investigations are generally undertaken as soon as a site can be identified, and prior to the commencement of design.

3.0 SITE PREPARATION

Site preparation is a major component of the construction project and proper drawings representing all the required elements are critical. Refer to ***NBCC -Part 2 General Requirements - Section 2.3 and Yukon Government, Design Standards-Section L Sitework Design Standards.***

Requirements	Rationale
3.1.1 Site Preparation	
Do not cut into existing slopes to accommodate building foundations where permafrost is present.	*Exposes frozen soil causing degradation of permafrost*

3.1 SHALLOW FOOTINGS

Shallow footings are generally used only in combination with built-up granular pads in the Yukon. Seasonal movement is to be anticipated with this type of foundation unless thermosiphons are installed to maintain the frozen soil beneath the footings Work on a gravel pad for a shallow footing foundation cannot proceed until early summer when conditions permit excavation and proper compaction of fill.

Requirements	Rationale
3.1.2 Granular Pads	
Where granular pads are installed as a part of a foundation system on a sloping site, provide an impermeable liner on slopes which lay in the path of run-off.	*To divert water around pad, rather than allowing it to seep under or through it potentially degrading permafrost*
3.1.3 Footings	
Pressure preservative treated wood pads preferred in communities remote from concrete sources. Concrete acceptable only where quality of concrete can be assured.	*Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines*
3.1.4 Adjustment	
In areas of anticipated settlement adjustable wedges or screw jacks allowing 100 to 150 of adjustment are required. A minimum height of 600 mm must be available for maintenance.	*The need for annual adjustment should be anticipated, and adequate clearance must be available for maintainers to work under building for several hours at a time*
3.1.5 Thermosiphons	
Wherever thermosiphons are installed as part of the foundation system: • the cooling medium should be a material that if leaked below the slab will not degrade the permafrost. • the system should allow for loops to be isolated. • Radiators must be protected from damage by vehicles, and be situated away from exhaust vents a metal plate should be installed adjacent to risers and painted to match.	*To allow building operators and maintainers too regularly monitor operation of the thermosiphons.*

3.2 BUIRED FOOTINGS

Buried footings are typically used in conjunction with a granular pad in areas of permafrost. As the footings are installed so that they bear on frozen soil, work must be scheduled so that it does not cause degradation of frozen soil beneath footings; once started, work must be completed quickly.

Requirements	Rationale
3.2.2 Granular pad Refer to Sitework Design Standards and Guidelines, L4 Fill and Grading.	
3.2.3 Bond breakers Grease or polyethylene wrap must be provided to act as a bond breaker on all column/pier surfaces below grade.	*To resist uplift forces of frost.*
3.2.4 Footings Pressure preservative treated wood pads preferred in communities remote from concrete sources. Concrete acceptable only where quality of concrete can be assured.	*Wood can be easily shipped and assembled, and can also be easily adjusted on site to line up with column grid lines.*
3.2.5 Adjustment In areas of anticipated settlement adjustable wedges or screw jacks allowing 100 to 150 of adjustment are required. A minimum height of 600 mm must be available for maintenance.	*There is always a potential for movement. Adjusting column height under an existing building is not a simple undertaking: providing a means of adjustment at the time of construction will simplify the process if and when it becomes necessary*
3.2.6 Thermosiphons Wherever thermosiphons are installed as part of the foundation system: see 3.4.5 above	

3.3 STRUCTURAL SLABS

Concrete slabs would seem an ideal choice for many buildings such as garages firehalls or warehouses given that they act both as a foundation system, and provide a durable, smooth floor surface. Problems caused by heat transferring from the building to underlying frozen soils have to be overcome however or the slab will fail in a very short time. Extreme care is required during the installation of heat removal systems beneath the concrete: obviously once in place inspections and repairs become extremely difficult.

Requirements	*Rationale*
3.3.2 Ventilated Slabs - Not Acceptable	
(1) Natural Ventilation Naturally ventilated slab foundations are not acceptable.	*System can easily fail when if ventilators are blocked by snow or fill with water (especially during spring run-off)*

(2) Mechanical Ventilation
Mechanically ventilated slab foundations are not acceptable.

Same potential problems as for natural ventilation systems, with added risk of mechanical failures and increased maintenance requirements. Operation may be simplified as intake and exhaust can be thermostatically controlled.

3.3.3 Thermosiphons

Wherever thermosiphons are installed as part of the foundation system:

see 3.2.5 above

3.4 PILES

Steel pipe piles have become one of the most common foundation systems used in the Yukon. Considered the most stable and low maintenance system, piles also allow the heated building envelope to be raised above frozen ground, which decreases the build up of drifting snow at the base of the building. Wherever possible piles are socketed into bedrock, but in areas of permafrost, piles can be supported by the frozen soil. Developments in the use of "adfreeze" piles over the years have included the addition of welded rings to increase bearing capacity, or incorporating thermosiphons to refrigerate the soil. Recent research into properties of saline permafrost is of particular interest to structural engineers working in the Yukon. Scheduling of piling work has to take into consideration the availability of materials and equipment in the community, as well as seasonal soil conditions (trying to avoid piling when sloughing of the active layer will occur). It is advisable to complete piling before early summer while soils are frozen so that foundations are ready for a construction start in the summer or fall (particularly when materials arrive by airlift).

Requirements | Rationale

3.4.2 Pile Types

(1) Steel Pipe Piles
Most commonly used and preferred. Installed as recommended by Structural Engineers: driven to refusal; drilled and frozen in place with slurry or grout; or socketed to bedrock.

Equipment and expertise are readily available, and experience has proven steel pipe piles to perform satisfactorily in most cases.

(2) Thermal Piles
May be considered where the bearing capacity of soil or permafrost is particularly low, and the modifying of steel pipe piles is not feasible or would be a more expensive option.

Thermal piles can carry higher loading than steel pipe piles, and may therefore be considered for areas of saline permafrost as current practise is to reduce by 1/3 the capacity normally estimated for permafrost soils. To date the Yukon has not used thermal piles.

(3) Wood Piles
Only acceptable in areas where woodpiles have been used in the past, and local materials, expertise and equipment are available.

(4) Concrete

3.4.3 Bond breakers

Grease or polyethylene wrap must be provided to act as a bond breaker on all surfaces of steel piles to be located in the active layer. (This is true for all piles, whether adfreeze or pinned to bedrock).

The freezing of the active layer (which can be as deep as 3 meters in some areas of the Yukon) can subject piles to considerable uplift forces in the fall and early winter (frost heaving). The dead load of a typical one or two storey building is not adequate to counteract this force, so bond breakers have been used to keep the ice from acting directly on the steel piles. Although bond breakers can reduce forces acting on piles by as much as 75%, the long-term performance of grease or poly wrap is not really known. It is suggested that this is a topic, which warrants further research.

3.4.4 Pile Caps

Adjustable pile caps should be used wherever piles cannot be pinned to bedrock.

There is always a potential for pile movement. Long term creep can result in significant movement and adjusting pile height under an existing building is not a simple undertaking: incorporating a means of adjustment at the time of construction will simplify the process if and when it becomes necessary.

3.4.5 Grade beams

If used in conjunction with piles, void filler is required below beam.

Some settlement usually occurs creating voids around the building perimeter. This may allow melt or rainwater to drain beneath the building around pile bases.

3.4.6 Monitoring performance

The installation of monitoring equipment the investigate the performance of piled foundations of Yukon facilities should be considered wherever a research project can be identified, responsibility for monitoring is acceptable to the Yukon, and the results will be made available to the Yukon.

Research projects may be instigated by the Yukon, by private consultants or educational institutions. The Yukon would like to encourage researchers to take advantage of opportunities provided by Capital Construction projects, where the results will add to current knowledge of "permafrost engineering".

S4 WOOD STRUCTURES

Due to its versatility and general availability, wood should be given first consideration in the selection of a structural system. Wood frame structures are appropriate to northern conditions: they are relatively low cost and offer an opportunity for local employment (as compared to pre-fab or steel structures). Materials have a high strength to weight ratio, are more compact and less susceptible to damage in transit than prefabricated assemblies.

4.1 FLOORS

The structural requirements of floors in the Yukon are no different than requirements elsewhere in the country. However, special attention must be paid to coordination of structure with the building envelope and mechanical systems. Floor assemblies must often accommodate high levels of insulation, careful attention to air/vapour barrier details, plumbing runs and ventilation ducts.

Requirements	Rationale
4.1.1 Joists Use plywood web joists in place of dimensional lumber greater than 210mm depth.	*Improved weight to strength ratio, thereby reducing shipping costs, and less prone to shrinkage than dimensional lumber.*

4.2 WALLS

There are no design practices unique to the Yukon when it comes to structural systems for walls. Although wind pressures can be very high, they are similar to those experienced elsewhere. The structure must be coordinated with envelope design to ensure adequate space is provided for insulation, and that elements such as sheathing and blocking are located to benefit both structural and envelope design. Special attention must be paid to the structural support of air barriers at building corners where wind loading is greatest.

4.3 ROOFS

There are no design practices unique to the Yukon when it comes to structural systems for roofs. Although wind pressures can be high, they are similar to those experienced elsewhere. The roof structure must be coordinated with envelope design to ensure elements such as sheathing and blocking are located to benefit both structural and envelope design. Special attention must be paid to the structural support of air barriers at building corners where wind loading is greatest.

Requirements	Rationale
4.3.1 Roof Slope see A3.5	

S5 STEEL STRUCTURES

Prefabricated metal buildings are in use in the Yukon. The establishment of "design build" companies in the Yukon has made the use of prefabricated metal buildings an option worth considering for certain building types: garages, firehalls, arenas and warehouses - all buildings with fairly simple spatial requirements, which are easily defined and require large open spaces. Before deciding to use a steel structure, the designer must be satisfied that equipment is available in the community to move and lift components into place. Consider the cost of importing equipment; that shipping costs are reasonable in comparison to wood systems, and that the potential for local involvement is acceptable. Bolted connections are preferred, as there are few qualified companies capable of meeting CSA standards for field welding.

5.1 FLOORS

No special structural requirements.

5.2 WALLS

No special structural requirements.

5.3 ROOF

No special structural requirements.

S6 CONCRETE

6.1 FLOORS

Requirements | Rationale

6.1.1 Slabs

see S 3.4 Foundations

6.2 WALLS

Concrete walls are not to be used except where no other assembly can be used to meet NBC requirements, or where it can be shown that concrete would be the most economical choice.

6.3 ROOF

Concrete roofs are not be used except where no other assembly can be used to meet NBC requirements, or where it can be shown that concrete would be the most economical choice.

M. MECHANICAL STANDARDS

Introduction

People have come to expect a closely controlled, comfortable indoor environment, and ample supplies of hot and cold running water in the buildings in which they live and work. At the same time high energy costs have resulted in the need to make efficient use of energy. These two factors have led to the use of increasingly sophisticated mechanical systems, particularly with respect to heating and ventilation. However, in the Yukon, operation and maintenance of sophisticated mechanical systems can be difficult as qualified or experienced personnel are not always available in small communities and response time can be slow if someone has to be brought in. For this reason Property Management wants "simple and reliable" mechanical systems in all Yukon buildings. Of course, the demands made of a system limits just how simple it can be. There are no trouble free systems. Standards included here cover installations which have been found acceptable by Property Management to date, balancing the sometimes conflicting demands for comfort, energy conservation, simplicity and reliability.

Design consultants to ensure all equipment supplied and installed is completely operational regarding the Y2K time spans and that warranty(s) also cover the situation.

M1 CODES AND REGULATIONS

<u>National Building Codes</u>
See G6 Codes and Regulations

<u>Other Related Documents</u>
Documents referenced by the NBC, or these DESIGN STANDARDS include:

ASHRAE Handbooks and Standards
National Fire Code
National Plumbing Code
SMACMA (Sheet Metal and Air Conditioning Manufacturer's Association)
CGSB-41-GP-22 "Process Equipment: reinforced polyester, chemical resistant, custom-contact moulded"
Code for Oil Burning Equipment CSA B139
Code for Propane CSA B149
Measures for Energy Conservation in New Buildings
Department of Health "Building Standards for Potable Water and Sewage Holding Tanks"
Environmental Fuel Storage Act – 1996
Environmental Code of Practice for Aboveground Storage Tank Systems
Environmental Code of Practice for Underground Storage Tank Systems
ASME Boiler and Pressure Vessel Codes
B-51 Boiler and Pressure Vessel Codes
B-52 Mechanical Refrigeration Code
CAN/CSA – B64 Backflow Prevention Devices

M2 OPERATION AND MAINTENANCE

2.1 GENERAL

See G1 "Local Resources" and G4 "Appropriate Technology"

2.2 ACCESS

Along with the selection of equipment and systems, the design of mechanical systems must consider how location and access can affect the simplicity and reliability of mechanical systems. For example, the quality and frequency of servicing can be adversely affected when it has to be carried out in cramped and uncomfortable spaces: especially when heavy winter clothing is worn. Ducts or equipment concealed in ceiling or floors must be located such that servicing is possible under reasonable conditions. Mechanical rooms and crawl spaces must be designed to provide adequate space for servicing or replacement of all equipment.

2.3 SPARES

Property Management Personnel should determine, in consultation with designers, what spares should be provided. Replacement equipment and parts are often difficult to transport to small remote communities.

2.4 STANDARDIZATION

In the interest of maintenance the equipment for any particular function should be of one manufacturer, and compatible with the existing Yukon parts inventory presently used in the Region.

2.5 OPERATION & MAINTENANCE MANUALS

At present manuals are to be prepared in accordance with good engineering practice. Guidelines for the preparation of O&M manuals are currently in draft form only and will be distributed when completed.

M3 IDENTIFICATION

Operating and maintaining mechanical systems requires an understanding of its components, including movement of fluids, air, and mechanical parts. Nameplates, tags and arrows can all be used to assist quick identification. Consistent identification in all Yukon buildings is required so that maintainers and operators can orient/familiarize themselves easily with any building in any community across the Yukon.

3.1 PIPE PAINTING & IDENTIFICATION

Refer to Yukon Standard Colour and Identification chart #15190.101-1 issue #1 dated January 1996 (see Appendix G). The following points are in addition to the chart and are included to clarify requirements.

Requirements	Rationale
3.1.1 Text Complete spellings of material names in English should be used**.**	*Not everyone will be familiar with abbreviations*
3.1.2 Locations Pipe markers and direction arrows should be located on piping systems where they are visible from the floor of usual operating areas or readily accessible points: beside each valve where pipes penetrate walls, floor and ceilings	*Convenience.*
3.1.3 Extent of Colour Piping is to be painted its entire length in all mechanical rooms. Elsewhere, piping is to be identified by using bands of classification colour (either paint or tape) at selected points including: • Where pipes penetrate walls, floor and ceilings • every 5 metres in concealed spaces	*Convenient and consistent identification*

3.1.4 Labels

Plastic coated cloth with protective over coating and wrap around tape OR plastic "snap on" type

Stick on types fall off after time when adhesive dries

3.2 EQUIPMENT IDENTIFICATION

Refer to Yukon Standard Colour and Identification chart #15190.101-1 issue #1 dated January 1996. The following points are in addition to the chart and are included to clarify requirements.

Requirements	Rationale
3.2.1 Equipment Laminated plastic plates with black face and white centre, minimum size 90 x 40 x 2.4 mm engraved with 12 mm high lettering for major equipment, 6 mm high for other equipment. All tags and identification labels to be mechanically fastened to equipment by rivets, bolts or chains, not adhesives.	*Legibility and permanence.*

3.3 VALVES AND CONTROLLER IDENTIFICATION

Refer to Yukon Standard Colour and Identification chart #15190.101-1 issue #1 dated January, 1996 (see Appendix G). The following points are in addition to the chart and are included to clarify requirements.

Requirements	Rationale
3.3.1 Valve Tags Metal or plastic tags with 12 mm stamped code lettering and numbers filled with black paint to be used.	*Legibility and permanence*
3.3.2 Instrumentation and Controllers Laminated plastic plates with black face and white centre, minimum size 90 x 40 x 2.4 mm engraved 6 mm high letters mechanically fastened using pop rivets, screws or bolts, not adhesives.	*Legibility and permanence*
3.3.3 Valve List A typewritten valve list corresponding to "as-built" plans to be framed under clear acrylic sheet (such as plexi-glass) and mounted securely on wall with four screws	*Provides maintainers with a permanent reference in the mechanical room.*
3.3.4 Concealed Valves All concealed valves in “T” bar ceilings are to be marked with a colour coded dot as to identify its location and type.	

M4 PLUMBING AND DRAINAGE

The requirements noted here generally apply to systems contained within the building.

4.1 DOMESTIC WATER - PIPED SERVICE

Water treatment in all communities consists of the addition of chlorine and/or filtration and is the responsibility of the municipality. Even though the Yukon has abundant fresh water, capital and operating costs of delivering water are high, making conservation very important.

Requirements	Rationale
4.1.1 Water Metres to be installed in all Yukon buildings, except for buildings with holding tanks and wells, as part of construction contract.	*Water use is not currently monitored by all municipalities.*
4.1.2 Water Mains Inside water mains must be type L hard copper 75 mm and under.	*PVC alternative is susceptible to vandalism and it is difficult to ensure proper joints are made in cold temperatures.*

4.2 DOMESTIC WATER SUPPLY - TANKS

Water delivery by truck for storage in holding tanks located within buildings is common in all Yukon communities. Deliveries are generally made once or twice a week following a regular schedule. Conservation is especially important where tanked water supplies are used. The space required to store adequate water for a building can be considerable.

Requirements	Rationale
4.2.1 Gov't. Regulatory Standards	*Currently none in place*
4.2.2 Potable Water Supplies	
(1) Consumption Estimates The following are the minimum acceptable amounts to be used in calculating the estimated total daily consumption of potable water:	*Consumption estimates are normally based on program information or engineering standards, however that information is not always available or appropriate for Yukon conditions*
a) Residential Occupancies 90 litre/resident/day except that 25 litres/staff/day is sufficient for non-resident staff	*MACA Standard for residential occupancies*
b) Non-residential Occupancies 25 litres/person/day	*Based on a review of actual consumption figures for existing buildings*
(2) Supply a) a **seven day** supply is to be provided where total daily consumption is estimated at less than 600 litres (calculated on normal building operation)	This would apply to residences with up to 6 residents, or non-residential buildings with up to 24 occupants. The maximum tank size would be 4,200 litres (about 1,000 gallons). Previous Property Management direction was to size tanks for a minimum two week supply, however this was based on the need to provide adequate water for emergencies, which is not necessary for all facilities. Smaller tank sizes will help to ensure the tank will be replenished with fresh water at least once a week; and that capital and O&M costs will be minimized.
b) a **four day** supply is to be provided in all buildings where total daily consumption is estimated at more than 600 litres (calculated on normal building operation)	*This would normally apply to residences with more than 6 residents or non-residential buildings with more than 24 occupants. Smaller tank sizes will help to ensure the tank will be replenished with fresh water at least once a week; and minimize capital and O&M costs.*

4.2.3 Emergency Water Supplies

Potable water storage capacity may be increased up to a maximum 10 day supply if:

It is generally preferable to keep water supplies to a minimum in order to maintain a fresh water supply. Tanks are generally in a warm mechanical room or crawlspace and water can stagnate in that time.

a) a building is designated as a community reception or evacuation centre under the "Civil Emergency Measure Act", or

There are currently no regulations governing water supplies that must be provided in buildings designated as community reception or evacuation centres. The ten day supply is suggested by Property Management, as interruption to water delivery service could occur during severe winter storms. Typically this would apply to schools (which are often considered as community evacuation or reception centres), but this could apply to other community buildings as well. See notes in Appendix.

b) a prolonged shortage of water would require the relocation of residents

Typically this would apply to any long term care or detention facilities, and student or staff residences.

4.2.4 Fire Protection Sprinkler System Reserve

See Section 5.2

4.2.5 Combined Potable and Fire Protection Water Supplies

In buildings equipped with a sprinkler system the total amount of water required for domestic use and fire protection cannot be stored in a common tank or series of interconnected tanks:

(1) <u>Separate Tanks</u>

Potable water supplies must be stored in dedicated tanks, separate from any water supplies reserved for fire protection:

Complaints about the quality of potable water in schools where large reserves of water for fire protection have been combined in a single tank (or series of tanks) have been numerous. Combining large water supplies in one tank also makes cleaning operations cumbersome and expensive. (Potable water storage tanks require frequent cleaning while fire protection water supply tanks do not.)

a) in any building with a sprinkler system that must conform to NFPA 13

Typically this applies to schools; correctional centres or long term care facilities. This may exceed the requirements of the Environmental Health "Building Standards for Potable Water Tanks".

b) in any building with a sprinkler system conforming to NFPA 13R where daily consumption is estimated at less than 750 litres.

This will typically apply to larger community office buildings, libraries or visitor centres (where sprinkler systems are installed

4.2.6 Water Meters

to be installed in all Yukon buildings.

All municipalities do not currently monitor water use. In order for Property Management to monitor consumption, meters can simply be supplied and installed by the plumbing contractor while on site

4.2.7 Tank Construction

All water storage tanks to be fibreglass or plastic and constructed to CGSB-41-GP-22 standards.

It is now agreed that the CGSB standard is a more suitable standard for water storage tanks, replacing the previous requirement for water storage tanks to meet AWWA 950. The rated test pressures of the AWWA standard far exceed those required for an atmospheric tanks and construction to CGSB ensures better longitudinal strength of pipe tanks

Galvanized steel, aluminium and concrete are not acceptable.

Fibreglass and plastic tanks have proven durability, are relatively lightweight for shipping and can be manufactured to an acceptable and consistent standard

4.2.8 Location of Domestic Water Tanks

Potable water tanks must be located in a heated area where the temperature is kept between 5 and 15º C.

To prevent tank contents from freezing

Avoid locating tanks in the same room as boilers or furnaces.

If potable water supply is warm it is objectionable to users and promotes bacteria and algae growth.

Buried water storage tanks are not acceptable.

Difficult to access for maintenance

(1) Small Tanks
(up to 4,200 litre capacity)

a) Tanks enclosed within occupied building area (may include a basement) are preferred.

Tank small enough to be located in occupied building areas where it is easily accessible

b) Tanks enclosed in a heated crawlspace are acceptable.

Where a heated crawlspace is available the space may serve as a service space. It is preferable if the tank location in the crawlspace takes advantage of any natural slope on the building site. The objective is to limit the extent the main floor level has to be raised to accommodate tanks and access clearance, and reduce ramp and stair access requirements.

c) Tanks enclosed in suspended tank rooms are acceptable.

Where the building footprint must be minimized and space cannot be made available within the occupied building area, and a heated crawlspace cannot be provided due to soil conditions, a suspended tank room is acceptable. This generally results in main floor level being raised considerably above grade, and can result in the need for extensive ramp and stair construction.

(2) Large Tanks
(over 4,200 litre capacity)

a) Tanks enclosed in a heated crawlspace or basement are preferred.	*Tanks of this size take up considerable space and locating them beneath the main floor does not increase the building footprint. Although the main floor level may have to be raised to accommodate tanks and access clearance (resulting in additional costs for stairs and ramps) this is generally preferable to increasing the main floor area, building envelope size and structural capacity*
b) Tanks enclosed in suspended tank rooms are acceptable.	*Where a heated crawlspace or basement cannot be provided because of soil or site conditions, a suspended tanks room is acceptable. This generally results in the main floor level being raised considerably above grade, and can result in the need for extensive ramp and stair construction. As much as possible, suspended tank rooms should be located to take advantage of any natural slopes on the building site.*
c) Tanks enclosed in the occupied building area may be considered.	*Cost of providing main floor area with adequate structural support, and site limitations generally makes this alternative undesirable*
4.2.9 Fill and Vent Piping Fill and vent piping to be Schedule 80 PVC within the building and change to copper pipe where it penetrates exterior walls or fire separations.	*Plastic pipe gets very brittle in cold outdoor temperatures and can easily crack or break. See NBC 3.1.9.1 and 3.1.9.4 regarding penetrations of fire separations*
Fill pipe to be located such that water delivery personnel do not have to pass sewage pump-out connection when connecting hose from vehicle to fill pipe	*This reduces the risk of the water hose being dragged through spilled sewage at pump-out location. Fill and pump out service points, to be determined based on access route, with water fill point being the first accessible to arriving vehicles*
Fill and vent piping to be graded back to tanks	*So that water drains back to tank rather than spilling on ground where it freezes and creates a hazard for water delivery personnel.*
Vent outlets to be located on the top of water tanks	*When located on the side of the tank the effective capacity of the tank is reduced.*
Dual venting to be provided for all water tanks over 3000 litres: a primary vent to the exterior of the building; and a secondary vent terminating at an interior drain (i.e. over janitor sink)	*Frozen condensation from tank can block exterior vent through winter months, and create potential for tank to rupture when filled*
Vents terminating outside the building may be screened where dual venting is provided.	*Environmental Health standards suggest both means of preventing dust, birds and*

Otherwise terminate with elbow to comply with Environmental Health Standards.

insects from entering tank, but screen fine enough to exclude insects during summer months will freeze over in the winter.

4.2.10 Access to Water Tanks
Water tanks must be accessible to maintainers for cleaning and repairs when necessary. The following access locations are preferred:

a) Top access with a minimum of one meter clear space above the top of at least one manhole(s) is preferred. Built-in steps or ladders to be provided where access located more than 1200 mm from adjacent ground level.

It is important to make access to interior of tanks as simple as possible to facilitate frequent cleaning. Maintainers must work in enclosed tanks in uncomfortable conditions so the tanks themselves should be constructed to make the chore as easy as possible. The extra effort in providing easy access should result in fewer complaints about contaminated water supplies.

b) End or side access to tanks is acceptable where service space height is restricted, and tank construction allows for removable ends

End or side access may in fact provide easier access for maintainers than top access, however tank construction is complicated by the need to provide a sealed closure at the tank ends

4.3 DOMESTIC HOT WATER SUPPLY

Hot water use can account for a significant portion of a building's energy costs. Systems must be selected based on initial capital costs as well as operating costs of the equipment.

Requirements	Rationale
4.3.1 Oil Fired Domestic Hot Water Heaters Dedicated, oil fired HW heaters to be used in all Yukon buildings where: a) fuel oil is used for the building heating system b) over 100 litres HW per day are needed in all Yukon regions	*Lowest operating cost where large quantities of domestic hot water required, and can be tied into the same fuel supply used for heating system. Typically installed in schools and recreation facilities with showers, and residential facilities including student hostels, long term care facilities and group homes Lower electrical costs in the Yukon make oil fired heaters less economical unless larger quantities of HW required*
See note re: electric HW heaters M4.3.2	*In some instances a combination of oil fire and electric HW heaters should be considered for the same facility*
High efficiency burners only (85% or better) to be used.	*Minimizes fuel consumption*
Non-combustible block bases w/6mm steel plate are to be used under all oil fired HW heating equipment.	*Past experience has shown that even equipment approved for use on a combustible base has burned into the floor.*
The high limit controls on fuel oil fired domestic	*Provides safety protection shutdowns*

water heaters are to be manual reset type.

Refer to section in M7.2.2 for chimney and vent requirements.

4.3.2 Electric HW Heaters
may be used only where few fixtures are served and estimated daily hot water use is less than less than 100 litres per day in all other regions.

Typically selected for smaller buildings with low HW use, in conjunction with forced air heating system such as maintenance garage, fire halls, community offices. Life-cycle cost will generally be lower than that of oil fire heaters for this type of application.

Use a minimum of RSI 1.8 (R-10) insulation on water heaters and hot water storage tanks.

Reduce life cycle cost.

Small under the counter electric domestic hot water heaters may be used alone or in addition to an oil fired HW heater. Electric HW heaters should also be considered where a few fixtures must be located some distance from a central domestic HW source and a recirculating system would otherwise be needed to maintain HW.

The high cost of a recirculating system is not justifiable where fixtures use is not high. Local heaters should be considered for complexes or multi-purpose buildings where hot water is required at remote areas of the buildings. Typically this would include public washrooms where HW is only required for hand washing.

4.3.3 Propane / Natural Gas Fired HW Heaters
To be used in all Yukon buildings where propane or natural gas is used for the building heating system.

Use a minimum of RSI 1.8 (R-10) insulation on water heaters and hot water storage tanks.

Reduce life cycle cost

4.3.4 Temperature
See "Measures for Energy Conservation in New Buildings"

Note: this document is being revised and will be released as an Energy Code in 1995. (see NBC/NFC News, Spring 1992)

a) When less than 50 per cent of the total design flow of a *service water* heating system has a design discharge temperature higher than 60 C, separate remote heaters or booster heaters shall be installed for those portions of the system with a design temperature higher than 60 C.

Recommended by National Energy Code for Buildings Review 2.0 Reference 6.2.5.1(1)
Allows primary DHW heater to be set at lower temperature to save energy. Typically acceptable for buildings where large volumes of hot water are not required, such as air terminal buildings, school, offices, libraries and service buildings

b) Tempered water is required for showers, lavatories, and classroom sinks in elementary schools and similar applications. The tempered water is to be provided by using a pressure balanced mixing valve located at the fixture and set at 42 C.

This is a more cost-effective method of providing tempered water than having two separate domestic storage and distribution systems.

4.4 DOMESTIC WATER CIRCULATION

Domestic water pressure is provided either by a municipal system or by individual pressure pumps where buildings are equipped with holding tanks. Although freezing of water circulation lines was a common problem in older buildings, changes to standard design principles have decreased this risk: increased insulation and air tightness of new buildings; concentration of plumbing fixtures locations; and keeping plumbing lines out of exterior walls are now accepted as common practice in cold climates.

Requirements	Rationale
4.4.1 Insulation Insulate all hot water piping with RSI 1.4 (R-8) insulation.	*Reduce life cycle cost.*
4.4.2 Domestic HW Circulation Domestic hot water re-circulating line should be provided only where: heat loss due to distance of fixture from HW tank would cause users to waste more water than they need waiting for hot water; and where HW requirement at the fixture is estimated at more than 30 litres per day.	*Typically required wherever showers, baths, or laundry facilities are provided and hot water use is high. The cost and complexity of re-circulating system is generally not warranted in the case of small buildings where only a minimal amount of hot water is used*
When required, re-circulating lines are to be controlled by a time clock and off during unoccupied hours. Pump is to be smallest kW possible**.**	*Reduce energy requirements.*
4.4.3 Drain Valves All water pipes must be pitched and drain valves must be provided at all low points.	*Plumbing Code allows pipes to be blown out with air, or drained by valves at low points. Property Management prefers drains as this simplifies operation for maintainers.*
4.4.4 Location Avoid locating water piping in exterior walls.	*To reduce potential for pipes to freeze*
4.4.5 Tees Use factory tees only. Do not use Tee-drill.	*Replacing the tee can repair factory tees. Repairs to Tee-drill require special equipment to which maintainers may not have access.*
4.4.6 Access Easy access must be provided to all valves and faucets.	*To allow maintainers to respond to any problems or repair equipment.*

4.5 SANITARY WASTE AND VENTING

The combination of the extremely cold climate and the need to use low volume fixtures in most Yukon buildings can cause drainage problems, which can be minimized by design. The goal is to keep the drainage system operational with minimal use of supplementary heating such as heat traces, and to ensure easy access to clean-outs so that when problems occur (generally blockages) they can be quickly corrected.

<u>Requirements</u> <u>Rationale</u>

4.5.1 Grade

All waste lines must be graded a minimum of 2%.

Although this is the minimum allowed by Code within a building actual grades achieved in construction have commonly been inadequate

4.5.2 Location of Drain Lines

Do not locate drainage lines in exterior walls

To reduce potential for freezing of drain lines.

4.5.3 Trap Seal Primers

If a drain is provided for occasional use a trap seal primer is required.

Traps dry out and allow odours into the building. Typically occurs in floor drains of mechanical rooms and change rooms.

4.5.4 Clean-outs

Clean outs are required at <u>all</u> changes of direction greater than 45º on sanitary waste lines.

Note: this exceeds requirements of the Canadian Plumbing Code but is considered necessary because there have been so many cases of blocked drains in Yukon buildings.

4.5.5 Roof Vents

Copper vent piping to be used for the last 3 meters before vent exits roof. Pre-insulated sloped copper plumbing vent jacks required. Plumbing vent jacks by Thaler Roofing Specialities are the suggested standard.

Uninsulated vents can freeze over rising vapour condenses then freezes on where the vent exits the heated building. Frost build-up can eventually close the vent entirely. Heat trace has been used in the past to rectify this problem, but an insulated copper vent reduces frost build up by keeping vent surface warm: avoiding the cost and maintenance associated with heat trace.

4.5.6 Insulation

40 mm standard pipe insulation to be used for drainage stacks and vents within 1800 mm of outside wall and roof openings

To prevent freeze-up of condensation which may block vents by keeping stacks and vents warm.

4.5.7 Special Traps

(1) <u>Plaster traps</u>
must be installed on sinks used for any biology, horticulture or art activities.

Required because of potential for blockage by materials going into the sink. Typical locations include schools, colleges, adult education facilities, group homes, health care centres, workshops, young offender facilities, and hospitals

(2) <u>Interceptors</u>
must be installed wherever deep frying equipment may be used.

Typically required wherever commercial kitchen equipment is installed, such as in correctional facilities, hospitals, or in community kitchens located in community halls or gyms.

(3) <u>Acid dilution traps</u>
must be installed wherever acids may be used.

(4) <u>Oil Interceptors</u>
Must be installed in grading station, garages or shops where there is a possibility of grease or oil entering the sanitary system or septic system.

Typically required in photo developing facilities which may be included in schools or health centres.

4.6 SEWAGE DISPOSAL- PIPED SERVICES

Where they are in place, the owner is responsible for all costs associated with connecting a new building to existing mains. Work required generally extends beyond the property line, and is completed as part of the general construction contract.

Notes and Recommendations: It should be noted that in all communities with piped services, there are usually some areas still served by truck. Consultation with the municipality is essential to determine the capability and capacity of existing services, and to become aware of any planned changes or improvements to the system which may affect the project.

4.7 SEWAGE DISPOSAL - HOLDING TANKS

Where piped services are not available, soil conditions make septic fields a viable option in very few locations in the Yukon. Buildings in the Yukon rely on holding tanks serviced by pump-out trucks operated by the municipality. Frequency of pump-out service varies with communities and may be dependent on equipment available. Tanks can be located either in an enclosed crawlspace, within the building, or sometimes buried outside the building. This system is dependent on regular servicing to function properly: sewage must be emptied as often as water is delivered.

Requirements	Rationale
4.7.1 Health Standard Refer to Environment Canada Standards.	*This is a clarification of Environmental Health Standards, which could be interpreted to include fire and emergency reserves.*
4.7.2 Capacity Sewage holding tanks are to be sized for minimum 1.5 times capacity of the domestic potable water supply only i.e. do not include water supply reserved for fire protection or emergency use in this calculation.	*Specifies type of device referred to in Environmental Health standards.*
4.7.4 Construction All sewage holding tanks used in Yukon buildings are to be fibreglass, polyethylene or CPPVC.	*Concrete or metal tanks unacceptable due to potential cracking or corrosion.*
4.7.5 Removal of Solid Matter Environmental Health Standards state that "Sewage holding tanks shall be designed and constructed to allow the complete removal of solid matter that can be expected to settle in any part of the holding tank".	*A clarification provided by Environmental Health notes that this was intended to mean removal by sewage pump out vehicles. They are concerned over reports that sewage tanks have, on occasion, been cleaned out manually, and will be looking to see that tanks are designed to allow sludge to be effectively removed by the vacuum truck - whether by sloping the tanks or by having extra access points.*
4.7.6 Location of Sewage Holding Tanks To prevent tank contents from freezing, tanks must be located in a heated area, or be double walled, insulated and heat traced. The following preferences should serve as a guide:	
a) Tanks buried outside the building are acceptable wherever the soil conditions and water table permit. Buried tanks must be insulated and heat traced.	*This installation allows sewage tank to be located close to roads for servicing and does not require additional building space*

b) Tanks enclosed within the building (including enclosed crawlspaces) are acceptable where gravity flow is provided. The use of lift stations and/or grinder pumps is not generally acceptable

Typical of most Yukon buildings in areas of permafrost. Lift stations and grinder pumps increase maintenance problems and costs.

c) Tanks located in unheated crawlspaces are not acceptable.

Heat trace would be required to prevent contents from freezing, and would result in high electrical operating costs

4.7.7 Pump-out and Vent Piping

Sewage tank pump-out suction line is to be graded back to the sewage holding tank, securely anchored to building.

Prevent sewage spills on ground around pump out

Pump-out piping to be:

- black iron piping outside the building and extending 2 meters into the building
- schedule 80 PVC within the building (with the exception of the first 2 meters)
- insulated within 2 meters of the building
- securely anchored to the building

Plastic pipe not to be used outside as it is subject to cracking or breaking at very cold temperatures

Cap and chain to be installed on the pump-out suction line quick connect fitting.

This is in addition to the requirements noted in Environmental Health Standards

A secondary vacuum relief vent is required on all sewage holding tanks. A spring loaded check valve set to 14 kPa must be used.

In the event the tank vent is blocked, the check valve provides a relief to prevent the tank from collapsing while it is being pumped out.

4.8 FIXTURES AND BRASS

Fixtures in Yukon buildings are generally required to be low consumption type to conserve water used, and wastewater produced. This requirement is most important for buildings with water and sewage holding tanks.

<u>Requirements</u> | <u>Rationale</u>

4.8.1 Colour

All vitreous china or fibreglass plumbing fixtures to be white. Coloured fixtures may be considered only under special circumstances.

General appearance, and to make matching simple if replacement is necessary.

4.8.2 Fittings and Trim

Triple chromium-plated exposed fitting and trim to be used.

Quality and durability required for public use buildings

(1) <u>Infra-red sensing plumbing trim</u>
Generally is acceptable for use in Yukon facilities.

Infra red sensing trim has been approved for use on several projects to date.

(2) <u>Spring-loaded faucets</u>
Spring loaded faucets or flush-o-meter type are acceptable for use in Yukon facilities.

Spring-loaded faucets discourage users from using them.

(3) <u>Shower heads</u>
All shower heads to be low-flow type (9 litres per

Reduce water use, water heating and life-cycle cost minute or less)

4.8.3 Sinks

All sinks to be stainless steel.

Sinks typically required in kitchens, health centres, correctional facilities, and classrooms where enamel finishes would be subject to damage

P-traps for copper piping are to be cast brass. ABS or PVC TRAPS are to match the installed drainage piping.

Lighter gauge traps require frequent replacement.

4.8.4 Hand Basins

All hand basin faucets to be low-flow type (9 litres per minute or less).

Reduce water use, water heating and life-cycle cost

Stainless steel basins to be used for all high public use facilities.

Vitreous china or stainless steel basins are acceptable in all other facilities

Enamel on steel and plastic or fibreglass basins are not acceptable in any Yukon facility.

Typically required in schools, community recreation facilities, air terminal buildings, and in all corrections facilities. Fixtures must be durable enough to withstand the level of abuse they are often subject to in these types of buildings. Basins in schools and community recreation facilities are frequently damaged.

4.8.5 Toilets and Urinals

All toilet fixtures to be low water use (4 to 9 litres per flush).

To reduce water use. Although there have been problems in the past with blockages designs have improved and most low flush fixtures are now as effective as conventional 20 litre toilets. Handicapped fixtures are also now available in 6 litre flush

Vitreous china toilet fixtures are preferred. Fibreglass or plastic models are acceptable only in very low-use facilities.

Fibreglass and plastic models are not durable enough for most public use buildings, although they may be acceptable for installation in facilities normally occupied by less than 6 people

Use of propane fired incinerating toilets is prohibited

Propane supply is generally difficult, and installation and maintenance costs are high.

Toilet seats in schools and community recreation facilities to be extra heavy open front seat ring only.

Toilet seats in arenas and schools have been high vandalism targets.

4.8.6 Drinking Fountains

If self-contained refrigerated type drinking fountains are used remote refrigeration units are not acceptable.

Water is wasted when people run the water to empty warmed water from lines. Self-contained units are easier to access for maintenance and repairs

4.8.7 Hose Bibs

To be keyed, non-freeze, self-draining type, 18 mm complete with stop and drain valves inside building.

Simple to drain in preparation for winter.

4.8.8 Shock Absorbers

Manufactured water hammer arrestors c/w-isolating valves are required at all groups of fixtures.

4.8.9 Roof Drains

Where roof drains empty into a rock pit or are goose necked on to the ground, a hose bib and valve must be installed at the base of the stack. The hose bib must be easily accessible.

Provides alternate method for draining when the outside drain is frozen.

M5 FIRE PROTECTION

Fire fighters and fire-fighting equipment available in most Yukon communities is limited and the consequences of fire in small remote communities can be severe. The basic principles here are to ensure occupants are alerted and can get quickly and safely out of the building, and to stop localized fires quickly, before they spread.

5.1 PORTABLE EXTINGUISHERS

Are to be provided in all Yukon buildings and intended for use by occupants to extinguish small fires, immediately.

Requirements | Rationale

5.1.1 Room Temperature Operation

ULC approved, rechargeable fire extinguishers are acceptable for use in all facilities which are occupied on a daily basis, are not subject to sudden temperature drops, and are equipped with low temperature alarms. Extinguishers are to be ABC rated.

ABC rated extinguishers require less maintenance than other types allowed by code, such as pressure water types.

5.1.2 Low Temperature Operation

Wherever there is a potential for the temperature of space where fire extinguisher is kept to fall below freezing, extinguishers must be multiple purpose dry chemical extinguishers rated for -40ºC.

Typical application are maintenance garages, firehalls, warehouses or any other facility which may not be occupied daily; where opening of large garage doors can cause temperatures to drop quickly; or anywhere extinguishers are intended for outdoor use.

5.2 SPRINKLER SYSTEMS

Sprinkler systems have been installed in many new Yukon buildings since the 1960's, either as required by code or regulation, at the request of the Fire Marshal, or at the request of the Yukon funding department. Combining potable water with sprinkler system reserves has been a much-discussed topic for several years (see section 4.2). The following requirements should clarify Property Management preferences and respond to public safety concerns:

Requirements | Rationale

5.2.1 Design

Pipe sizes and fire protection system layout must be reviewed by the Fire Marshal, Government of Yukon. Systems to be hydraulically designed, with as-built drawings and calculations stamped by a professional engineer.

Yukon Fire Marshal is the authority having jurisdiction.

Dry systems are acceptable for Yukon facilities.

5.2.2 Sprinkler Heads

Quick response heads, rated to 74º C are required except as noted below.

By responding quickly, the quantity of water reserved for fire protection can be reduced.

High temperature heads, rated at no less than 100º C required in mechanical equipment rooms, such as generator and boiler rooms

Temperatures can often exceed 74ºC in the mechanical room.

Dry pendant heads are required in entrance foyers.

There is a greater potential for freezing in entranceways where doors are opening to the outside.

A glycol loop is required wherever sprinkler piping is installed in crawlspaces close to outdoor air vents, louvres or intakes.

Pipes subject to freezing.

5.2.3 Pumps and Controllers

Fire pumps and controllers must be ULC listed.

5.2.4 Water Reserve - Tanked Water Supply

Whenever an automatic sprinkler system is installed water supply calculations must be designed by an engineer with stamp drawings provided

Previous practice was to conform to NFPA 13 regardless of building type or size. This recent ruling takes room size and building use into consideration and may result in significant cost savings by reducing size of tanked water reserve.

a) Buildings where NFPA 13D applies will require a minimum of 985 litres of water reserved for sprinkler system.

This will apply to most residential uses, including student hostels, group homes with fewer than 10 residents.

b) Buildings where NFPA 13R applies will require a minimum of 5,910 litres of water reserved for the sprinkler system.

Typically this will apply to small gymnasiums, community offices containing council chambers, courthouses, visitor centres, and libraries where sprinkler systems are installed.

c) Buildings where NFPA 13 applies will require a minimum of 17,035 litres of water reserved for the sprinkler system.

This will typically apply to buildings designated as community reception or evacuation centres under the "Civil Emergency Measures Act of the Yukon", and all Group B occupancies as classified by the National Building Code, such as long term care facilities, detention centres and treatment centres. See Appendix E.

5.2.5 CO2

Use is limited to where required for commercial range hoods, unless approval is given to use where special electronic equipment installed.

Difficult to clean up

5.2.6 Halon

Not permitted

Halon use is restricted because of environmental damage, (destroys ozone) and transportation hazards

5.2.7 Victolic Fittings

When using Victolic fittings in unheated areas, the Victolic rubber seals must be rated for -40 C.

M6 FUEL SUPPLY

The most commonly used fuel in the Yukon is P-50 diesel, which will flow in temperatures as low as -50º C. Propane is currently distributed in most communities. Propane is also susceptible to liquefying at cold temperatures and requires the use of a vaporizer or heating blanket at temperatures below -30ºC. Electrical power is generally generated by community diesel power plants, making it far too expensive to use for heating.

6.1 FUEL OIL DELIVERY AND STORAGE

Fuel delivery is through private distributors. The Government of the Yukon keeps track of fuel consumption and cost figures to monitor building performance and for planning purposes.

Requirements	Rationale
6.1.1 Fuel Metres and Gauges Totalizing fuel oil metres are not required unless one tank is serving more than one unit in the same building, and metres are required to monitor consumption for each unit.	*Metres allow maintainers to monitor fuel consumption, however, consumption figures are now available through the "Utilities Management System" and the use of metres is redundant.*
All tanks must be equipped with a remote reading level gauge	*Code requires some means of measuring the fuel in the tank, and the remote gauge can be located in the mechanical room where it is easy for the maintainer to monitor*
6.1.2 Tanks (1) Tanks To comply with these standards CCME – Environmental code of practice for above ground storage tank systems CCME – environmental code of practice for underground storage tank systems.	*All tank installations and repairs to comply with all codes listed under (M-1 Codes & Requirements). Environmental Act 1996/194 Storage Tank Regulations and B139 Oil Burner Code.*
(2) Auxiliary tanks To comply with B139	
(3) Stands Fuel storage tank stands must be fabricated from steel. Timber stands are not acceptable.	*Although required by code, this is sometimes overlooked*

6.1.3 Fuel Tank Capacity

(1) Primary Tanks

a) A two week supply, calculated at continuous maximum operating load (including heat and standby power) is the minimum required wherever a standby generator is to be installed or a long disruption in heating would require relocation of residents, or could potentially damage essential equipment This calculation of maximum operating load will be based on a minimum of 12 hours continuous fuel supply to all oil fired units running at maximum firing rate.

Even with regular fuel delivery, blizzards or storms can make delivery difficult for periods of up to 2 weeks. Two week supplies are not always enough in the communities as weather gets colder, fuel delivery delays get longer.

Buildings intended to remain operational at all times include student hostels, long term care facilities, detention centres, firehalls and schools

b) A one week supply, calculated on continuous maximum operating load is the minimum required for all buildings that are not essential in the event of power failures, and can be prepared (i.e. water lines drained) for freezing conditions

i.e. libraries, visitor centres, arenas, curling rinks, adult education centres, maintenance garages

(2) Auxiliary Tanks

Where auxiliary tanks are required (see M 6.2 Fuel Temperature), interior fuel tanks are to be sized for a two day supply at peak load (including consumption by the standby generator if there is one) with automatic refill at 2/3 point. This calculation of maximum operating load will be based on a minimum of 12 hours continuous fuel supply to all oil fired units running at maximum firing rate**.**

Ensures a tempered supply of fuel is available and provides a 2-day back up supply.

If fuel does run low there is time to refuel tanks before the situation becomes critical. Adequate advance time is given by monitoring the level in the auxiliary tank, and the expense of extending the alarm to the exterior tank can be avoided.

6.1.4 Location and Access

(1) Primary Tanks

Suitable platforms with steps and handrails to be provided for filling exterior tanks.

To provide safe conditions for fuel deliverer.

Buried fuel tanks are acceptable for Yukon buildings

Although environmental protection requirements make them costly. Buried fuel tanks should not be used for buildings with wells supplying domestic water.

Tanks of up to 2,275-litre capacity may be installed within the heated building envelope.

Where space can be provided allows tanks to be concealed; however the potential for spills makes this option undesirable

No fuel tanks are to be located in crawlspaces.

Spills can go undetected.

(2) Auxiliary Tanks

To be located in mechanical or boiler room convenient to oil burning equipment.

6.1.5 Spill Protection

(1) Exterior Tanks

If a fuel tank is required to have spill protection because of its size, the tank is to be horizontal type for above-ground installation. The containment dike is to be closed off and secured with a removable cover, and the tank is to be enclosed on all sides by a fence, leaving adequate access on all sides of the tank for maintainers and to permit fuel delivery. Self-contained tank assembly or double wall vacuum monitored are recommended**.**

The "Environmental Protection Act" specifies when spill protection must be provided Unprotected dikes are a safety hazard especially to small children as they can fill with water if not covered. Fencing will further discourage access and tampering by unauthorized persons

(2) Interior Tanks

Containment with 110% capacity is required beneath all interior tanks**.**

To contain spilled fuel and prevent infiltration to other areas or buildings. All tanks to have an overflow return line to primary tank.

6.2 OIL SUPPLY (DISTRIBUTION)

Requirements

Rationale

6.2.1 Fuel Temperature

Fuel stored in exterior tanks must be preheated before reaching burners either by providing an auxiliary tank or extending run of supply pipe in mechanical room

Peak efficiency of oil burners depends on constant oil temperature. As most heating oil is stored in exterior tanks, it enters the building at very low temperatures. Auxiliary tanks are typically used in larger public buildings such as schools, community gyms, larger health centres, or correctional facilities. Extending supply pipe is adequate in most smaller buildings where fuel consumption rate low enough that fuel in line has time to temper before reaching burners

6.2.2 Transfer Pumps

Two bulk fuel oil transfer pumps are required wherever an auxiliary fuel tank is installed. To be controlled by electric liquid level controllers for on-off automatic pump operation. Pressure gauges and a pressure relief valve (integral or external) to be installed on all fuel transfer pumps.

To transfer fuel from exterior primary tank to interior auxiliary tanks.
One pump is operational; the other a standby pump than can be put into operation quickly and easily. Pressure gauges allow monitoring of pump performance.

Standby fuel pumps are to be installed and sized to handle 100% of full system load. Do not use automatic start / alternators use hand selector switch only.

In the event of a pump failure a maintainer must come to the facility and is then aware that the primary pump has failed. The standby pump is permanently installed to ensure it is there when needed, and the system can be quickly and easily switched over.

6.2.3 Piping

(1) Materials

All exterior fuel-oil piping to be schedule 40 steel screwed pipe minimum 50 mm size, valved at the tank and immediately inside the building, and properly supported. Buried lines must be welded when used - however their use is to be avoided whenever possible.

Type K tubing is approved for underground fuel lines. Copper doesn't need painting.

(2) Weather Protection

All exterior oil piping (buried or exposed) must be protected with weather resistant tape

To protect pipe from rusting

(3) Two Pipe Systems

Where an auxiliary tank is installed, a two-pipe system (supply and return) is required for all oil burning equipment.

Eliminates problems with air locks, and returning the fuel to an interior tank maintains it at room temperature.

(4) Gravity Feed

If fuel is gravity fed to burners directly from an exterior tank, do not use two pipe system

Would cause preheated fuel to be returned to exterior tank and result in condensation.

(5) Yukon Territory Standard

A valved 50x150 nipple and cap is to be installed on all fuel tank piping with installation as follows: tank – valve -- 90 elbow -- tee (branch to building) -- valve -- 50x150 nipple and cap

Serves as a dirt pocket and allows condensation to be drained from the tank to prevent water build up from reaching outlet to burner.
This is a preference of Yukon maintainers - others rely on other methods of removing condensation build-up from tanks

6.2.4 Flex Connectors

Exterior fuel piping (supply and return) must have braided steel flex connectors installed prior to pipe entering building.

To prevent stress from differential settlement.

6.2.5 Isolating Valves

Each piece of fuel burning equipment must have an isolating valve, on the supply line. Oil burners must have check valves on return lines.

To allow equipment to be disconnected for maintenance or replacement.

Fusible valves to be used for all supply lines to all oil burning equipment, including generating plants

Code only specifies heating equipment as requiring fusible valves. As generating plants are common in larger Yukon buildings, it is important to note that fusible valves are also a requirement on fuel lines to generators to stop flow of fuel in case of fire

6.2.6 Gauges

Provide dial type pressure gauges with 90mm diameter dial, scaled to the application intended and located at the suction and discharge of each pump.

Pressure gauges installed at appropriate locations assist the building operators in system operation and performance evaluation. Incremental cost of gauge installation can be offset by operational and operating system efficiency

Provide an isolation valve for each gauge, a snubber for pulsating operation, and a diaphragm for corrosive service applications.

6.2.7 Filters

Requirements	Rationale
Adequate oil filter to be provided at each oil burner.	*Ensures clean fuel to all burners.*

6.3 PROPANE DELIVERY & STORAGE

Gas installation codes combined with local experience dictates installation and storage practices.

6.4 PROPANE SUPPLY

Propane code.

M7 HEATING

Minimizing the energy consumption of public buildings is important in the Yukon where fuel costs are extremely high. Added to this, the severe climate means that heating must be provided over much of the year.

7.A "DUAL FUEL OPTION"

<u>Requirements</u>	<u>Rationale</u>
Government Services has committed: 1. To complete engineering for the dual fuel option. 2. To provide for required space in the mechanical room. 3. To provide conduit space connecting the utility transformer to the electrical and mechanical rooms, and 4. To upgrade the utility transformer to provide sufficient capacity.	*To provide opportunities to utilize Surplus Hydro Electricity in Government Buildings*
The design objective for indoor space temperature in occupied areas during winter conditions is 21 degrees C and during summer conditions is 24 degrees C	*To ensure heating and cooling systems are properly sized for the actual requirements of the building.*
The outdoor air design temperature shall be according to the 2.5 percent January or July Design Temperature indicated in the most recent supplement to the National Building Code. Use similar data available from Environment Canada, for specific communities, which are not listed in the supplement.	*To advise the design industry of acceptable building criteria in the Yukon.*
Whenever possible make provision for temperature setback of buildings during unoccupied periods, using a direct digital control (DDC) system, automatic setback thermostats or other automatic system	*To minimize energy consumption*

7.1 FORCED HOT AIR SYSTEMS

Forced hot air heating systems are common in the Yukon as elsewhere in the country. Although forced hot air systems are not suitable for all types and sizes of facilities, their relatively simple servicing requirements make them a good choice in many circumstances.

Requirements	Rationale
7.1.1 Furnace Type	
Rated seasonal furnace efficiency shall be 85% or better.	*Reduce life cycle cost for heating building.*
Riello Burners must be specified.	*Standardization and Efficiency*
Two speed fans required where ventilation provided by furnace	*Provides continuous air circulation, and reduces stratification of air.*
Where a separate ventilation system is installed, a one speed fan only to be provided.	*. Continuous use of the furnace fan is redundant and undesirable considering high electrical costs.*
Provide stainless steel heat exchangers on forced hot air heating systems where more than ten- percent outdoor air for ventilation is required and/or where the entering air temperature is below 13 C Refer to Section M 7.2.2. for chimney and vent requirements.	*Standard heat exchangers tend to corrode and fail prematurely when exposed to low inlet air temperatures*
7.1.2 Combustion Air All fuel-burning appliances require combustion air. see requirements in 7.2 below	
7.1.3 Heating Capacity Forced air heating is suitable only for buildings where multiple heating zones are not required.	*Typically used for small buildings such as firehalls, garages, small office buildings, small health centres or residences. Not considered suitable for use in arenas or gyms or where more than one furnace would be required to provide separate heating zones.*
7.1.4 Distribution Ducts located in a raised floor are preferred over those located in ceiling spaces.	*Better heat distribution when hot air is introduced at lower levels, and avoids penetration of building envelope assembly*
Where exposed ducts are acceptable, they may be located overhead.	*Generally results in poor heat distribution, but this may be acceptable in some situations where comfort levels are not critical. An example would be a firehall where offices are located on a second floor/mezzanine so comfort level is fine where it's needed. Ceiling fans increase comfort level at floor area if overhead ducts are required.*

7.2 HYDRONIC HEATING SYSTEMS

The most commonly used heating system in Yukon public buildings because of the ability to heat large areas with multiple heating zones.

Requirements — Rationale

7.2.1 Boilers

Rated seasonal furnace efficiency shall be 82% or better

Reduce life cycle cost for heating building

Three oil-fired cast iron wet base boilers, suitable for use with propylene glycol heating solution, are required. Each boiler to be sized to handle 50% of the design load.

Sizing the three boiler heating system to no more than 100% of the building design heating load with any two boilers running will ensure the heating plant matches the actual building heating load. The heating plant will operate more efficiently when not oversized. The third boiler supplies required back up boiler.

Retention head burners only to be used.
Riello Burners must be specified.
Full modulating burners preferred.

Most efficient burners available.
Standardization and Efficiency.
Efficiency.

High limit controls to conform to ASME standards.

In cases where there is not a daily inspection carried out on the boiler, it is undesirable to have the boilers remain shut down until the high limit is reset manually. If not reset promptly considerable damage could result to the building from frozen piping and fixtures.

7.2.2 Chimneys and Vent Connectors

A separate chimney for each oil burning appliance is preferred.

Although this may increase the number of penetrations through the building envelope, shared chimneys are always oversized

***Note: although the terms "stacks" and "breechings" are commonly used, CSA Standard B139 no longer includes these terms in its definitions**

Pressure rated chimneys is required for all forced draft appliances.

Chimney lengths should be minimized, and kept within the heated building envelope as much as possible with the exposed exterior length kept to a minimum.

Keeps stack temperature high for more efficient combustion: low stack temperatures result in condensation on the "chimney cap" which freezes and builds up over the winter and can eventually block the chimney

Where vent connectors are necessary, they are to be installed to permit easy removal for cleaning.

Insulation is required on vent connectors to prevent accidental burns (of maintainers). The insulation must be easily removed and replaceable, or there is a risk that it will be improperly replaced

Each oil burning appliance is to be provided with its own barometric draft regulator.

The pressure in the chimney varies considerably because of wind conditions, stack effect from temperature difference, and (in the case of multiple fuel burning appliances) according to how many fuel burning appliances are operating at a time. Barometric dampers eliminate one major *variable, and stabilize draft conditions for each fuel burning appliance*

Cleanouts are required on all changes of direction of the vent piping on all fuel burning appliances.

All portions of venting are to be easily accessible for cleaning

7.2.3 Combustion Air

Where possible, bring air in at a low point in the mechanical room, and duct to outlet at a high level close to ceiling. Where this is not possible the duct should have a trap

This installation controls the amount of cold air drawn in for oil burning equipment, and avoids cold air from flooding in at floor level which can freeze water lines

If combustion air cannot be ducted within mechanical room to a high level outlet, then the air must be preheated using a unit heater. Quantities of preheated air required (i.e. after expansion) to be calculated as per CSA B139, considering that special engineering practice is necessary in the extremely cold climate of the Yukon. Calculations are to be based on maximum heating load, not including standby generators.

Combustion air intakes are commonly oversized and more cold air than necessary is brought into mechanical rooms. This can result in freezing of water lines and pumps located in the mechanical room. It is important to recognize the extremely cold temperature of outdoor air and problems associated with bringing it directly into a building. A 33% reduction is recommended to recognize the expansion of cold air to demand temperature.

7.2.4 Heating Fluids

<u>(1)Glycol</u>

A glycol and water mix is the preferred fluid for use in hydronic heating systems in Yukon buildings.

Based on past experience, systems using 100% water were prone to freezing resulting in high maintenance costs and disruption to users. Glycol can be tested regularly and inhibitors (potassium phosphate) added as required. The use of glycol is sometimes questioned because of its corrosive effects that can damage equipment. It has been suggested that water may in fact not pose the same threat of frequent freeze-ups as it once did, given the improved quality of building insulation and air tightness. However, until this has been studied further the Yukon is unwilling to change the practise of using glycol which has generally proven to work well

<u>(1 B) Glycol – Based</u>

Heat transfer fluids used in hydronic heating systems are to be low in acute oral toxicity and be protected with corrosion inhibitors. Dowfrost HD is the preferred propylene glycol-based heat transfer fluid

A premixed glycol solution will eliminate problems encountered with the on-site mixing of glycol utilising local water. Water in a community, which has more than 50 ppm of hardness, Ca++ or Mg++ or more than 25ppm of chloride and sulphate, is considered unsuitable for use as part of the heating fluid. Water quality varies unpredictable between seasons and communities. A premixed glycol solution will ensure proper thermal and corrosion (inhibitor) characteristics.
Alternatives to Dowfrost HD will not be

.

considered until those products can be shown to be of equivalent and consistent quality

(2) Glycol Fill

A 100-mm air gap must be provided between water supply line and top of the glycol make-up tank

To ensure there is no direct connection between the domestic water supply and glycol solution: to prevent any possibility of glycol accidentally backing up into domestic water lines

Provide convenient and adequate means of charging hydronic heating piping system by using a motor driven pump, automatic pressure controlled makeup system, and relief piped back to the glycol fill tank. A manual diaphragm type pump would be acceptable on hydronic heating systems sized at less than 117kw

Manual vane type pumps have proven to be unsatisfactory. Because most hydronic heating systems do have continuous supervision, it is preferable to have system pressure maintained for as long as possible in cases where heating fluid is being lost from the system. Piping the glycol relief back to the tank avoids wasting glycol whenever the pressure relief valve is activated

3) Glycol fill tanks to be plastic, fibreglass or a non-corrosive material with an airtight lid.

4) HVAC systems that are subject to prolonged winter shutdown, but which must start up again while weather is still cold will require at the minimum, a 35% by volume glycol concentration or burst protection

Closed loop-heating systems not exposed to freezing temperature and in buildings that are occupied 24 hours per day and seven days a week, may not require a glycol-based heating transfer fluid. These unprotected buildings may also require a low temperature alarm for additional protection.

5) Atmospheric propane fired boiler systems are not to have glycol-based heat transfer fluids because of the high film temperatures that the glycol may be subjected to.

6) It is recommended that if the main heating loop contains glycol, that the boiler(s) be isolated from the glycol system by means of a heat exchanger.

7.2.5 Circulation

(1) Piping

Primary / secondary piping loops which allow constant flow on both loops under varying load demands are preferred for systems supplying over 50 kW. A single loop is acceptable for most smaller heating loads.

Allows continuous flow through boilers, and controlled flow through heating loop and therefore doesn't subject boilers to temperature shocks.

Unions, isolating valves and drains are to be provided at all heating equipment connections.

Isolation and bypass valves are to be installed so that the flow through each heating coil in the air handling system can be adjusted even if the secondary coil circulating pump and/or the three way control valve is out of service

In order to facilitate isolation of heating coils, heat exchangers, pumps, and heating zones for periodic maintenance and/or repair.

Hydronic system piping arrangements are to be designed to maintain full and balanced flow through each boiler when it is operating. Provide balancing valves in each boiler circuit to facilitate balancing of system. Larger systems should have flow switches for boiler protection

It must be possible to operate the system manually when the 3-way control valve is removed for maintenance or repairs. Forced shutdown of systems could result in loss of ventilation and heating source in certain appliances

To prevent damage to boilers by overheating boiler sections or tubes

(2) Equipment

Pumps and other heating equipment must be selected while keeping the different properties of glycol vs. water in mind. For example, expansion tanks must have an EDPM bladder that is compatible with polypropylene glycol, and the tank must be sized to accommodate the increased expansion of glycol over water.

Because use of 50/50 glycol / water heating fluid is not common in other parts of the country, this is easily overlooked by designers

Standby pumps are to be installed with each pump and sized to handle 100% of full system load. Do not use automatic start / alternators use hand selector switch only

In case of pump failure a maintainer must come out and is then made aware that the primary pump has failed. The standby pump is permanently installed to ensure it is there when needed, and the system can be quickly and easily switched over

Circulation pumps are to be sized to circulate water through all boilers in multiple boiler installation.

To assure continuous flow through all boilers under all operating conditions.

Circulating pumps to have mechanical seals. Do not use packings.

Provides a reliable seal

Strainers are required for each pump suction line.

Strainers catch any particles in the system coming through domestic water supply.

Side stream filters with sight glass are required for each hydronic heating system over 117kw (400,000BTU). Each side stream filter is to be provided with one case of replacement 10 micron filters

Side stream filters provide an economical, effective means of keeping the heating fluid clean. Sight glasses provide a means of determining cleanliness of the heating fluid. Small heating systems are less likely to require continual cleaning and it is not cost effective to provide side stream filters.

(3) Insulation

Insulation is required on all circulation piping

Heat from piping can cause overheating in the mechanical room. Periodic access to located in mechanical rooms. Insulation may be omitted from valves, unions and strainers where piping is under 63 mm. Removable prefabricated insulation to be used at all valves and unions on all piping over 63 mm.

valves and unions requires removal and replacement of insulation in such a way it does not damage adjacent insulation.

7.2.6 Distribution

(1) <u>Wall Fin Radiation</u>
Wall fin radiation is the preferred heat exchange system.

Most frequently used and a system maintainers are familiar with

Wall fin covers or enclosures to be sloping top model, minimum 14 gauge steel.

Sloped tops prevent people from placing things on them and obstructing heat. The heavier gauge steel will be less easily damaged than standard gauge covers

When permanent cabinets or built-in furniture must be located against the same wall as radiation units ensure appropriate inlet and riser vents are installed.

Cabinets obstruct airflow, and vents will alleviate this problem.

A shut-off valve is required for each zoned section of radiation. Shut off on upstream and downstream sides of rad to allow isolation of rad.

Allows zones to be isolated for repairs

A positive shut off balance valve must be provided on the return line for each zone of radiation.

Reduces the chance of systems becoming air locked and potential damage to carpeted areas.

Isolation valves and unions to be provided on both sides of zone valves and a piggy back drain valve is to be provided on the discharge side of the zone valve.

In low traffic use vestibules and entrances wall fin radiation is preferred over a force flow unit. The wall fin radiation is to be controlled by a zone valve and a wall thermostat c/w tamper proof metal guard.

Provides a low cost, low maintenance alternative to force flow-heating unit.

(2) <u>Force Flow Units</u>
Required for vestibules, entrances, etc. Floor and wall mounted models must be recessed where structural conditions allow.

Provides cost effective and efficient heating at building entrances and vestibules

(3) <u>Radiant Floor System</u>
Generally unacceptable in Yukon buildings. Where it is important that a warm floor is provided, and in-floor heating is approved, the entire system must be easily accessible from a heated crawlspace. YTG Technical Support Mechanical must approve all in-floor heating tubing.

In-floor heating is generally difficult to maintain and prone to air-lock problems. The additional expense of this type of system (installation and maintenance) must be justifiable (Functional Program must clearly outline requirements) and will generally only be considered where body contact with the floor will be usual e.g. kindergartens or play rooms

7.2.7 Provisions for Monitoring Performance

(1) Low Water Cut-offs
Devices installed to allow testing of low water cut-offs must allow testing without draining the boiler.

To minimize the loss of heating medium. See also Technical Bulletin issued by Safety and Public Services, Boiler Safety Division dated March 25, 1992, “Installation of Low Water Cut Offs

(2) Thermometers
Provide dial type thermometers with 75mm diameter dial and scaled to the application intended in the following locations:
-domestic hot water supply
-heating fluid supply and return to each heat generating device
-chilled water supply and return
-supply air, mixed air, return air and outdoor air for each air handling unit
-return piping from each heating zone
-supply and return piping to each main heating coil (not required on reheat coils)
-converging side of 3 way control valves
In piping systems brass or stainless steel bulb wells complete with thermal grease are required. Thermometers to be located in a visible and readable location

Thermometers installed in appropriate locations assist the building operators in system operation on performance evaluation

(3) Gauges
Refer to M 6.2.6.

7.2.8 Alarms

*See Electrical Standards E 9.2 Mechanical System Alarms

7.2.9. Maintenance

(1) Air Vents
Manual air vents should be installed at all high points of hydronic heat piping throughout the building and provided with clearly identified access covers
Auto air vents are to be used in mechanical rooms only. All air vents must have isolation valves.

To facilitate maintenance of system and releasing air locks. Because propylene glycol quickly deteriorates the seat of autovents, their use should be limited to the mechanical room where leaks will not damage carpeting

(2) Boilers
18 mm combination cold and hot water hose connection required close to boilers. Hose bibs must be equipped with hose vacuum breakers.

Required to flush boilers. Vacuum breakers required to prevent backflow and eliminate potential for contamination of potable water supply

(3) Access to Valves
Access doors to all control valves and isolation valves required

(4) Radiation Fins
Radiation cabinets should be secure, but easily removable by maintainers.

To provide some protection from vandalism or inadvertent damage by users, but allowing fins to be cleaned

7.3 UNIT HEATERS

Requirements

Hydronic unit heaters are to be used only for spaces which are normally unoccupied, such as mechanical rooms, large storage areas, etc where noise levels are not a consideration. Unit heaters are to be hung with appropriate vibration isolation. Balancing, isolation, drain valves, air vent and unions are required on unit heaters. Unit heaters are to be equipped with fan guards.

Rationale

Unit heaters are an inexpensive, yet effective means of providing a controlled heat source in unoccupied spaces, but are generally considered too noisy for other applications.

7.4 FLUSHING NEW SYSTEMS

Requirements

1. Clean each system off all construction debris, oil, grease, varnish and mill scale.

2. Immediately after the system is filled up with softened water, start the flushing and chemical cleaning process.

3. The system should be flushed with a mixture of heated (180 F) softened water with trisodium phosphate and circulated for 48 hours.

4. During this procedure all strainer and filters are to be left in place and cleaned as needed during the flushing procedure.

5. During this flushing procedure all coils and zones are to be left open. Water should be drawn from all points that are equipped with draining valves until water runs clean.

6. This procedure may have to be run more than once or until the water runs clean and free of all oils.

7. All low spots and coils may have to be flushed individually.

8. Only softened water is to be used for this flushing procedure

9. Drain and rinse the complete system with clear softened water until the discharge water shows the same PH and TDS as the softened water entering the system.

10. During the entire flushing procedure, the system is to be kept under pressure as to limit the amount of air entering the heating system.

Rationale

7.5 HEATING, FLUSHING OF EXISTING CORRODED SYSTEMS

Requirements | Rationale

1. During the flushing procedure leave in all strainers and filters, and remove and clean as required during this flushing procedure.

2. Leave all zones and coils open during flushing procedure

3. Drain system while adding softened water and maintaining system pressure until system runs clean.

4. Add manufacture recommended amount of a Boiler Cleaning Compound approved for cleaning of seals and valve packings and appropriate heating piping and coils.

5. Circulate for 48 hours under manufacturers recommendations (heated or unheated).

6. Immediately after the cleaning cycle drain system while maintaining system pressure and restrict the amount of air entering the heating systems. Make sure all air vents are open. Be sure cleaning solution and rinsing solution runs out, avoid trickling. Cleaning solution should be almost colourless. If cleaning solution is milky, or dirty, repeat cycle.

7. Fill system with softened water, circulate for 4 hours.

8. Drain system, cushion tank, coils, boiler and all low spots while maintaining system pressure as not to allow air into system.

9. Fill system with softened water and continue rinsing until water does not foam. Test for foam by shaking a small sample of return water in a small bottle. Foam should die within 25 seconds. A defoamer might be necessary.

10. All filters, strainers, coils and low spots must be clean and free from scale, sludge, and foreign material.

11. Fill system with a corrosion inhibitor and test pH, TDS, and freeze point. Test for appropriate levels of corrosion inhibitors.

7.6 CORROSION INHIBITORS AND CONDITIONS

Requirements | Rationale

1. On new systems we recommend a molybdenum base corrosion inhibitor. Recommended levels of 50-80 p.p.m. molybdenum.

2. TDS levels of 600-850 p.p.m.

3. PH levels of 9.5 – 10.5.

4. P – alkalinity of about 200-400 p.p.m

5. If nitrite is to be used, recommended levels of 700 – 1100 p.p.m.

7.7 HEATING MEDIUM SYSTEM VOLUME

<u>Requirements</u>	<u>Rationale</u>
1. During the mechanical design stage it will be the responsibility of the mechanical engineer to determine the total volume of the heating medium solution and mark these volumes on M-1 of the mechanical drawings.	

M8 AIR DISTRIBUTION

Air quality of a reasonable standard is a basic human need, not a luxury. As buildings have become increasingly air tight in the interest of reducing heating requirements, the supply and control of ventilation has grown to be increasingly important. When ventilation is inadequate, as has been experienced in some Yukon buildings, users are not only uncomfortable, but may experience health problems. The extreme cold experienced during much of the year in the Yukon can make it difficult and costly to achieve adequate ventilation. Toxic and noxious chemicals released by building materials and finishes as well as air used by occupants must be removed by the ventilation system.

8.1 NATURAL VENTILATION

Building users commonly believe that opening windows provide the most satisfactory form of ventilation in a building, even though this is not really a very effective way of introducing adequate fresh air or ensuring even distribution during winter months. Blasts of cold air coming in through a window are not tolerated for long. This is not to say that “natural” ventilation is undesirable - simply that opening windows are probably not the best means of providing it, if users expect consistently comfortable conditions. A properly designed system relying on natural airflow can provide adequate ventilation, without adding to the mechanical and electrical complexity of a building.

For occupied buildings, which require ventilation, the harsh climate of the Yukon, make mechanical ventilation the only practical alternative during the heating season. Systems, which require the opening of windows or portholes designed as a substitute for mechanical ventilation, have proven to be unsatisfactory.

<u>Requirements</u>	<u>Rationale</u>

8.1.1 Supply

Whatever the means of supply air, it must prevent entry of snow and dust. Any filters or screens required to do so must be easily accessible and easy to clean.

Ventilation hoods are often used in place of operable window sections. Typically used for residential occupancies or small offices where users are capable and willing to control ventilation. Operable windows are preferred for summer use buildings only

8.1.2 Exhaust

Must be located to create an even flow of fresh air through rooms, without creating uncomfortable or disruptive drafts.

A common shortcoming of natural ventilation is that air is not mixed, or air currents are so great that paper flies off tables and desks! As stipulated for natural air supply, users must be capable and willing to control exhaust

8.2 MECHANICAL VENTILATION

Most public use buildings are too large or configured in such a way that natural ventilation systems are not feasible. Consequently mechanical systems are required to ensure adequate ventilation in most Yukon buildings: the climate, even in the milder areas of the Yukon, also makes mechanical means of ventilation preferable for much of the year. The quantity and temperature of outdoor air brought into a building needs to be adjusted frequently to suit changing outdoor conditions and indoor requirements: automatic controls can perform this function for the building users.

<u>Requirements</u> — <u>Rationale</u>

8.2.1 Choice of Systems

a) Natural air supply and mechanical exhaust

Limited to use in residential or seasonal use buildings

System relies on users: generally consists of opening windows for supply, and turning on kitchen or bathroom fans for exhaust. Considered unsuitable for buildings used by the public, or by groups of people who will not likely take on responsibility of controlling ventilation, or be concerned with energy conservation

b) Mechanical air supply and natural exhaust

Limited to use in small residential or seasonal use buildings, where a forced air furnace is provided for heating.

Relies on users to control exhaust, hence not considered suitable for public use buildings or where used by groups of people who will not likely take on responsibility of controlling ventilation, or be concerned with energy conservation. This approach has been used in several recent school projects with unsatisfactory results.

c) Mechanical air supply and mechanical exhaust

A two fan system is required

Both supply and exhaust can be automatically controlled using temperature sensors and time clocks, and do not rely on users. Although improper maintenance, or operational difficulties (which may be design-related) can lead to user complaints, this in not a problem exclusive to mechanical systems.

8.2.2 Outdoor Air Supply

(1) <u>Supply</u>

A minimum of 15 CFM (71/s) of outdoor air per person, calculated at peak occupancy load and under all anticipated conditions is required. (Minimum design temperatures can be as low as -50 C)

This is a requirement of ASHRAE 62-1989, however because there is a concern that this allows too much cold outdoor air into buildings in the Yukon (given the climate, and high energy costs) people are often tempted to reduce this quantity. It is not recommended that this ASHRAE standard be compromised: providing adequate ventilation for building users outweighs benefit of energy cost savings The required ventilation rate should be used, rather than over-ventilate..

(2) <u>Free Cooling</u>

Air volumes and system arrangement must allow up to 100% outdoor air to be used for preventing overheating of occupied spaces.
Do not preheat outdoor air.

Most Government facilities are very energy efficient and even at quite low outdoor temperatures (i.e. -10 to -15 C) there may be a need to cool the building during occupied hours to dissipate internal gains from light, equipment and people.

(3) <u>Outdoor Air Intakes</u>

Outdoor air intakes must be provided with downturn hoods designed to eliminate the potential for the system to draw snow in or to become blocked by snow. This requires:

To prevent air intake filling up with snow (a frequent occurrence where precautions have not been taken).

- hoods with a sufficiently long vertical leg to ensure low velocity (minimum 1.5 m/s)
- hoods to be set out approximately 200 mm from the wall surface, not tight up against it
- hoods mounted high enough to avoid becoming blocked by snow accumulations
- expected in the selected location
- outdoor air intakes located on the sides of buildings scoured by the wind or, where possible, on the underside of the building where it is swept clear of snow

Setting the hood out from the wall reduces the potential for snow entry during windy conditions.
Wind hitting the face of the building can force snow up into hood
A review of snow drifting patterns must be done when locating intake, as drifts may impede system operation for many months of the year. Setting the hood out from the wall reduces the potential for snow entry during windy conditions.

Do not install insect screen on outdoor air intakes.

Insect screening becomes blocked by snow, and insects can be trapped in filters.

Outdoor air intakes must be separated at least 10 meters horizontally from all trucked service points (including sewage pump-out, water fill, and fuel delivery, chimneys and exhaust outlets).

To reduce the chance of bringing in objectionable odours, vehicle exhaust, or flue gasses from chimneys, with the outdoor air

(4) <u>Dampers</u>

Outside air dampers are to be low leakage type.

To limit infiltration of outdoor air

Minimum fresh air damper should be separate from the operating fresh air damper and controlled with a separate motor.

A single motor uses long connecting rods to control more than one damper and can easily malfunction.

(5) Insulation

Insulate outdoor air ducts using duct liner up to the mixing chamber where ducts contact space conditioned air. Duct liner to be adequately fastened using a pin spotter: do not use self-adhesive clips.

The use of duct liner prevents condensation forming on the outside of the duct where it enters the building. Exterior insulation has not been found effective in preventing condensation. Past experience has shown that self-adhesive clips often detach and allow duct liner to block ducts, and for this reason a more secure fastening method is required.

8.2.3 Air Mixing

Packaged mixing boxes are not to be used.

Conventional equipment is designed for conditions typical of the southern portion of Canada or the central USA In the Yukon, where outdoor air temperatures may be as low as -50 C, mixing outdoor with room temperature air is more difficult than standard equipment is designed to handle.

There must be adequate provision for outdoor and return air to mix to a uniform temperature before reaching the filter and heating coil in the air-handling unit. A variance of no more than plus or minus about two degrees from one point to another should be achievable.

*Supply air is a mix of fresh outdoor air, and return air from within the building. A temperature sensor is provided to read the mixed supply air temperature: the amount of outdoor air admitted is controlled by this sensor. If return and outdoor air are not thoroughly mixed when they get to this sensor, it will be reading the temperature of either a warm or cold stream of air and will let in either more or less than optimum amounts of outdoor air. *see notes in appendix*

The following guidelines are suggested in order to ensure thorough mixing in most severe conditions:

- arrange mixing dampers such that the coldest air stream (outdoor air) is located physically above warmer (return air) point of connection.

Promotes mixing of warm and cold air by taking advantage of principles of convection

- use opposed blade type dampers.

Promotes mixing by directing streams of air towards each other

- locate connection points at least 3 meters upstream from the heating coil with at least one duct elbow before the mixed air duct connects to the air handling apparatus.

Gives air more distance in which to mix before reaching the heating coil.

Air blenders or stratification eliminators are to be provided to ensure mixing of (cold) outdoor air and return air.

Packaged air handling units with integral mixing boxes are not designed for Yukon winter conditions. Their use should be avoided where possible. During extreme cold conditions, good mixing is important to enable air handling systems to operate normally, without nuisance trip outs of low temperature controls. Effective temperature control is difficult to achieve without good mixing.

Exhaust, relief air, and outdoor air ducts are to be insulated 3 meters from the connection to the louvre.

Insulation prevents the formation of condensation on ductwork, which is exposed to cold outdoor air (i.e. when the fan is off).

8.2.4 Air Distribution

Other systems, such as fixed horizontal diffusers or floor registers, do not promote proper air flow under all conditions and may result in stratification in the winter which is to be avoided.

(1) Diffusers
Ceiling diffusers, adjustable for horizontal and downward flow, located at the midpoints of approximately equal divisions of room area are preferred. The use of several supply registers located along the longest interior wall, blowing towards the perimeter wall is an acceptable alternative.
Floor diffusers (for return or forced hot air heating systems only) are to be heavy gauge appropriate type, not domestic type (unless it is for a residence).

Residential grilles and registers are unsuitable for buildings such as schools, where they may be easily damaged. Registers designed for residential use have balancing dampers which are easily adjusted, possibly resulting in avoidable air balance problems

(2) Dampers
Balancing dampers are required on all main branches at each branch duct takeoff. Dampers to be line mounted, locking quadrant type. Splitter dampers are not acceptable for use as a balancing device. Volume control dampers at diffusers are not an acceptable means of controlling air volume.

Line mounted dampers provides a reliable means of balancing. Results of adjustments made with splitter dampers are unpredictable as the air flow in the main ducts as well as in the branch duct is changed. Dampers placed adjacent to supply outlets contribute to high noise levels because of the high velocity of air at that point

(3) Flexible Ductwork
Flexible ductwork when used shall be limited to short lengths within 1 metre of equipment to be connected. Flexible duct is to be fastened to the sheet metal ductwork and diffuser with an approved tie wrap or met clamp (not with duct tape).

Improperly fastened and excessive lengths of flexible ductwork creates air delivery problems by increasing pressure drops in ductwork and in many instances when fastened with duct tape falls off

(4) Flexible Connections
Flexible connections of approved, fire resistant design are required at the suction and discharge connections of fans and air handling units. Fan equipment is to be installed so that the connecting ductwork is lined up with the fan inlet or outlet, and the flexible connection does not obstruct the air flow

Flexible connections reduce the noise and vibration from the fan equipment from being transmitted through the building structure to the occupied spaces. The fan performance is adversely affected If the ductwork connection is offset, or if the flexible connection projects into the air stream. This results in increased energy consumption as well as reduced fan performance

(5) Branch Take off Ducts
Branch takeoff ducts to each air supply or exhaust outlet are to a minimum 0.5m, located in an accessible location with a duct mounted

Supply or exhaust (return) air outlets which are mounted directly on the main branch ductwork tend to have uneven velocities, to be noisy, and to be uncontrollable. I balancing damper positioned near the takeoff fitting.

Balancing dampers located too close to the actual air outlets cause noise.

6) <u>Duct Sealant</u>
An approved duct sealant is to be used for sealing ductwork such as Duro Dyne duct sealant. Duct tape is not acceptable.

Duct tape is not satisfactory for sealing ducts as it tends to lose its adhesive properties, particularly on cold ducts

(7) <u>Test & Balance</u>
An independent test and balancing agency must be hired to balance all HVAC systems. Test and balancing firms must follow AABC or NEBB standards

8.2.5 Air Exhaust

(1) <u>Location</u>
Outdoor exhaust vents to be located where they will not be susceptible to snow accumulation, or discharge directly into prevailing wind. Avoid locating in vicinity of the outdoor air intake (i.e. Within 10 metres).

Snow accumulation can hamper or eliminate exhaust capability. A review of snow drifting patterns must be done when locating intake, as drifts will impede system operation for may months of the year.

(2) <u>Insulation</u>
Exhaust air stack must be insulated where contact is made with outside air.

To reduce the amount of condensation that may freeze and build up, reducing size, or possibly closing off the exhaust opening

(3) <u>Local Exhausts</u>
- Local exhausts should be provided in all rooms and spaces where high level of contaminants or odours are generated.

Typically provided in industrial arts rooms, change rooms washrooms and kitchens.

- Individual major exhaust fans are to be interlocked with the air handing system

  Unless air is being brought in at the same time it is being exhausted from the building, a strong negative pressure can be created in the building.

- Local exhaust fans must not discharge into boiler rooms.

  Because this may affect boiler performance the Boiler Inspector will not accept this type of installation

- Areas having manually controlled exhaust fans are to be provided with timed switches

  To avoid the possibility to exhaust fans being left operating for long period of time.

8.2.6 Maintenance *(ACCESS DOORS)*

600mm x 600mm access doors required for fresh air dampers

To allow operators and maintainers access for adjustments and repairs

300 x 300 access doors are required for fire dampers.

It must be possible to operate the system manually if the 3 way valve must be removed for maintenance or repairs

500 x 500 mm access doors are required for:
- exhaust air dampers
- return air dampers
- filters, coils
- balancing dampers
- mixing boxes
- reheat boxes
- turning vanes

Isolating and balancing valves must be installed so that the flow through each heating coil in the air handling system can be adjusted with the secondary coil circulating pump operating or not

8.2.7 Provisions for Monitoring Performance

Test ports are costly and not required frequently enough to warrant extra expense. Test holes can be drilled on site by balancing contractor where and as required, eliminating the need for co-ordination with other sub-contractors.

(1) Balancing
Instrument test holes, drilled on site and sealed with duct plugs are preferred to test ports for ventilation system balancing.

(2) Adjusting Outdoor Air
Instrumentation must be installed to allow operators to regularly monitor temperatures of outdoor air, mixed air and supply air temperatures. Dial type thermometers are preferred

By monitoring temperatures, the correct proportions of outdoor air and mixed air can be set to ensure suitable supply air temperature. When this is not possible users may be subjected to uncomfortable conditions. Other types of thermometers can be difficult to read

8.2.8 Heat Recovery Systems
Heat recovery systems may be considered in the Yukon, however their use has been problematic and is not always advisable - Regional or Facilities Managers should be consulted.

The heating of outdoor air makes up a significant portion of the total energy requirements of buildings using mechanical ventilation systems. However, electric defrosting and preheating of outdoor air is generally required and can result in an increase in energy consumption.

8.2.9 Filters
All air shall be filtered before entering coils, equipment or occupies spaces, using throw-away, standard size filters.
Filtering shall be achieved by one set of filters, i.e. not by a “summer-winter” filter arrangement.

To filter out dust or other airborne particles, and to make it simple to replace filters regularly
A summer-winter filter bank arrangement is unsatisfactory, because it is based on allowing entry of snow into the air handling system. Where this has been tried, the maintainers sometimes may not be aware that they are to remove one set in each season

8.2.10 Acoustic Control
(1) Duct Lining
Acoustic lining to be provided in supply air, return air and exhaust air ducts 5 metres downstream and 2 metres upstream of fans. Duct liner to be adequately fastened using a pin spotter: do not use self-adhesive clips

To minimize noise from fans transferred to occupants. Past experience has shown that self-adhesive clips often detach and allow duct liner to block ducts, and for this reason a more secure fastening method is required

Adhesive must be applied to the entire adhering surface area of acoustical duct lining

There have been several cases where the duct liner has come loose, because of inadequate adhesion. Loose duct insulation can block ductwork totally, and it is difficult to diagnose

(2) Acoustic Separations

Mechanical noise and vibration of fans and

All components of the mechanical ventilation system must be designed so that sound level will be within noise criteria limits recommended by ASHRAE.

pumps can be objectionable to building occupants. NBC 6.2.1.1 required HVAC systems to be designed to conform to good engineering practice such as described in the ASHRAE Handbooks and Standards. There have been a number of school ventilation systems in which noise levels have been unacceptable

8.3 AIR CONDITIONING

Although outdoor air temperatures can rise above comfortable indoor levels during the summer months, the additional cost of providing air conditioning is rarely justifiable for the short period of time it will be required in the Yukon. There are instances however where it may be justified because important normal operation would otherwise be disrupted.

<u>Requirements</u>

<u>Rationale</u>

8.3.1 Cooling

For most of the year the supply air temperature can be controlled by varying the amount of outdoor air introduced into the system, and adjusting heat supplied to heating coils: free cooling is generally adequate for the hottest days of the year.

The additional expense of cooling equipment must be weighed against the benefit of cooling - where cooling may be required only for several days of the year the use of cooling equipment is discouraged because of the added capital and O&M costs.

When even the maximum amount of outdoor air (see 8.2 “Outdoor Air” - reference to free cooling) will produce supply air above 18 C for an extended period of time, the need for cooling equipment should be reviewed.

Where air conditioning is installed, equipment must be designed in conformance with the ACNBC Canadian Heating, Ventilation and Air Conditioning Code.

8.3.2 Humidification

Humidification is not typically required in Yukon facilities. Where humidification is deemed necessary, it should be steam generated and equipped with controls that automatically reset the humidity level to the outside air temperature

More reliable than atomization systems which regularly malfunction due to calcium build-up.

Electric humidification systems should not be used.

Reduce life cycle cost. In most cases the cost of electricity makes this option uneconomic

M9 AUTOMATIC TEMPERATURE CONTROLS

An Automatic Temperature Control System properly designed, installed, maintained and operated provides the best possible occupant comfort and the most efficient mechanical system operation.

9.1 GENERAL

Requirements	Rationale
Conventional, low voltage (24 volt) electric control systems are preferred for most buildings.	Electric controls are simpler to operate and to service, especially in more remote communities.
Pneumatic control systems may be used where approved specifically in combination with electronic or direct digital control (DDC) systems. The sensing and logic is done electronically; the controlled devices are operated by pneumatic operators.	*Although pneumatic control systems are more complicated and prone to failure from lack of service, they have cost advantages for larger installations and can provide full modulation.*
Direct digital control (DDC) systems with electronically operated control devices may be used where specifically approved. **Client Comfort System** standards are included at the end of this section as an appendix.	*Where competent trades people are available, these systems have proven to provide excellent results considering control and monitoring of conditions in the building*

9.2 CONTROL COMPONENTS

Requirements	Rationale
9.2.1 Components - General All controls regardless of type, are to be calibrated in degrees Celsius, whenever possible.	*Yukon has standardized on the Metric system. It is confusing to have mixed markings on controls*.
CSA approval is required for all control equipment, including alarm panels.	*The code requirements are vague; this is intended to remove ambiguity, because it has not been followed in several cases*
Stand-offs are required for all duct mounted controls and accessories mounted on externally insulated ducts.	*Stand-offs are intended to keep these items fully accessible for operation and servicing*
9.2.2 Thermostats and Sensors Thermostats and/or sensors located in gymnasium are to be located at 2400 mm above the floor and be complete with a heavy duty metal guard.	*Gym thermostats and sensors need to be protected against damage and the students need to be protected from sharp corners. Gyms are used for public functions, which requires that they have tamper proof covers*
In cases where a space thermostat controls a heating control valve and a variable air volume or cooling control in sequence, there is to be a dead band of 2 degrees C. Between the heating and cooling	*The intent is to optimize energy consumption by avoiding simultaneous heating and mechanical cooling, or heating and "free cooling*
Thermostats located in public areas must have vandal proof guards	*To prevent intentional or unintentional tampering by building users*

Locking type thermostats to be used in public facilities where maintainers only should be able to adjust temperatures

It *is often preferable for maintenance staff to control temperature in public areas of facilities where there are a variety of users such as arenas, lobbies, public washrooms, public areas of air terminal buildings, etc*

Locking type thermostats are not to be used where it is desirable to allow users to adjust room temperatures (refer to functional program for direction). Where users should be able to adjust room temperatures range limits to be used to restrict the amount of adjustment above or below predetermined values

In many cases it is more appropriate to allow users to adjust room temperatures (rather having them rely on maintainers for minimal adjustments) - examples would include health centres, staffed areas of schools (classrooms, offices and classrooms), community offices, etc. Range limits would protect against overheating.

Low voltage electric heating thermostats are to be SPST (i.e. similar to Honeywell T86A.)

In cases where SPDT thermostats have been used, the wiring has sometimes been installed incorrectly. The SPST thermostats are simpler, and less likely to be installed incorrectly

Control valves (i.e. two and three way control valves for heating or cooling coils) are to be sized based on a Cv rating required to provide a pressure drop of 21kPa. Or other rationale to ensure that there will be no “hunting” at low flow rates.

In past installations, some control valve sizes were provided at line size. In those cases, there was very poor control, and considerable energy waste. Typically the control valves will be smaller in size..

Normally open, electrically operated heating zone valves to be used. Do not use thermostatic valves.

Allows gravitational flow through heating system in the event of a power failure. Thermostatic valves plug up easily and need constant servicing

On small piping sizes, the paddle type flow switches are difficult to install properly and do not function well. The sensitivity cannot be adjusted, and this results in nuisance alarms

9.2.4 Flow Switches

Flow switches are to be vane type on piping 50 mm and smaller. Paddle type flow switches will be acceptable on larger piping

9.2.5 Control Transformers

The number of control devices, i.e. low voltage electric zone control valve for heating radiation, is to be limited to 3 devices for each 40 VA transformer.

Limiting the number of control devices on a circuit avoids excessive voltage drop for each controlled device and premature failure

9.2.6 Damper Actuators

Independent damper actuators are to be appropriately sized and installed on each outdoor air, return air and relief air control damper.

Where a common damper actuator is used, a long connecting rod is sometimes required, which is near impossible to set up and the quality of control is reduced

9.3 VENTILATION UNIT CONTROL

Requirements	Rationale

9.3.1 Outdoor Air

The amount of outdoor air brought in to the system is to be controlled by mixed air temperature sensor with minimum setting to ASHRAE standard.

Outdoor air (normally cold) is mixed with room temperature return air to produce supply air (mixed air). The amount of outdoor air is varied to provide more or less cooling.

9.3.2 Return Air

In no case should the thermostat in the return air duct control the heating coil in the air handling system

Normally air returns to mixing chamber from user areas and will therefore be at or above 20 C. If for any reason it falls below this, and this activates the heating coil, the ventilation system ends up acting as a heating system (like a forced air system) rendering the hydronic heating system thermostat controls ineffective

Return fan to be supplied with a minimum outdoor air position potentiometer

9.3.3 Supply Air (Mixed Air)

A supply air controller is required to control the temperature of the supply air to between 13 and 16 C. For most of the year varying the amount of outdoor air introduced into system can control the supply air temperature. When even the maximum amount of outdoor air will produce supply air above 18 C for extended periods of time, the need for cooling equipment should be reviewed. See section M8.3 Air Conditioning.

Air is supplied at a high level: if it is supplied at a temperature equal to or warmer than the room it tends to remain at a high level in the room and not come down into occupied space where it is needed

The mixed air controller in the air handling system (controlling outside and return air dampers) must be averaging type.

The averaging type sensor avoids inaccurate measurement by averaging colder or warmer streams.

A manual reset type freezestat located downstream of the heating coil must be provided and set at 2 degrees C

The manual reset type freezestat is required to reduce the likelihood of air handling systems cycling on and off during cold weather

9.3.4 Heating Coils

The thermostat controlling the heating coil in each AHU must be located a minimum of 3 metres downstream of the coil in the supply air duct.

Distance from coil to ensure thermostat reads actual supply air temperature (not the temperature immediately next to heating coil).

Fast response type controllers must control heating coil control valves.

Without fast response controllers, the control valve hunts from full open to full closed position, never reaching a position of equilibrium and the end result is overheating of occupied spaces

Electric, modulating controls are preferred for heating coils and they must remain energized even when the AHU fan is shut down.

If the controls are de-energized when the air handling system is shut down, the heating medium circulates freely to the *heating coil (given that normally open valves are preferred) when it is not required often resulting in overheating*

9.3.5 Time Clock

Direct digital control system or a 7 day programmable time clock c/w quartz control clock and battery back-up is required in all buildings with mechanical ventilation systems. (See section 9.1)

Ensures mechanical equipment required to operate during occupied periods shuts down during unoccupied periods. Reduces operating and maintenance costs

Timeout manual over-rides should also be provided and located where it may be operated by responsible user.

9.4 HYDRONIC HEATING CONTROL

Requirements	Rationale
9.4.l Radiation Control The radiation zone is to be controlled by a low voltage room thermostat controlling the normally open two-position control valve	*Provides cost-effective radiation zone control.*
All heating loops, including those installed in washrooms and storage rooms are to be provided with individual or zone control, and not “run wild.”	*The small savings in initial cost by not providing control are not justified considering the high cost of heating energy in the Yukon.*
9.4.2 For Flow Control The force flow unit is to be controlled by a line voltage, low range wall mounted thermostat complete with locking metal guard. The thermostat is not to be mounted above the force flow unit or in the direct air stream of the force flow unit.	*Provides cost effective control of force flow units.*
9.4.3 Unit Heater Control The unit heater is to be controlled by a line voltage, low range wall mounted thermostat complete with locking metal guard.	*Provides cost effective control of unit heaters.*
The room thermostat is to be located on the wall not directly in the air stream and provided with a locking guard.	
9.4.4 Boiler Temperature Control Provide indoor/outdoor controls for boilers with 2 or 3 step settings.	*Seasonal adjustments to boiler temperature can occur automatically (increased in cold weather, decreased in warmer weather) thereby increasing energy efficiency.* *This could be problematic if domestic HW were dependent on boilers, however, dedicated HW tanks are now required in all Yukon buildings (see M4.3).*

9.5 MECHANICAL ALARMS

Requirements | Rationale

9.5.1 Mechanical Alarms

Mechanical alarms are to be minimized and restricted to essential building conditions. The only critical condition is low building temperature, which will activate the automatic diallers and/or outdoor alarm light

CLIENT COMFORT SYSTEM (CCS)

DESIGN STANDARDS

Purpose

To instruct and assist designers specifying a Client Comfort System (CCS) for Government of Yukon (PROPERTY MANAGEMENT AGENCY).

Contents

Introduction - describes what to do and when to do it.

Specification Documents - describes how to prepare Specifications.

Resource Material - provides information on CCS and related issues and explains why PROPERTY MANAGEMENT AGENCY has adopted particular methods and requirements.

Contacts:

Issue and Updates: Property Management Agency
Phone 867-667-5916 Fax. 867-667-5349

Review, Approvals, and Questions: As advised by the PROPERTY MANAGEMENT AGENCY – Technical Support Unit

PROPERTY MANAGEMENT AGENCY CLIENT COMFORT SYSTEM (CCS) - DESIGN STANDARDS

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0.0 GENERAL INSTRUCTIONS

0.1 UPDATING THIS MANUAL

0.1.1 If you are maintaining a hard paper copy of the manual, contact PROPERTY MANAGEMENT AGENCY (see front cover) to obtain a fax copy of the current table of contents of the manual. Ensure your copy of this manual is up to date by checking the date in the footer of Table of Contents (Section 0) of your manual with the faxed copy.

0.1.2 If your manual is out of date (as per 0.1.1 above), check the "Date of Latest Update" (right hand column) of each section of the Table of Contents to see which sections have been updated.

0.1.3 Contact PROPERTY MANAGEMENT AGENCY (see front cover) to obtain copies of any sections which are out of date.

NOTE:
All sections of the manual have a date in their footer, indicating when they were last updated. This same date is shown in the right hand column of the Table of Contents.

0.1.4 ***Rationale for Updating Method***:

The CCS Design Manual is expected to evolve, therefore, additions and changes to the document are expected to occur on an ongoing basis.

This method of controlling and distributing updates is intended to make it easy for users to bring their copy up to date when needed and avoid the cost of frequent reissues of the entire manual.

0.2 ABOUT PROPERTY MANAGEMENT AGENCY AND THIS MANUAL

0.2.1 PROPERTY MANAGEMENT AGENCY is an agency established in 1995 to provide accommodation and real estate services to the Yukon Government.

0.2.2 This manual is intended to instruct and assist designers specifying a Client Comfort System (CCS) for PROPERTY MANAGEMENT AGENCY. The Agency is very supportive of the dissemination of information as a means of Technology Transfer and accordingly is prepared to supply a copy of this manual to other interested parties. Readers are encouraged to contact PROPERTY MANAGEMENT AGENCY with any questions on, or suggestions for improvements to, any part of this manual

0.3 DESIGNERS' RESPONSIBILITY

0.3.1 Intent

This manual is intended to instruct and assist those specifying CCS for PROPERTY MANAGEMENT AGENCY. It is NOT intended to reduce in any way the designers' professional responsibility for a complete design and functioning installation.

0.3.2 Action

It is the designers' responsibility to ensure all aspects of their design and specification are complete and workable. This includes all standardized PROPERTY MANAGEMENT AGENCY documents, which should be used as if they were prepared directly by the designer’s own staff (this applies particularly to using the PROPERTY MANAGEMENT AGENCY naming convention for all equipment including CCS components).

If changes to the standardized PROPERTY MANAGEMENT AGENCY document appear necessary, contact PROPERTY MANAGEMENT AGENCY and resolve this to your satisfaction.

The designer will make project specific changes as mutually agreed.

0.3.3 Rationale for Designer Responsibility

The reasons for assigning responsibility are as follows:

- It avoids the danger of unclear or divided responsibility.
- It makes it clear the designer must become totally familiar with the standard PROPERTY MANAGEMENT AGENCY documentation to be used on the project.
- The designer knows the details of the project best and is best placed to determine if the standard documentation is appropriate or sufficiently complete for the particular project

0.4 ACTION REQUIRED OF THE DESIGNER

This section outlines actions required of the Designer from project inception through to completion of the bid documents.

The Designer's role in the bidding, installation, commissioning, acceptance and occupancy stages is also important but is beyond the scope of this manual.

Milestone or Stage	Activity Required or Product Delivered
Concept	Investigate alternative HVAC systems, control and contract options. Discuss them with PROPERTY MANAGEMENT AGENCY. Investigate further as agreed. Resolve with PROPERTY MANAGEMENT AGENCY which options to adopt.
Design Development	Draft the items required in the Project Brief submission and obtain PROPERTY MANAGEMENT AGENCY's agreement to them.
Project Brief Submission	Submit an outline of the HVAC system and agreed drafts of the following sections of the CCS Specification. 15910 Scope - An overview and explanation of the CCS objectives. 15920 Project Specific Alterations to PROPERTY MANAGEMENT AGENCY - CCS Performance Spec. 15925 Sequence of Operation (if required) 15930 Systems (Points Lists, Graphics & Start up Logic) Summary Page DDC Points Misc. Points Non DDC Points Other Graphics 15940 PROPERTY MANAGEMENT AGENCY - CCS Performance Specification
Documentation	Develop the Specification and any associated documents. Get PROPERTY MANAGEMENT AGENCY's approval for any material change from the Project Brief.
95% Submission	Submit a complete specification and associated documents.
Final Check	Check and coordinate the specification and associated documents. Incorporate any changes arising from PROPERTY MANAGEMENT AGENCY's 95% review.

Rationale for Required Timing of Action

-The rationale for early development of key sections of the Specification is as follows:
- The information contained, outlines how the work will be specified and provides a check that communication, understanding and agreement have been reached.
- The information is needed by those designing and specifying related sections of the project.
- It eliminates the need to separately communicate and record this information in reports, letters or minutes.

0.5 DETERMINING PRIMARY SYSTEM CONTROL TYPE

0.5.1 Selection of Primary Control System Type

PROPERTY MANAGEMENT AGENCY uses DDC wherever economically feasible because experience has shown DDC is the only consistently successful route to comfortable conditions and effective operation.

Very few PROPERTY MANAGEMENT AGENCY buildings have permanently staffed, on-site CCS operator stations. PROPERTY MANAGEMENT AGENCY's operators primarily access CCSs by modem from their office or from laptop computers.

0.5.2 When PROPERTY MANAGEMENT AGENCY Considers Alternatives to DDC

PROPERTY MANAGEMENT AGENCY considers alternatives to DDC in the following circumstances.

- Very small properties such as store front offices
- Properties on short term lease

The reasons for these exclusions are:

- the threshold cost of a small DDC installation generates a high cost per occupant per annum when the property is very small and/or the occupancy is of short duration.

- the HVAC systems installed usually offer little opportunity for improvement through DDC.

0.5.3 Hard Wired Control Systems

PROPERTY MANAGEMENT AGENCY uses hard wired control systems in three basic situations.

1. For very small projects if there is a significant cost premium to use a DDC system.

2. For non-critical elements on CCS projects if there is a significant cost premium to use the DDC. eg. A unit heater which would require a new or expanded DDC panel.

3. For critical safety interlocks.

USING THIS DOCUMENT TO SPECIFY NON-PROPERTY MANAGEMENT AGENCY PROJECTS

PROPERTY MANAGEMENT AGENCY encourages consultants and contractors to use this manual to assemble specifications and requests for proposals for non PROPERTY MANAGEMENT AGENCY projects, provided that the following acknowledgment is inserted once into your specification or request for proposal.

> The following document has been assembled using some of the resources of the Government of Yukon (PROPERTY MANAGEMENT AGENCY) CCS Design Manual, based on British Columbia Building Corporation.

Please feel free to reference PROPERTY MANAGEMENT AGENCY's Graphic Guidelines or point naming conventions if you do not wish to develop your own.

The more this document, or a similar format, is used, the more useful it will become. PROPERTY MANAGEMENT AGENCY welcomes constructive criticism and information on generic changes that you have made to the document to improve its usefulness for your project. Please feed these back to us so that we may consider them for incorporation into the document.

Disclaimer

Government of Yukon disclaims all responsibility for the accuracy of information provided. Information provided should not be used as a basis for making financial or any other commitments.

"CLIENT COMFORT SYSTEM (CCS)"
PERFORMANCE SPECIFICATIONS SECTION 15940

Section 2.0 - 2.3

2.1 Instructions to Designers

This section is intended to give designers specific instructions as to how to structure the construction documents.

2.1.1 Technical Requirements

2.1.1.1 Table of Contents - Prepare a Table of Contents following the headings below.

2.1.1.2 15910 Scope - Prepare an overview and explanation of the CCS objectives as they relate to this project. Note any particular features or issues which may assist the controls contractor to understand the project better.

2.1.1.3 15920 Project Specific Alterations to PROPERTY MANAGEMENT AGENCY - CCS Performance Specification - This is where any deviations to the PROPERTY MANAGEMENT AGENCY standard CCS Performance Specification , Section 15940, can be made, if necessary. This approach is used to assist the controls contractors in focusing on issues which may affect pricing of the project.

2.1.1.4 15925 Sequence of Operation (if required) - This section is to be used if there are any strategies to be programmed by the contractor which do not have standardized System Points Lists, Graphics & Start up Logic prepared.

2.1.1.5 15930 Systems (Points Lists, Graphics & Start up Logic)
Summary Page - Prepare a summary page of the points and graphics following the format in the example in Section 10 (form 10_E5).
DDC Points - Choose the PROPERTY MANAGEMENT AGENCY standardized System Points Lists, Graphic & Start up Logic sheets from Section 5 for each mechanical or electrical system. For more in-depth instruction see Section 5.1.
Misc. Points - Add these points on form 5_O2 found in Section 5.O.
Non DDC Points- Add these points on form 5_O3 found in Section 5.O.
Emergency/Safety Points - Add these points on form 5_O4 found in Section 5.O.
Other Graphics - Add any other graphics required. Where standardized graphics are not in manual, PROPERTY MANAGEMENT AGENCY will prepare same for the project in conjunction with the designer.

2.1.1.6 15940 PROPERTY MANAGEMENT AGENCY - CCS Performance Specification - Section 2.3 - Attach this document unaltered.

PS 1 - GENERAL

1.1 General

It is the intention of the Agency to obtain a complete, operational Client Comfort System (CCS). The Contractor shall provide everything, both materials and labour, required for a complete and fully operational system including, but not limited to:

.1 All engineering and documentation necessary to define all details of the contractor's system for both Agency review and Contractor installation;

.2 All computerised and electronic hardware, including network communications devices, standalone panels and terminal unit controllers;

.3 All hardware components necessary for a complete system, including field devices of all types (e.g. sensors, actuators, relays, contractors), transformers, wiring, conduit, raceways, and piping;

.4 All application programming, databases, graphics and other activities related to computer software or firmware, required to implement the generic start-up logic and the graphics screens (including dynamic data points and "hot" spots) defined in this specification. Refer to 15930;

.5 A complete installation of all non-DDC and emergency controls listed in this specification;

.6 Labour and supervision for the installation, calibration, adjustments, checkouts, commissioning of all components and devices provided, and Substantial Performance requirements; and

.7 Complete documentation of the completed installation, with commissioning reports and operations and maintenance manuals.

Installation shall be in accordance with the PS 8 Installation Standards.

1.2 Standards and Guidelines

.1 Installation shall conform to the latest building codes and standards in effect.

.2 Wiring to be in accordance with C.E.C. and the standards of Division 16 for the project.

.3 Openings through fire separations shall be sealed with an approved fire stopping product.

.4 The location of all devices to be reviewed with the Agency's representative prior to installation.

.5 It is the Contractors responsibility to be familiar with and abide by the latest issue of the PROPERTY MANAGEMENT AGENCY Point Naming Convention and Graphics Guidelines for Client Comfort Systems. These are available on the Internet or in hard copy from PROPERTY MANAGEMENT AGENCY Technical Support Unit.

1.3 Shop Drawings

.1 Submit shop drawings for the project, in accordance with Section 01340 of the General Conditions of the Contract for the Project, and as follows:

.2 Submit product data on all computer components, Standalone panels, (SAPs), terminal unit controllers, (TUCs), and field devices. All data not applicable to project to be crossed out. Refer to PS 6.1.

.3 Provide schematics showing system architecture including network, SAPs and TUCs, wiring ladder diagrams and point layouts referenced to Points Lists.

.4 Submit graphic screens in software format and hard copy to the Engineer for review a minimum of 4 weeks prior to the 7 day test.

.5 Provide written software for proposed sequences of operation which differ from the generic start-up logic software included in the specifications section 15930, to Consultant for review, prior to installation in panels and equipment start-up.

.6 Apply PROPERTY MANAGEMENT AGENCY Point Naming Convention to all points.

.7 Submit calculations on a panel-by-panel basis, confirming the random access memory (RAM) requirements in Clause PS5, item 5.6 Memory, are met.

.8 Provide recommended list of spare parts to be stocked on site.

.9 Provide an outline of the training program and the name and background of the person who will perform the training.

10. Submit two copies of shop drawings to PROPERTY MANAGEMENT AGENCY Project Manager for review.

1.4 Warranty

Without restricting any warranty or guarantee implied or stipulated by law or elsewhere in the contract documents, the Controls Contractor will, at his own expense, rectify and make good any defect or fault that appears in the work within TWELVE (12) months from the date of the Certificate of Substantial Performance. Provide service inspections and servicing of equipment during the warranty year.

1.5 Training

Include a program, of at least 20 hours duration, for on-site operator training. This program shall, at a minimum, cover the following:

.1 All procedures necessary for writing, editing, saving, uploading, and downloading of application software, point definition database, and any other software accessible to the user.

.2 The set-up, documentation, and editing of system displays for all systems and interfaces included in this contract.

.3 The set-up, documentation, and editing of totalizers, trend logs and trend graphing for operator selected points in each of the systems.

.4 All procedures necessary to set up and execute point monitoring, point command (e.g. auto/manual toggle and in manual, assigning a specific value), and point response monitoring functions.

.5 Training for all of the foregoing shall be carried out from both the onsite user interface terminal and from a remote terminal by modem, and using both the Contractor’s full graphics interface software and text-based terminal mode software (if the latter is provided).

1.6 Approved Products

.1 The following products are approved for this project, subject to the system component and configuration restrictions listed for each manufacturer:

.1 **Delta Controls**

HVAC System		Product Number 1 to 9	10 +
		Thermal Zones in Building	
1.	Single Zone (reheat optional)	ICP015	ICP015
2.	Central VAV(reheat optional)	ICP015	ICP015 and IZ
3.	Bypass VAV(reheat optional)	ICP015	ICP015
4.	Multizone	ICP015	ICP015
5.	Dual Fan Dual Duct	n/a	ICP015 and IZ
6.	Air to Air Heat Pump	ICP015	ICP015
7.	Water Loop Heat Pump	n/a	ICP015 and IZ

Must include two (2) licensed copies of IGRAPH.EXE software.

.2 **MultiNet**

HVAC System		Product Number 1 to 9	10 +
		Thermal Zones in Building	
1.	Single Zone (reheat optional)	LC500	MNC100 & LC500
2.	Central VAV(reheat optional)	LC500	MNC100 & LC500
3.	Bypass VAV(reheat optional)	MNC100	MNC100
4.	Multizone	MNC100	MNC100
5.	Dual Fan Dual Duct	n/a	MNC100 & LC500
6.	Air to Air Heat Pump	LC500	MNC100
7.	Water Loop Heat Pump	n/a	MNC100 & LC500

Must include two (2) licensed copies of MultiNet Incontrol IC500 software.

.2 Every system shall be compatible with PC terminals and operating under a Windows 95 environment.

.3 Other vendors who wish to receive approval to bid shall submit complete data for review. For the CCS, the review procedure may include an all day interview session with the vendor, the Consultant and the Agency, to evaluate capabilities in detail. Such an interview will require attendance by technically knowledgeable staff from the vendor. Allow time for this procedure when the approval request is submitted.

PS 2 - OPERATOR INTERFACE

2.1 Access Requirements

.1 All functions of the system, storage of data, execution of commands, editing of programs, creation and display of graphics, etc., must be available regardless of the method of access to the system. Functionality must not be dependent on a continuous connection to the CCS in the building, as there may not be a PC installed on-site.

.2 The Agency will be accessing the CCS through Agency Standard equipment by the following methods:

.1 Through an on-site desktop or notebook PC, connected to the CCS, but not necessarily permanently installed.

.2 Through either a desktop PC or a notebook PC, which will connect to the CCS periodically by modem.

.3 The Agency requires two modes of access to the CCS:

.1 Through a text based terminal emulation interface available at all points of connection to the CCS.

.2 Through the full graphics interface described below, where the graphics are resident on any PC, whether connected directly to the CCS or remotely through the modem.

.4 For communities outside of Whitehorse, the system must have the ability to be accesed from the Property Management Agency office in the community where the building is located as well as from the Regional head office for that building...

2.2 Access Security

.1 The system shall have a minimum of 4 levels of password access security.

.2 Describe the functionality assigned to each level.

2.3 Modem Requirements

.1 Provide and install, (complete with connecting cables), a 28,800 baud auto-dial, auto-answer modem that will also allow access at any incoming lower speed, (US Robotics Sportser 28,800 data/fax).

.2 PROPERTY MANAGEMENT AGENCY will provide for the installation of the phone line.

2.4 Operator Interface Software

.1 Provide 2 copies of all software required to access the control system and carry out all the specified operator interface functions. This software will be for Agency use only, from either on-site or remote access locations. Tender price amount to include any licensing costs for the software.

.2 The operator interface software provided with the system shall be compatible with the Agency's standard hardware and operating system and be fully supported by the manufacturer for the next five years.

.3 Supply in disk format to conform to Agency Standard hardware and operating system.

.4 Provide the following dynamic graphic data display capabilities:

.1 Dynamic data display on each graphic which can accommodate any combination of dynamic (point type) information, graphic symbols and text, displayed at any location on the entire screen.

.2 User control over attributes of dynamic data for display, including:

- values
- units
- point names and full descriptions
- auto/manual indication
- access to full point parameters
- text size

.3 Dynamic linking of screens via definition of "hot spots" at any location on screen.

.4 User definable sizing of “hot spots” and ability to control colour and transparency of same.

.5 User-controllable automatic update of dynamic data.

.6 Minimum of 64 dynamic graphic displays per Stand Alone Panel.

.7 Minimum of 100 points per graphic display.

.8 Ability to print directly from screen, to either a black & while, or colour printer.

.9 Automatic display of alarm indication and the ability to disable auto-display of graphic.

2.5 Executing the Dynamic Colour Graphics

.1 Apply PROPERTY MANAGEMENT AGENCY’s Graphic Guidelines to all colour graphics specified.

.2 Provide all graphics listed in Section 15930.

2.6 Static Screen Graphics Generation Software

.1 Provide static, colour graphics generation software to run on Agency standard equipment.

.2 Software must provide the following capabilities:

.1 System that allows user to create, modify, and delete static graphics screens.

.2 Minimum VGA resolution with sixteen colour capability.

.3 Mechanism for copying and editing graphics of similar layout.

.4 Mechanism for importing Windows 95 graphics file formats, such as TIFF, GIF, PCX, DXF, BMP. JPG.

.5 Graphics creation features shall provide:

- User creation of symbols that can be stored for future use.
- Control of symbol location on screen.
- Control of line drawing, type, colour and thickness.
- Control of infill colour, background colour.
- Control of alpha-numeric text, including font size and colour.

2.7 Operator Interface Hardware Standards

The Agency minimum Standard equipment is as follows:

.1 Desktop AST Premmia MS - Pentium [P5] 75 Mhz

Includes: MS Windows 95, MS Mouse,

8 MB SIMM RAM

256 KB cache, Mach 64 video accelerator c/w 2 MB RAM

1003W -1 GB HDD c/w 16 MB RAM

NEC XE15 VGA colour monitor

8 MB RAM [2 X 4 MB SIMMS]
Premmia 1 MB video memory upgrade
MS Serial Mouse

.2 Notebook - Zenith Z-Noteflex 4/75 dx4
c/w 4 MB RAM, MS Windows 95
520 MB HDD / Passive Colour

Motorola Celect PCMCIA 14.4/14.4 FAX modem

8 MB RAM upgrade

MS Ballpoint Mouse

NEC VGA monitor, Expanded keyboard, Docking station
Nylon case
Battery, 110 VAC adaptor / charger

.3 Operating System

Windows 95

.4 Printer

Colour Ink Jet Printer

Note: If system requirements are greater then minimum, then system requirements will take precedence.

2.8 Temporary Operator Interface

Do not provide any operator interface equipment for the project. The contractor shall provide a PC and an alarm printer for the duration of the commissioning, startup, and training.

PS 3 - PROGRAMMABILITY

3.1 Database Creation and Modification

.1 Provide means for addition, deletion, definition and modification of points and point types through the operator interface.

.2 Provide links in the database such that if a point name is changed in database, all database occurrences of that point will automatically be changed.

.3 Provide direct keyboard override of all physical and virtual points with an indication on the display of any point that is operating under a keyboard override.

.4 The database for each physical or virtual point must only require definition once, regardless of the number of locations where it is used.

3.2 Alarm Definition and Processing

Provide the following:

.1 Operator defined digital and analogue alarms including operator defined limits and differentials from set points.

.2 Auto lockout of alarms when alarmed system is commanded off.

.3 Auto display of operator defined alarm messages.

.4 Operator defined routing of alarms.

.5 Log of points in alarm.

3.3 Trends

.1 Provide point trend logging capability for any system point as follows:

.1 User defined start/stop time or continuous trending.

.2 Sampling period user-adjustable from 5 seconds to 24 hours as a minimum.

.3 Change of value or change of state initiated.

.4 Display and print a minimum of 4 points simultaneously across the page.

.5 Ability to automatically dump trend logs to disk in ASCII format.

3.4 Trend Graphing

.1 System shall have the ability to graphically display logs or trended points in colour:

.1 Capability for display of a minimum of 4 points simultaneously, both analog and digital on the same graph.

.2 Capability for auto-scaling and ability to manually control horizontal and vertical scales.

3.5 Totalization

.1 Provide the capability to accumulate units of all analog and digital points.

3.6 Scheduling

.1 Provide scheduling feature that allows for creation of start/stop schedules and their use in programs as follows:

.1 Weekly
- 20 minimum per SAP
- time of day, day
- weekend, alternate day
- direct override by Annual Schedules
- 8 daily stops/starts per day

.2 Annual
- 6 minimum per SAP
- entire calendar year available

3.7 Point Definitions

.1 Analog Points

.1 System shall have the capability to accommodate user defined scale ranges which can be attached to any input or output.

.2 Provide conversion tables or other mapping functions for analog input and analog output points that define how the input or output hardware values relate to the engineering units used.

.3 This function must accommodate non-linear relationships.

.4 If a conversion table type function is used, it must have a minimum of 10 individually definable segments.

.5 Provide capability to assign any user defined unit to the analog point (i.e. percent, Deg C, Deg F, etc.).

.2 Digital Points

.1 Provide the capability to define in database whether a digital input point is normally open or normally closed.

.2 Provide the capability to assign any pair of engineering units to the relay open and relay closed positions of digital output points, (i.e. start/stop, on/off, open/closed).

3.8 Software Controllers

.1 Provide controllers, resident in each SAP and/or TUC, including a three-term, proportional, integral, derivative, (PID) control algorithm.

.2 Provide, in each controller, the following set up and tuning capabilities:

.1 Direct or reverse acting.

.2 Output value to control, 0 to 100%.

.3 Set point.

.4 Proportional Gain.

.5 Integral gain.

.6 Derivative gain.

.7 Sampling time - variable from 1 to 60 seconds.

.8 Control loop bias.

.3 Provision shall exist for the modification of the above by OCL programs and/or the operator while on-line through a terminal.

3.9 Operator Control Language (OCL) Capabilities

.1 The stand alone panels (SAPs) and soft terminal unit controllers (TUCs) shall have the capability for the operator to develop and run custom application programs. For this, the system shall have a proven OCL which shall be capable of reading the value and/or status of all system points and initiating both digital and analog control actions from any user defined combination of calculations and logical expressions which shall at a minimum include:

- Addition, subtraction, multiplication and division;
- Square roots, summations, absolute differences;
- Logical “not”, “and”, “or”, “nor”, “and”, “less than”, “greater than”, and “equal to” or their logical equivalents;
- Time delays in seconds, minutes or hours;
- Ability to embed comments in system generated documentation;
- Ability to use time-of-day and day-of-year in algebraic calculations; and
- Ability to use weekly and annual schedules.

.2 The supplied system’s OCL shall support the concept of output oriented code, or in other words, a program shall be generated for each controlling output or logical group of outputs. Required programs for each system are listed in the generic start up logic, although manipulation will be required to achieve the intent in each vendor’s system.

3.10 OCL Editor

.1 Provide a full screen editor to enable editing of the OCL programs source code down to character by character changes.

.2 Provide the capability in the editor of accepting programs from ASCII files that have been created on other MS-DOS compatible computers and word processors.

.3 If a point is removed from the database, show an error signal for undefined character on the appropriate line whenever a program using that point is viewed, edited or printed.

PS 4 - INTRA-SYSTEM COMMUNICATION

4.1 Network Communications

.1 Stand-Alone Panels (SAPs)

.1 Provide a fully networked system of SAPs which use a peer-to-peer communications protocol to support the distributed control features as specified herein. Each SAP shall be connected directly to the network. Each SAP shall have equal network access priority and shall not require a separate interface panel (gateway) to accomplish network communications.

.2 Provide a means to ensure communication integrity.

.3 To prevent damage to the system each data highway line shall be provided with a means of isolation, either optically or by some other means.

.4 Upon failure of the network to communicate information from one SAP to other SAPs, retain the last legitimate value of each point in the SAPs that require it, and continue to control the systems based on those values. Failure of any SAP, or any part of a SAP on the network, shall not affect the ability of the network to communicate among the remaining SAPs.

.5 Each physical or virtual point shall have a user-definable, unique, system-wide logical point mnemonic. The format of this point mnemonic shall conform to PROPERTY MANAGEMENT AGENCY Point Naming Convention. All point functions such as commands, overrides, trends, reports, logs and graphics shall only need to use this unique logical point mnemonic.

.6 Values, status's and attributes of physical and software points from one SAP shall be available for use in any other SAPs. Any broadcast points, send-receive blocks or any other form of table or database that is required to initialize and accomplish this function shall be created solely, and automatically, by the operating system, without the need for operator intervention. Listings of physical and software points shall not include tables referred to in this paragraph.

.2 Terminal Unit Controllers (TUCs)

For systems which include terminal unit controllers (TUC's).

.1 TUC's shall be considered to be any panel connected to a sub-communication network, where access to the features and points of the TUC is only obtainable through the SAP to which the sub-network is connected. TUCs shall have a limited number of inputs and outputs, which are specifically designed to control one component serving a single thermostatic zone (e.g., VAV terminal unit, dual-duct terminal unit, fan-coil unit, zone heat pump, etc.).

.2 The terminal unit controllers (TUCs) shall incorporate all of the requirements for the stand-alone panels (SAPs), except for peer to peer communications (PS 4.1.1.1) and auto-networking provisions (PS 4.1.1.6).

.3 The auto-networking requirements defined in PS 4.1.1.6 for SAPs apply between the TUC and the SAP it is connected to. If the TUC is connected to the main peer to peer communication network, the full requirements of PS 4.1.1.6 apply.

4.2 System Processing Speed

.1 For multi SAP systems, the system processing speed is intended to address inter-SAP communications and will be checked during the commissioning phase by evaluating value updates from one SAP as received and displayed in another SAP. This will be done by setting up a display of all SAP counters and checking how frequently each counter is updated on the refreshed display on site.

.2 Every counter shall show an updated value on the display within TWENTY (20) seconds of the previous update value appearing. This feature will be checked during the commissioning phase.

PS 5 - HARDWARE FEATURES

5.1 Power Conditioning

.1 Provide fitters to protect the system from power line surges and voltage transients.

5.2 Power Failure Protection

.1 Provide automatic retention of RAM and real time clock from any power failure of at least SEVENTY-TWO (72) hours duration. This feature will be checked during the commissioning phase.

.2 Provide for automatic restart of the system upon power return.

5.3 Hardware Failure Isolation

.1 Any component malfunction shall not damage any of the remaining components.

.2 Provide over voltage protection on inputs and outputs.

5.4 Ease of Hardware Replacement

.1 SAP and TUC replacement shall be possible without any hardware modification.

5.5 Database Back-Up and Off-Line Storage

.1 The system shall have the capability to be taken off line in the event of failure or for maintenance and returned to operation without the need for entering any portion of the software program manually. To accomplish this, an off-line disk storage device shall be utilized to provide software backup and reload.

.2 On-site backup and verification of the entire system, with full applications software, shall be less than TWO (2) seconds per real point. This feature will be checked during the commissioning phase.

5.6 Memory

.1 Each SAP on the main network proposed shall have enough random access memory (RAM) for all of the following:

.1 Trend Logs - One and a Half (1.5) TL for each input and output point connected to the SAP with 100 samples each.

.2 Controllers - TWO (2) for each analog output point connected to the SAP .

.3 Software Points - THREE (3) for each output point connected to the SAP .

.4 Operator Control Language (OCL) - TWENTY (20) syntactically correct lines each with at least 4 operators, for each output point connected to the SAP .

.5 Descriptor - ONE (1) for each user definable point, real or software, in the SAP . In addition, on multi-SAP systems, every descriptor in the system must be accessible from every operator interface device.

.6 Time Schedules - ONE (1) for every 3 output points connected to the SAP .

.7 Totalizers - ONE (1) for each digital point in the SAP.

.8 In the event there are TUCs networked to the SAP, which do not have their own memory meeting items .1 through .7, the SAP must have full memory for all TUC points as well as points connected directly.

.9 Provide with shop drawing submittal, calculations which confirm the foregoing RAM requirements are met for each SAP.

5.7 SAP Processing Speed

.1 Effective SAP Processing Speed - Maximum permissible execution time is TWO (2) seconds. Execution time is defined as the time it takes the SAP CPU to execute all application software in the SAP, with no system timing errors, from some point in the software back to the same point, assuming full memory usage, as defined in Clause 5.6 above, while simultaneously responding to operator or terminal display requests and carrying out normal inter-SAP communications averaged over a ONE (1)-minute period. This will be done during the commissioning phase by setting up a counter in each SAP and monitoring their counting rate.

5.8 System Display Speed

.1 The minimum time to change from one dynamic screen to another is 7 seconds. This test will be carried out from a remote site with the Agency's standard modem and will be the average of 10 typical displays for the project. Test will be carried out with the specified system configuration, excluding multi-user and alarming functions.

PS 6 - FIELD DEVICES

6.1 General

.1 This Clause contains a comprehensive range of field devices listed alphabetically by "Point type" code, not all of which will necessarily be applicable to this project. Refer to the "Point Type" column on the points lists in Section 15930 to identify the devices relevant to this project.

.2 Some point types have a number as the last character in order to identify variations in a group of similar field devices. For each separate point type or group of similar devices (common point type except for number) all items provided shall be the product of one manufacturer.

.3 All field devices shall be selected to have full compatibility with the SAPs, TUCs or other controls components being proposed.

.4 Any field device proposed for use which is not one of the products listed under "Standard of Acceptance" will be evaluated by the Owner's representative against the specified technical performance and the quality and characteristics of the products which are listed. If any proposed field device is deemed not equivalent to the specification, then the controls contractor shall provide another device which does meet specification at no extra cost.

.5 The shop drawing submittal shall include technical data for all field devices listed in the points lists, specifically cross-referenced to the particular point type to facilitate the shop drawing review.

.6 Some devices may require different ranges, capacities, etc. in particular applications, even though the device or component is otherwise the same. Where definition of such variations is required in the specifications or points lists, the point type will use suffixes, for example "DPS/x" or "DA1/x". The suffixes are explained in the "Technical Performance" portion of each point type specification.

.7 The end-to-end accuracy required for analog devices shall include the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the output at the operator interface device, or between the panel signal to the digital-to-analog converter and the controlled variable.

.8 Devices shall meet the specific requirements listed, and shall be compatible with respect to power supply, signal characteristics, or other factors with the CCS being proposed. Power supplies shall be provided as required for any and all devices.

6.2 Point Type "CRS"

.1 Description - Control Relay Status "CRS" is used where the field device will be either:

- an auxiliary dry contact, supplied as part of the equipment whose status will be monitored by this point, or
- if there is no auxiliary dry contact on the equipment, a relay as specified in 2. and 3., provided by the control contractor.

.2 Technical Performance - a high impedance relay to produce a dry contact.

.3 Standard of Acceptance - Omron Model GSD

- Veris Model 607 voltage bug.

6.3 Point Type "CR1"

.1 Description - Control Relay (Solid State)

.2 Technical Performance - 240V, 10 amp capacity. SPST function. Normally open (or normally closed) as required by points list or application complete with optical isolation. Suitable for switching inductive AC loads.

.3 Standard of Acceptance
- Electromatic - RS104240.
- Potter & Brumfield EOTZ Series.
- Grayhill 7052-04-C-12-S.

6.4 Point Type "CR2"

.1 Description - Control relay (dry contact electro-mechanical relay).

.2 Technical Performance - 240V, 10 amp to suit application.

.3 Standard of Acceptance
- IDEC-RH Series.
- Johnson R1020 series.

6.5 Point Type "CR3"

.1 Description - Control relay (Solid state relay suitable for switching D.C. loads).

.2 Technical Performance - 60 VDC

.3 Standard of Acceptance - Grayhill.

6.6 Point Type "CS1"

.1 Description - Current sensor (analogue).

.2 Technical Performance - Self powered, with insertion impedance loss less than 0.0006 ohms under all conditions. End-to-end accuracy ± 2% of full scale at each range. Ranges: 1.0 to 10.0 amps, low; 5 to 50 amps, middle; 20 to 200 amps, high; selectable by switch or by setting jumpers.

.3 Standard of Acceptance - Greystone CS-150.

6.7 Point Type "CS2"

.1 Description - Current Sensor (switch).

.2 Technical Performance - Solid State N.O. AC switch. Same ranges as point type "CS1". Manual adjustment of switch threshold setting.

.3 Standard of Acceptance - Greystone CS-125.

6.8 Point Type "CV1"

.1 Description - Control Valve (2 way, 2 position)

2. Technical Performance - Brass or bronze globe valve construction, with screwed ends. Materials suitable for chilled water or hot water up to 125ºC. 24 VAC. Working pressure, 875 kPa. N.O. spring return. Minimum close off pressure rating shall meet requirements in the points lists; if no requirement, minimum close off pressure rating shall be 70 kPa.

3. Standard of Acceptance
- Honeywell V8043 series
- Johnson J-series

4. Submittal Data - Submittal data shall include the proposed Cv rating for each control valve. If a specific Cv is specified in the points list or on a valve schedule, ensure the control valve proposed has a similar Cv to that specified.

6.9 Point Type “CV2”

.1 Description - Control Valve (2 way, floating control).

.2 Technical Performance - Brass or bronze body, globe valve with equal percentage flow characteristic, screwed ends. Materials suitable for chilled water or hot water up to 125ºC. Working pressure 875 kPa. 24 VAC reversing motor drive. Minimum close off pressure rating shall be 30 psi, or as stated in the points list, which ever is higher.

.3 Standard of Acceptance - Johnson

- Honeywell

.4 Submittal Data - Submittal data shall include the proposed Cv rating for each control valve. If a specific Cv is specified in the points list or on a valve schedule, ensure the control valve proposed has a similar Cv to that specified.

6.10 Point Type “CV3”

.1 Description - Control Valve (2 way modulating, non-spring-return).

.2 Technical Performance - Globe valve body, with equal percentage flow characteristics. Materials suitable for chilled water or hot water up to 125ºC. Modulating actuator with 0-10VDC signal range, power to open and power to close. Working pressure 875 kPa.

.3 Standard of Acceptance - Johnson
- Honeywell

.4 Submittal Data - Submittal data shall include the proposed Cv rating for each control valve. If a specific Cv is specified in the points list or on a valve schedule, ensure the control valve proposed has a similar Cv to that specified.

6.11 Point Type “CV4”

.1 Description - Control Valve (2 way, modulating, spring return).

.2 Technical Performance - Technical performance shall be as specified in 6.10.2.

.3 Standard of Acceptance - Johnson
- Honeywell

.4 Submittal Data - Submittal data shall include the proposed Cv rating for each control valve. If a specific Cv is specified in the points list or on a valve schedule, ensure the control valve proposed has a similar Cv to that specified.

6.12 Point Type “DA1/x”

.1 Description -Direct Coupled Damper Actuator (Electric, modulating, non-spring-return).

.2 Technical Performance - Power Voltage 24 VAC or 120 VAC.
- Control Voltage 0 - 10 VDC.

Suffixes -	“DA1/A”	- 50 in-lb torque capacity.
-	“DA1/B”	- 90 in-lb torque capacity.
-	“DA1/C”	- 130 in-lb torque capacity.

.3 Standard of Acceptance - Belimo NM-24SR or NM-24SRS (“DA1/A”)

- Belimo SMC-24SR (“DA1/B”)
- Belimo SM-24SR or SM-24SRS (“DA1/C”)
- Johnson Controls M140-GGA (“DA1/A”)
- Johnson Controls M150-GGA (“DA1/B” or “DA1/C”)

6.13 Point Type “DA2/x”

.1 Description - Damper Actuator (Electric, modulating, spring return).

.2 Technical Performance - Power voltage 24 VAC or 120 VAC
- Control Voltage 0 - 10 VDC

Suffixes - “DA2/A” - 50 in-lb torque capacity.
- “DA2/B” - 90 in-lb torque capacity.
- “DA2/c” - 133 in-lb torque capacity

.3 Standard of Acceptance - Belimo FM-24SR, NF-24 SR (“DA2/A”)
- Belimo AF24-SR (“DA2/C”)
- Johnson Controls M130-GGA (“DA2/A” only)

6.14 Point Type “DA3/x”

.1 Description - Damper Actuator (Electric, 2-position, non-spring-return).

.2 Technical Performance - Power Voltage 24 VAC or 120 VAC

Suffixes - “DA3/A” - 50 in-lb torque capacity.
- “DA3/B” - 90 in-lb torque capacity.
- “DA3/C” - 130 in-lb torque capacity.

.3 Standard of Acceptance - Belimo NM-24 (“DA3/A”)
- Belimo SMC-24 (“DA3/B”)
- Belimo SM-24 (“DA3/C4”)

6.15 Point Type “DA4/x”

.1 Description - Damper Actuator (Electric, 2-position, spring return).

.2 Technical Performance - Power Voltage, 24 VAC or 120 VAC.

Suffixes - “DA4/A” - 130 in-lb torque capacity.

.3 Standard of Acceptance - Belimo SF-24, AF-24, NF-24, SF-120, NF-120

6.16 Point Type “DDC”

.1 Description - Point type “DDC” is used to describe on analog output which is to be connected to a piece of equipment not supplied by the controls contractor for the purpose of controlling that equipment’s operation in some way. Examples would be an output to a variable speed drive to control its speed, or an output to a modulating chiller (or boiler) to control its operating output.

.2 The controls contractor shall provide wiring, and interface devices.

6.17 Point Type “DHS”

.1 Description - Duct mounted relative humidity sensor.

.2 Technical Performance - Operating range, 10% RH to 90% RH, over a 0ºC to 60ºC temperature range. End-to-end accuracy ± 3% of operating range, with maximum temperature dependence of 0.2% per ºC change. 200 mm long probe, with enclosure, for mounting in duct.

3. Standard of Acceptance - Greystone HS-250-C-02

- Hy-cal CT-829-A

6.18 Point Type "DPS/x"

.1 Description - Differential Pressure Sensor

.2 Technical Performance - Solid-state design, operating on capacitance principle, with non-interactive fine resolution, zero, and span adjustments. End-to-end accuracy ± 2% of full scale pressure range, including temperature compensation. Shall have integral filters at each air connection port.

Suffixes - "DPS/A" - 0 to 25 Pa pressure range.
- "DPS/B" - 0 to 50 Pa pressure range.
- "DPS/C" - 0 to 75 Pa pressure range.
- "DPS/D" - 0 to 125 Pa pressure range.
- "DPS/E" - 0 to 250 Pa pressure range.
- "DPS/F" - 0 to 500 Pa pressure range.
- "DPS/G" - 0 to 750 Pa pressure range.
- "DPS/H" - 0 to 1250 Pa pressure range.

.3 Standard of Acceptance
- Modus T20-xxx, T30-xxx, or T40-xxx to suit pressure range and application.
- Autotran 700.

6.19 Point Type "DTS1/x"

.1 Description - Duct temperature sensor, with an averaging element.

.2 Technical Performance - Constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor, reporting the average temperature from all the individual sensors. Operating range: 0ºC to 60ºC; end-to-end accuracy ±0.3ºC. Assembly complete with wiring housing and mounting flange.

Suffixes - "DTS1/A" - 3.5 m sensor cable length
- "DTS1/B" - 6.0 m cable length

.3 Standard of Acceptance
- Greystone TE-200
- Pre-con

6.20 Point Type "DTS2"

.1 Description - Duct temperature sensor, with probe type element.

.2 Technical Performance - Sensor encapsulated in a 200 mm long, 6 mm OD copper or stainless steel probe. Operating range 0ºC to 60ºC; end-to-end accuracy ± 0.3ºC. Assembly complete with wiring housing and mounting flange.

3. Standard of Acceptance
- Greystone TE-200-B-7-C
- Pre-con

6.21 Point Type "FRZ"

.1 Description - "Freezestat" auto-reset , complete with auxiliary dry contact in order to provide a separate digital input to the DDC system.

.2 Technical Performance - Range: -10ºC to 15ºC; probe length 6 m. Control responds to the lowest temperature along any 0.3 m of the entire length of the element.

.3 Standard of Acceptance - Penn A170-GA-1

6.22 Point Type "GAS1"

.1 Description - CO_2 concentration sensor.

.2 Technical Performance - 0 - 2500 ppm ± 2% Full Scale.

.3 Standard of Acceptance - Quatrosense Environmental Ltd. QEL QTS - 2000.

6.23 Point Type "GAS2"

.1 Description - Carbon monoxide concentration sensor.

.2 Technical Performance - 0 - 125 ppm CO output drift < 2% signal per month.

.3 Standard of Acceptance - Quatrosense Environmental Ltd.

6.24 Point Type "GAS3"

.1 Description - flammable gas concentration sensor.

.2 Technical Performance -

.3 Standard of Acceptance -

6.25 Point Type "GAS4"

.1 Description - Refrigerant vapour concentration sensor.

.2 Technical Performance -

.3 Standard of Acceptance -

6.26 Point Type "GAS5"

.1 Description - Total volatile organic compounds (TVOC's) concentration sensor, designed for mounting within an occupied space. This type of device is sometimes referred to as an indoor air quality sensor.

.2 Technical Performance -

.3 Standard of Acceptance -

6.27 Point Type "LS1"

.1 Description - Photocell light level sensor, with analogue output related to light intensity.

.2 Technical Performance - Dark 1 meg ohm, bright 1.5K ohm.

.3 Standard of Acceptance - Greystone PSR-1.

6.28 Point Type "LS2"

.1 Description - Photocell, adjustable light level switch.

.2 Technical Performance -

.3 Standard of Acceptance –

6.29 Point Type "LV1"

.1 Description – tank sensor

.2 Technical performance

.3 Standard of Acceptance

6.30 Point Type "OS1"

.1 Description - Passive infrared occupancy sensor.

.2 Technical Performance -

.3 Standard of Acceptance -

6.31 Point Type "OTS"

.1 Description - Outside air temperature sensor.

.2 Technical Performance - 10K ohm thermistor sensor encapsulated in a 6 mm OD probe, complete with weatherproof enclosure, sun shield and mounting bracket. Operating range: -35ºC to +50ºC. End-to-end accuracy: ± 0.3ºC over the entire operating range.

.3 Standard of Acceptance - Greystone TE-200-F, c/w 100K ohm parallel resistor.

6.32 Point Type "PS1"

.1 Description - Pipe Pressure Transducer.

.2 Technical Performance - Brazed assembly with 300 series stainless steel parts that are in contact with the media, snap tract and circuit board c/w external pressure sensor and mounted in a NEMA 4 enclosure. Accuracy ± 3% span from best fit straight line.

Inputs - 7.5 - 32 VDC

Range - Suffix A) - 350 kPa

.3 Standard of Acceptance - Greystone PGS-100

6.33 Point Type "PTS1"

.1 Description - Pipe Temperature Sensor, immersion type .

.2 Technical Performance - 10K ohm thermistor sensor encapsulated in a 6 mm OD, 50 mm long probe, with screw fitting for insertion into a standard thermowell. Sensor assembly to be complete with enclosure and thermowell. Operating range: -10ºC to 100ºC. End-to-end accuracy: ± 0.3ºC over the entire operating range.

.3 Standard of Acceptance - Greystone TE-200-C

6.34 Point Type "PTS2"

.1 Description - Pipe Temperature Sensor, strap-on type.

.2 Technical Performance - 10K ohm thermistor encapulated in a stainless steel pad designed for strap-on installation. Assembly to be complete with solid-state circuitry in an enclosure and connecting cable to the thermistor. Operating range: -10ºC to 100ºC. End-to-end accuracy: ± 0.3ºC over the entire operating range.

.3 Standard of Acceptance - Greystone TE-200-E-7

6.35 Point Type "RHS"

.1 Description - Relative Humidity Sensor Room Type.

.2 Technical Performance - operating range: 10% RH to 90% RH, over a 0ºC to 60ºC temperature range. End-to-end accuracy: ± 3.0% of operating range, with maximum temperature dependence of 0.2% RH per ºC change. Assembly shall be complete with a baseplate for wall mounting, a rigid circuit board for all circuitry and the sensing element, and a ventilated enclosure.

.3 Standard of Acceptance - Greystone HS-150-B-02
- Hy-cal C102-H

6.36 Point Type "RTS1"

.1 Description - Room temperature sensor complete with momentary override switch.

.2 Technical Performance - Assembly shall consist of a 10K ohm thermistor and related circuitry mounted on a circuit board/baseplate for wall mounting, complete with a vented, plastic enclosure. Operating range: 10ºC to 30ºC. End-to-end accuracy: ± 0.3ºC over the entire operating range.

.3 Standard of Acceptance - Greystone TE-200-AE-OR

6.37 Point Type “RTS2”

.1 Description - Room Temperature Sensor, security type.

.2 Technical Performance - Assembly shall consist of a 10K ohm thermistor and related circuitry mounted on a rigid, metal cover plate designed for mounting into a recessed junction box. The sensing element shall be attached directly to the cover plate. Operating range: 10ºC to 30ºC. End-to-end accuracy: ± 0.3ºC over the entire pressure range.

.3 Standard of Acceptance - Greystone TE-200-AS

6.38 Point Type “RTS3”

.1 Description - Room temperature sensor complete with momentary override switch, setpoint adjustment, and setpoint indication.

.2 Technical Performance - Assembly shall consist of a 10K ohm thermistor and related circuitry mounted on a rigid, metal cover plate designed for mounting into a recessed junction box. The sensing element shall be attached directly to the cover plate. Operating range: 10ºC to 30ºC. End-to-end accuracy: ± 0.3ºC over the entire pressure range.

.3 Standard of Acceptance - Greystone TE-200-IT
- Delta Intellistat RTS406

6.39 Point Type “VS1”

.1 Description - Velocity sensor (single point flow sensor).

.2 Technical Performance - 0 - 3000 FPM Adjustable 4” - 16” ducts. (Thermal anemometer technology).

.3 Standard of Acceptance - BELIMO.

6.40 Point Type “VS2”

.1 Description - Air velocity sensor with thermal anemometer technology, using differential pressure signal from a flow grid in duct or VAV box inlet.

.2 Technical Performance -

.3 Standard of Acceptance -

6.41 Point Type “WPS”

.1 Description - (Window Position Switch) Point type “WPS” is used to describe a digital input connected to a dry contact which is part of a magnetic proximity switch on openable sections of glazing. The dry contact will be open when the window is open, and closed when the window is closed.

.2 If the window supplier provides the proximity switches, and wiring from their dry contacts, to 300 mm above the window head above the openable section, use the CRS designation for the point.

PS 7 - OPERATING SYSTEM SOFTWARE POINT REQUIREMENTS

7.1 General

This clause contains a list of system points , not all of which will be applicable to this project. Refer to the "Point Type" column on the points lists in Section 15930 to identify the points relevant to this project.

The contractor shall create and name all points indicated in the points lists. Software points shall have the same characteristics on the graphic screens as the real or hardware points. A few additional points may be required to comply with the intent of the generic logic, depending on the vendors system. All software points to be located on the graphic screens as shown.

7.2 Point Type "AL"

Description: Alarm Point
Set up alarm points , if required, so that nuisance alarms are minimized. Name as per points lists. First name in "notes" is alarmed point while second is associated system point. Route alarms to "AR" point and to the site terminal or modem.

7.3 Point Type "AS"

Description: Annual Schedule
Annual schedules will allow the operator to set up the statutory holidays one year in advance. When assigned to a weekly schedule the annual schedule will allow the weekly schedule to be overridden.

7.4 Point Type "CO"

Description: Controller
A point which allows a software controller to be set up as P, PI, or PID. The measured variable is noted as the first name in the "notes" column of the points lists, while the setpoint is the second. Set up as required to provide stable operation with no "dithering" or hunting. Output units are 0% to 100%.

7.5 Point Type "PG"

Description: Program
This is the nomenclature for the point which contains the OCL programs that allow writing of the “if, then, else” statements. Set up as detailed in the Generic Startup Logic.

7.6 Point Type "TL"

Description: Trend Log
Trend log points to be set up as detailed in the points lists and PS 9. Points list trend logs have the points noted in the "notes" column separated by commas, e.g. HCV,SAT_SP,SAT,HCP. Name as per points lists or PROPERTY MANAGEMENT AGENCY Point Naming Convention if not on points lists.

7.7 Point Type "TZ"

Description: Totalizers
Set up totalizers for each digital output point in the system, except for outputs to floating point devices. Name as per points list with units as hours.

7.8 Point Type "V"

Description: Variable
Variable or software points may be analog or digital as required. Set up as required in the points lists with the proper units, and as required to comply with the intent of the generic start-up logic.

7.9 Point Type "WS"

Description: Weekly Schedule
Weekly schedules provide the software time clock for use in OCL. Values are on or off. Set up with times as directed by the Owner’s representative.

PS 8 - INSTALLATION STANDARDS

8.1 General

.1 The intention of this clause is to guide the Contractor as to the quality of installation that the Agency requires.

.2 The installation shall conform both to manufacturer's recommended procedures and all applicable codes and regulations to the approval of authorities having jurisdiction.

.2 All installations to be performed by skilled and certified technicians and trades people.

.4 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.

.5 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

.6 Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.

.7 Co-operate with the construction team as a whole, to keep the job reasonably clear of waste material and rubbish at all times during progress of the work.

.8 Under the overall direction of the General Contractor, coordinate activities and co-operate at all times with the principal Divisions 15 and 16 Contractors and other Contractors on the project concerning scheduling and installation of the work, all phases of commissioning, and access to work areas.

.9 All points associated with a single zone or an individual system shall be connected to the same stand alone panel, and associated terminal unit controller.

8.2 Calibration

.1 Set control points immediately after installing controls.

.2 Set up and calibrate sensors and control loops during initial start-up of the systems and check, recalibrate and readjust as necessary during the Commissioning.

.3 Submit documentation to the Owner's representative before the systems performance verification indicating the final set points of all controls and confirmation that all control systems have been checked. Documentation may be graphic or tabular.

8.3 Electrical Work By The Controls Contractor

.1 The following clauses generally indicate the extent of responsibility for electrical wiring included for the controls system.

.2 All wiring required for devices supplied under this Section of the Specifications, regardless of the voltage, shall be the responsibility of the Controls Sub-Contractor.

.3 All such work shall be performed in complete accordance with the Electrical Specifications and local Codes and may include the following: (Refer to Section 15920 for exclusions or additions).

- .1 Provision of control panels, pilot lights, selectors, relays, etc., required for the proper operation of the CCS.

- .2 Conduit and wiring from the starter control or ASD circuits to the mechanical system control panels including 110V wiring.

- .3 Conduit and wiring required for the interlocking of mechanical system motor starters as required for the proper operation of the control system.

- .4 Wiring from pilot devices, relays, contactors, or other control interface devices supplied under other Sections of the Mechanical Specifications and referenced in the points lists, required to complete the control system.

- .5 Control wiring and interlocking required for refrigeration machines.

.6 Wiring from spare 15 amp circuit breakers in power panels for line voltage power sources where required by control system. Circuit breakers shall be locking type.

.7 Wiring of mechanical component controls, i.e., boilers, chillers, etc.

.8 Power wiring and control wiring to stand alone panels and terminal unit controllers.

8.4 Electrical Work by the Electrical Contractor (DIV 16)

.1 Generally the Electrical Contractor shall be responsible for the electrical connections from starters to equipment motors, and the following: Refer to Section 15920 for exclusions or additions.

.1 All disconnect switches on lock-out station at motor locations where required by Code.

.2 Remote control on H.O.A. stations where they are not part of a mechanical control system panel.

.3 Power wiring to line voltage thermostats controlling force flow units and unit heaters, and wiring to float devices for sump pumps, etc.

.4 Power wiring to variable speed devices and from variable speed device to motors, where specified.

.5 Spare 15 amp emergency circuit, one on each floor for controls.

.6 Supply and installation of the properly sized overload heaters in the magnetic starters and thermal overload switches.

8.5 Conduit, Wiring and Cabling

.1 All work shall be installed to Division 16 Requirements.

.2 Where there is no alternative to supplying equipment which is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtain approval before delivery of equipment to site. Such equipment must be individually identified in the Contractor's proposal.

.3 Use coded conductors throughout with different coloured conductors for each phase and white wire for neutral.

.4 *Low Voltage and Communications Wiring* - Size and type of low voltage control signal wiring shall be suitable for the service for which it will be put to use and be the responsibility of this Contractor; minimum wire size #18 AWG.

.5 Identify each wire and cable at every termination point. Identify all conduits with “neat” colour bands at no more than 7.5 m intervals and on both sides of walls and floors.

.6 120V circuits shall be, at a minimum, of #12 AWG RW-90 copper for power circuits and minimum, or 14 AWG RW-90 copper for control circuits

.7 All wiring in mechanical rooms and service rooms to be in conduit or raceway. Provide 600 mm, B-X flexible connection to input and output devices where required for servicing or to accommodate vibration.

.8 All communication wiring between stand alone panels and the Operator Interface shall be installed in conduit. Wiring from SAPs to TUCs does not have to be in conduit except in mechanical and electrical rooms, and where direct access is not available.

.9 All 120V interlock wiring and power supplies for panels to be installed in conduit.

.10 Provide 120V power supplies to all main DDC panels, separately circuited from all other loads.

.11 Low voltage wiring to input and output devices from SAPs and TUCs is not required to be installed in conduit except as noted. Use plenum rated wire in areas used as return air plenums. Provide sleeves where wire pass through walls and floors.

.12 Several TUCs may be supplied from one 120V power supply through a 120/24V transformer in accordance with the manufacturer's design. Only TUCs connected to the same SAP may be connected to a common power supply.

8.6 Control Hardware

.1 Provide metal enclosures to meet NEMA specs for mounting motor control relays, wiring terminations, and components provided which require additional protection.

.2 All components shall be positioned to provide easy access for maintenance or replacement.

8.7 Installation of Control Devices

.1 Sensors provided under this contract shall be installed in accordance with the manufacturer's prescribed procedure.

.2 Sensors shall be rigidly mounted and mountings shall be adequate for the environment within which the sensor operates.

.3 Supply approved thermal wells of the appropriate size and type for sensing water temperatures, as required in the Points List, to the mechanical contractor for installation.

.4 All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

.5 Install labels on the inside covers of all room sensors identifying the point name using peel and stick labels such as the Brother labelling system.

8.8 Installation of Actuators

.1 Where damper motors operate outdoor relief, exhaust and fresh air dampers, pretension damper drive linkage to ensure tight closure.

.2 Do not install damper motors on ductwork of less than 0.76 mm thick without first reinforcing it.

.3 Where a damper motor is installed on an insulated surface of a duct plenum, mount it on a stand-off bracket so as not to interfere with the continuity of the insulation.

.4 Locate damper motors so that they are easily accessible for testing and servicing.

.5 Damper motors shall be selected for the torque requirements of the damper. Damper operators that are undersized for the application shall be replaced with larger operators, at no extra cost.

.6 Provide one damper motor and linkage for every 2 m^2 damper section area, or as required to meet the torque requirements of the damper under design air-flow conditions (or minimum of one damper motor per damper section). Do not use two motors linked together on one shaft, or by jackshaft.

PS 9 - SUBSTANTIAL PERFORMANCE TEST PROCEDURES

9.1 Overview

The successful completion of a SEVEN (7) day acceptance test as described herein is a prerequisite to granting Substantial Performance. Before the SEVEN (7)-day acceptance test may begin, the CCS must be completely operational including the following:

.1 Every point shall be checked end to end to ensure accuracy and integrity of systems and be signed off by the Contractor and the Agency.

.2 Generic Start up Code shall be written in Operator Control Language (OCL) and successfully control the systems.

.3 Time schedules shall be built and in control of time-controlled equipment.

.4 Graphic displays must be installed and fully operational for each graphic screen page as per the CCS Project Summary in Section 15930.

.5 Each control loop measured variable, controlled variable and set point if calculated, shall be placed on a FIFTEEN (15)- minute continuous trend for at least TWENTY-FOUR (24) hours to prove stability of loop.

.6 Each space sensor shall be placed on a THREE (3)-hour trend for One Hundred (100) samples.

.7 Runtime totalizer shall be set on all digital outputs.

.8 Load/save of panel programs must be demonstrated.

.9 All features of system shall have been exercised.

.10 Operator shall have been briefed on operation of system.

.11 A trend on one panel shall be set up for a point from every other panel. These points shall also be trended in their own panels for the same intervals. Comparison of the two groups of trends will indicate if any communication problems are occurring during the SEVEN (7)-day test.

.12 All alarms shall be operational.

.13 Calibration of all sensors.

9.2 During SEVEN (7)-Day Test

.1 Fire alarm shall be activated to ensure correct action of all fire and smoke sequences.

.2 Power failure for building shall be simulated and system recovery monitored.

.3 System must be available for Agency's representative to exercise most features of the system.

.4 Demonstration of modem operation will be required. All functions of the CCS shall be accessed through the modem to prove operation.

.5 Demonstration of hardware low limits and damper interlocks will be required.

.6 Spot checks of points end-to-end integrity will be carried out. If several problems are identified, a complete reconfirmation of system integrity shall be carried out by the Contractor. When reconfirmation has been completed, the 7 day test will be restarted.

.7 Any upset of system operational functionality greater than 2 hours during the 7 day test shall cause the test to be restarted.

.8 Printer shall be left on for complete SEVEN (7)-day test. All printouts will be kept for review at completion of test. An alarm printer shall be supplied by the Contractor if none is supplied in this contract.

.9 Results of all tests shall be documented by the Contractor and submitted to the Engineer for review.

.10 System speeds as defined in PS 4.2, PS 5.5, PS 5.7 and PS 5.8 will be tested during the 7-day test.

9.3 Training and Demonstrations

The complete training program, (refer to item PS 1.5) shall be carried out. It may be convenient to schedule this during the 7 day test period.

9.4 Documentation

The following documentation must also be in place before completion of SEVEN (7)-day test and the granting of Substantial Performance:

.1 Panel layout sheets complete with point name, point address and wire identification number. One copy attached to each respective panel door.

.2 All points tagged with point name, point address and panel number.

.3 System generated data sheets and graphics signed off by both the contractor and the consultant showing successful commissioning of each point.

.4 As-Built control drawings showing interface with existing controls.

.5 As-Built ladder wiring diagrams showing all hardware interlocks and panel input or output number.

.6 Complete Operators Manual.

.7 Apparatus and Maintenance Manual for all sensors, transducers, valves, operators, solid state relays, DDC main panels and zone controllers.

.8 Graphic plates of floor plans showing sensors, terminals, devices, zoning and stand alone panel locations.

.9 Electrical approval certificate.

.10 All of the above information, with the exception of #2 (point tags) shall be bound and presented in TWO (2) copies turned over to engineer.

.11 A copy of each graphical screen page included in Section 15930 shall be signed off and dated by the successful Contractor, and the Owner’s representative. Any changes shall be noted. This signed set shall be left on site as the “as installed drawings”.

In addition, a summary print out generated by the supplied system of each group of point types for each panel shall be printed after commissioning and calibration. Each sheet shall be signed by the Contractor’s commissioning person, and the Owner’s representatives. The print out will be stored in a binder on site for reference by all parties. If any changes are noted during spot checks they shall be manually written on the original print out with the date and signature of person noting changes.

9.5 Project Acceptance

Once the above basic requirements are met and all other features of the system are complete and acceptable, Substantial Performance shall be granted. A deficiency list shall be prepared and holdbacks applied. All deficiencies shall be corrected prior to Total Performance. Warranty shall start from the date of Substantial Performance of the work.

5.A PROJECT SUMMARY AND TABLE OF CONTENTS

	Description	Status	Updated
A2	Example CCS Project Summary Table of Contents	Approved	95/09/01
A3	Blank CCS Project Summary Table of Contents	Approved	95/09/01

SECTION 15930 - CCS PROJECT SUMMARY TABLE OF CONTENTS

Project Number: 123		Project Name: EXAMPLE BUILDING												
	Page	DDC Hardware Pt				Virtual	Non	Emer/	Terminal Unit Controllers				# of Graphic Screens	
System Description	No	DO	DI	AO	AI	Point	DDC	Safety	V-A	V-N		Total		Notes
Help Screen	6												1	
Main Menu/Overview	7												1	
Graphics Index	8												1	
Floor Graphics	9												4	NW,NE,S-1,S-2
Detail Floor Graphics	10												4	NW,NE,S-1,S-2
VAV1	11-12	4	1	5	5	34							1	
VAV1 TUC	13-16								15	10		25	2	
VAV2	17-18	3	1	3	5	27							1	
VAV2 TUC	13-16								18	12		30	2	
Cooling	19-20	2	2	1	3	5							1	
Heating	21-22	2			3	8							1	
Miscellaneous	23-24	2	1		2	7							1	
Non DDC	[illegible]						[illegible]							
Emergency/Safety	26							[illegible]						
CCS Overview	27												1	
Panel Layout	28												*	*One per panel
Wire Detail	29												*	*Show as builts
Total Summary		13	5	9	18	81	2	2	33	22		55	21	
			33	33	66	297								
			44	44	66	264								
Grand Total Summary		13	82	86	150	642	2	2	33	22		55	21	

Project Number: 123		Project Name: EXAMPLE BUILDING												
	Page	DDC Hardware Pt				Virtual	Non	Emer/	Terminal Unit Controllers				# of Graphic Screens	
System Description	No	DO	DI	AO	AI	Point	DDC	Safety	V-A	V-N		Total		Notes
Help Screen														
Main Menu/Overview														
Graphics Index														
Floor Graphics														
Detail Floor Graphics														
VAV1														
VAV1 TUC														
VAV2														
VAV2 TUC														
Cooling														
Heating														
Miscellaneous														
Non DDC														
Emergency/Safety														
CCS Overview														
Panel Layout														
Wire Detail														
Total Summary		0	0	0	0	0	0	0	0	0		0	0	
Grand Total Summary		0	0	0	0	0	0	0	0	0		0	0	

PROPERTY MANAGEMENT AGENCY CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.C PRE-APPROVED COOLING SYSTEM TYPES

System Type	Description	Status	Updated
C:A	Single reciprocating chiller with air cooled condensers	Approved	95/10/10
C:B	Single screw chiller with air cooled condenser	Approved	95/10/10
C:C	Single screw chiller with cooling tower	No	
C:D	Single centrifugal chiller with cooling tower	Approved	94/10/28
C:E	Multiple reciprocating chillers with air cooled condensers	No	
C:F	Multiple screw chillers with air cooled condensers	No	
C:G	Multiple screw chillers with cooling towers	No	
C:H	Multiple reciprocating chillers with cooling towers	No	
C:I	Single screw chiller with 2 primary & 2 secondary pumps all sized for 50%	Yes	95/10/10

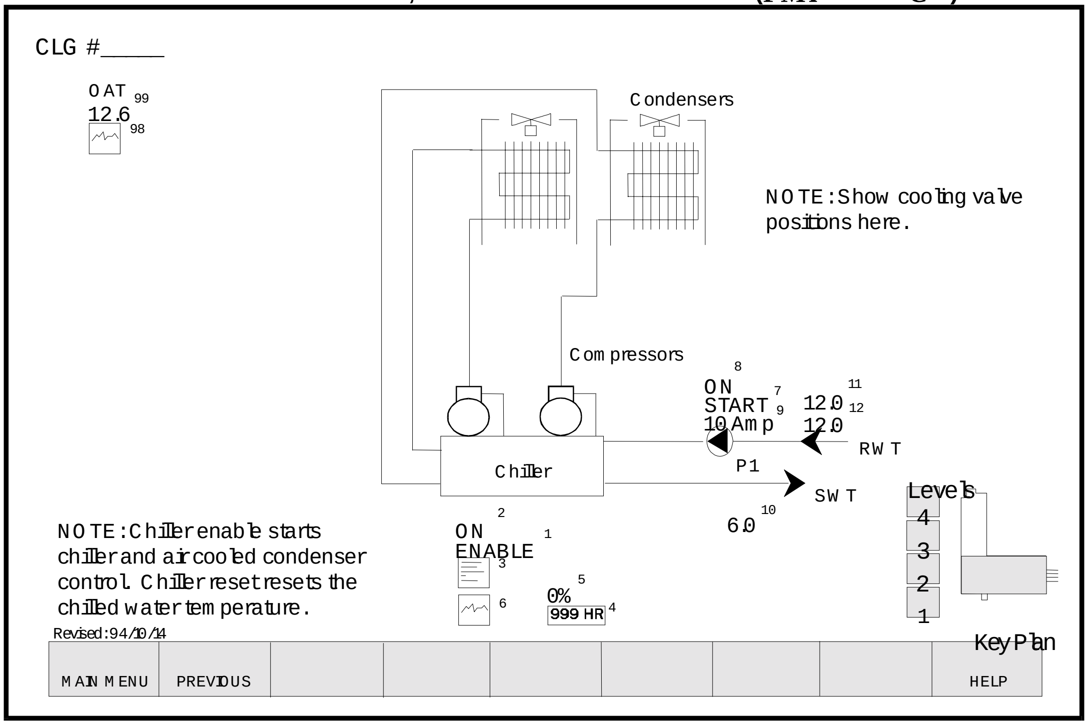
Custom:

X	Single screw air cooled condenser (BCCDC)	Yes	95/08/17

SINGLE RECIPROCATING CHILLER, AIR COOLED CONDENSERS (Property Management Agency TYPE C:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Chiller Control		ENBL	CR1	1						
2	Chiller Status		S	CRS		1					
3	Chiller Program		PG	PG					1		
4	Chiller Run Hours		TZ	TZ					1		
5	Chiller Reset		CR	DDC			1				
	Chiller Controller		CO	CO					1	use RWT:RWT_SP	
6	Chiller Trendlog		TL	TL					1	CR,SWT,RWT,ENBL	
7	Chilled Water Pump		P1	CR1	1						
8	Chilled Water Pump Status		P1_S	V					1		
9	Chilled Water Pump Amps		P1_AMP	CS1				1			
10	Supply Water Temperature		SWT	PTS1				1			
11	Return Water Temperature		RWT	PTS1				1			
12	Return Water Setpoint		RWT_SP	V					1		
	Total				2	1	1	3	6		

SINGLE RECIPROCATING CHILLER, AIR COOLED CONDENSERS (PMA TYPE C:A)-GRAPHIC



GENERIC START UP LOGIC

3 **Chiller (CLR_PG)**

IF OAT > 13 AND ENBL OFF-FOR 30 M AND
MAX (CCV1, CCV2, etc) > 90 THEN
    ENBL = ON, START P1
IF OAT < 11 OR
MAX (CCV1, CCV2, etc) < 10 THEN
    ENBL = OFF
IF ENBL OFF-FOR 15 M THEN STOP P1
IF P1_AMP > 6 THEN
    P1_S = ON
ELSE P1_S = OFF

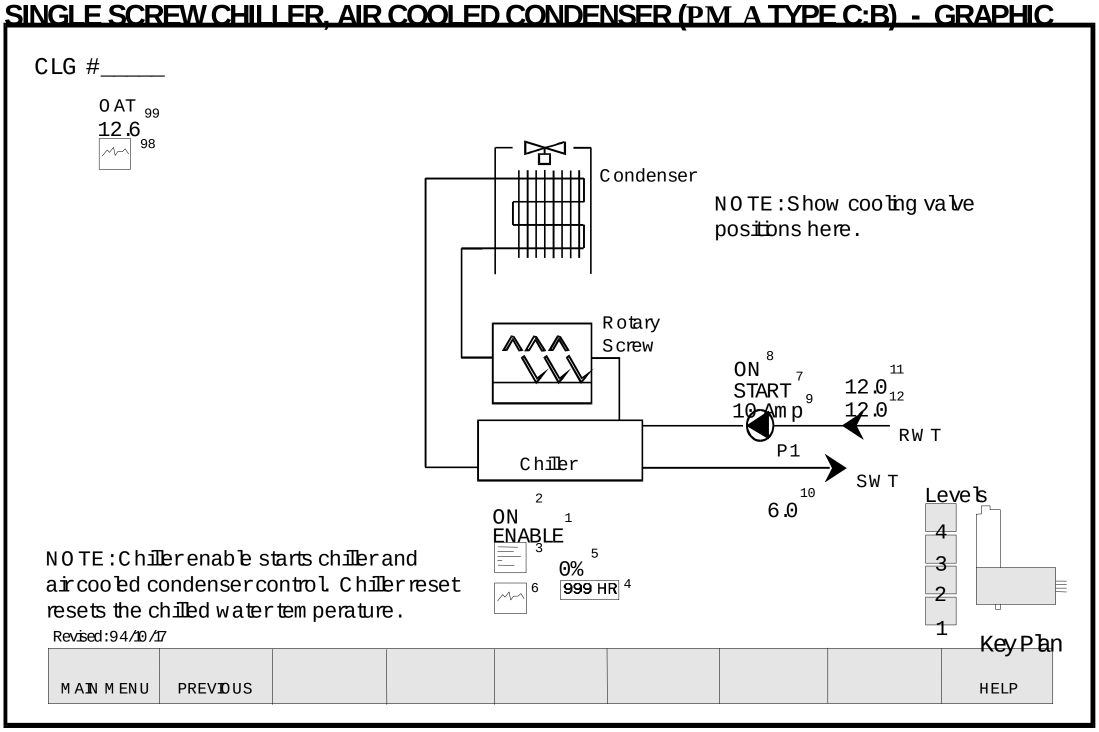
[Chiller Reset]

RWT_SP = 12
IF ENBL ON THEN CR = CO
ELSE CR = 0

SINGLE SCREW CHILLER, AIR COOLED CONDENSER (Property Management Agency TYPE C:B) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Chiller Control		ENBL	CR1	1						
2	Chiller Status		S	CRS		1					
3	Chiller Program		PG	PG					1		
4	Chiller Run Hours		TZ	TZ					1		
5	Chiller Reset		CR	DDC			1				
	Chiller Controller		CO	CO					1	use RWT:RWT_SP	
6	Chiller Trendlog		TL	TL					1	CR,SWT,RWT,ENBL	
7	Chilled Water Pump		P1	CR1	1						
8	Chilled Water Pump Status		P1_S	V					1		
9	Chilled Water Pump Amps		P1_AMP	CS1				1			
10	Supply Water Temperature		SWT	PTS1				1			
11	Return Water Temperature		RWT	PTS1				1			
12	Return Water Setpoint		RWT_SP	V					1		
	Total				2	1	1	3	6		

SINGLE SCREW CHILLER, AIR COOLED CONDENSER (PMA TYPE C:B) - GRAPHIC



GENERIC START UP LOGIC

3 **Chiller (CLR_PG)**

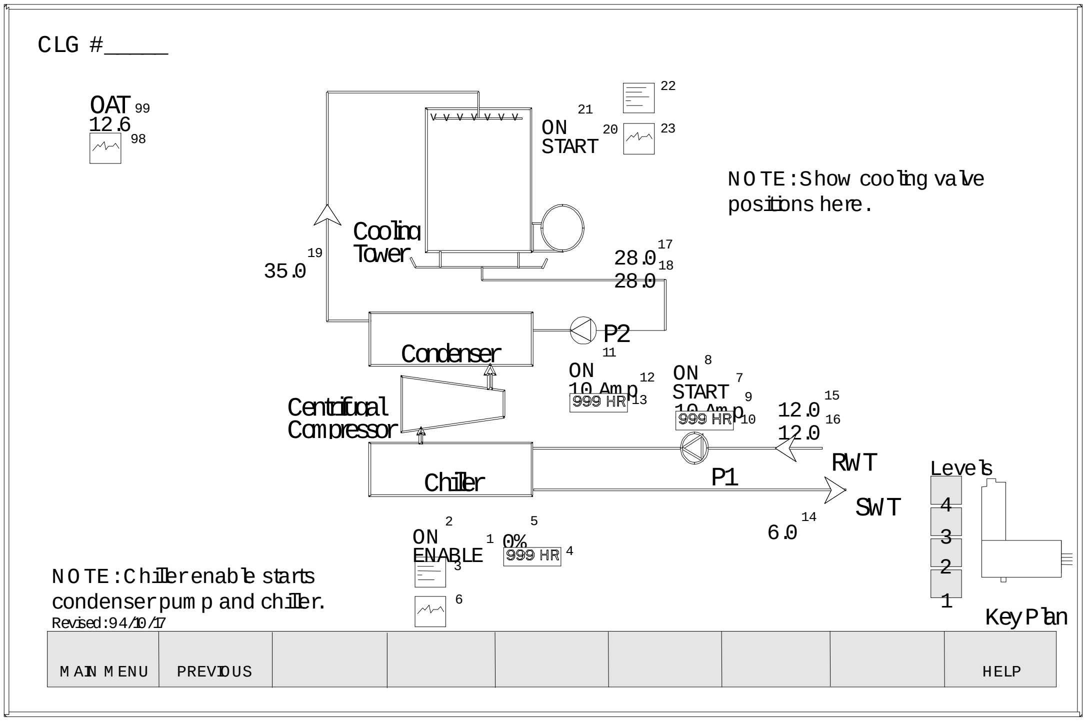
IF OAT > 13 AND ENBL OFF-FOR 30 M AND
MAX (CCV1, CCV2, etc) > 90 THEN
  ENBL = ON, START P1
IF OAT < 11 OR
MAX (CCV1, CCV2, etc) < 10 THEN
  ENBL = OFF
IF ENBL OFF-FOR 15 M THEN STOP P1
IF P1_AMP > 6 THEN
  P1_S = ON
ELSE P1_S = OFF

[Chiller Reset]
RWT_SP = 12
IF ENBL ON THEN CR = CO
ELSE CR = 0

SINGLE CENTRIFUGAL CHILLER, COOLING TOWER (PMA TYPE C:D) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Chiller Control		ENBL	CR1	1						
2	Chiller Status		S	CRS		1					
3	Chiller Program		PG	PG					1		
4	Chiller Run Hours		TZ	TZ					1		
5	Chiller Vane		VANE	DDC			1				
	Chiller Vane Controller		VANE_CO	CO					1	use RWT:RWT_SP	
	Chiller Vane Low Limit Controller		VANE_CO_LL	CO						use SWT:SWT_LL_SP	
	Chiller Vane Ramp		RAMP	V					1		
6	Chiller Trendlog		TL	TL					1	VANE,SWT,RWT,ENBL	
7	Chilled Water Pump		P1	CR1	1						
8	Chilled Water Pump Status		P1_S	V					1		
9	Chilled Water Pump Amps		P1_AMP	CS1				1			
10	Chilled Water Pump Run Hours		P1_TZ	TZ					1		
11	Condenser Pump Status		P2_S	V					1		
12	Condenser Pump Amps		P2_AMP	CS1				1			
13	Condenser Pump Run Hours		P2_TZ	TZ					1		
14	Supply Water Temperature		SWT	PTS1				1			
	Supply Water Low Limit Setpoint		SWT_LL_SP	V					1		
15	Return Water Temperature		RWT	PTS1				1			
16	Return Water Setpoint		RWT_SP	V					1		
17	Cooling Tower RW Temp		CT_RWT	PTS1				1			
18	Cooling Tower RW Setpoint		CT_RWT_SP	V					1		
19	Cooling Tower SW Temp		CT_SWT	PTS1				1			
20	Cooling Tower Fan Control		CT	CR1	1						
21	Cooling Tower Fan Status		CT_S	CS1				1			
22	Cooling Tower Program		CT_PG	PG					1		
23	Cooling Tower Trendlog		CT_TL	TL					1	RWT,SWT,CT,OAT	
	Total				3	1	1	7	14		

SINGLE CENTRIFUGAL CHILLER, COOLING TOWER (PMA TYPE C:D) - GRAPHIC



GENERIC START UP LOGIC

3 Chiller (CLR_PG)

```
IF OAT > 13 AND ENBL OFF FOR 30 M AND
MAX (CCV1, CCV2, etc) > 90 THEN
    ENBL = ON, START P1
IF OAT < 11 OR
MAX (CCV1, CCV2, etc) < 10 THEN
    ENBL = OFF
IF ENBL OFF FOR 15 M THEN
    STOP P1

[Pump Status]
IF P1_AMP > 6 THEN
    P1_S = ON
ELSE P1_S = OFF
IF P2_AMP > 6 THEN
    P2_S = ON
ELSE P2_S = OFF

[Chiller Vane Program]
RWT_SP = 12
SWT_LL_SP = 6
DO EVERY 3 S
RAMP = RAMP + 1%
IF ENBL OFF THEN
    RAMP = 0%
IF RAMP > 100% THEN
    RAMP = 100%
END DO
VANE = MIN(VANE_CO, VANE_CO_LL, RAMP)
```

22 Cooling Tower (CT_PG)

```
CT_RWT_SP = 28
IF ENBL ON AND CT_RWT > CT_RWT_SP THEN
    START CT
IF CT_RWT < CT_RWT_SP - 2 OR P2_S OFF THEN
    STOP CT
```

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.D PRE-APPROVED DUAL FAN DUAL DUCT AIR SYSTEM TYPES

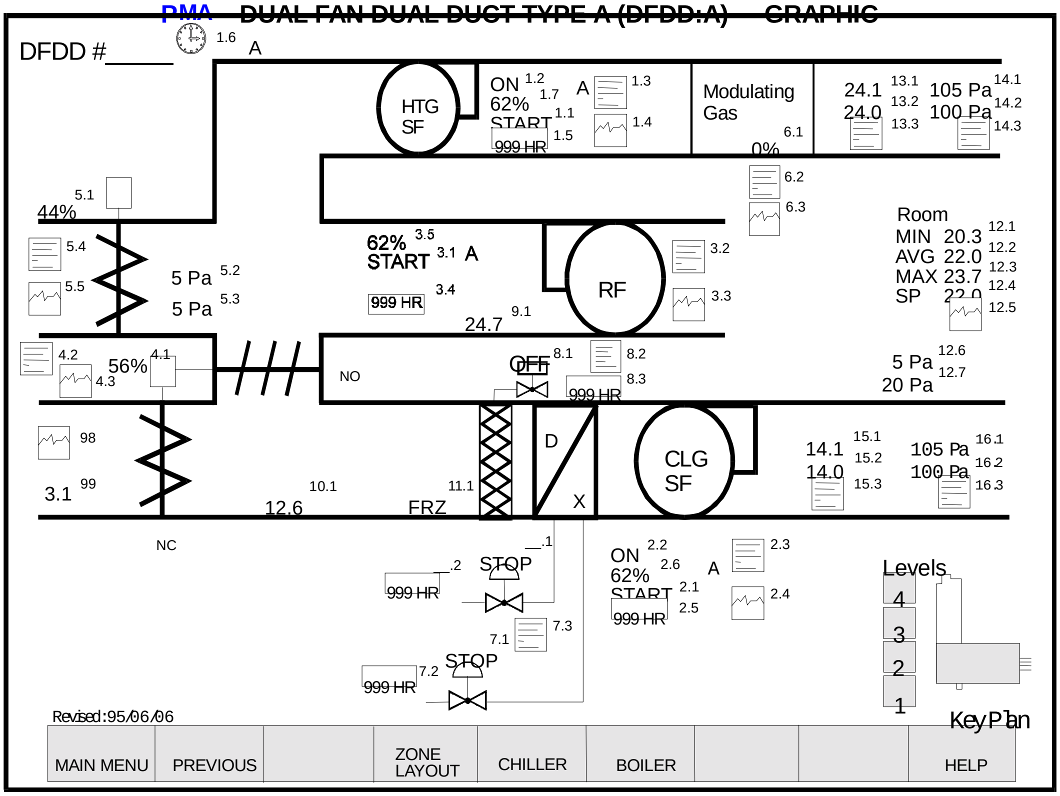
Assumption:
All systems have one supply fan and a full outside air economizer mixed air section.

System Type	Return Fan	Modulating Heating	On Off Cooling	Modulating Cooling	Evaporative Cooling	Status	Updated
A	X	X	X		X	Approved	94/10/28
B	X	X	X			Approved	95/02/08
C							
D							
E							
F							
G							
H							
I							
J							
K							
L							
M							
N							
O							
P							

PMA DUAL FAN DUAL DUCT SYSTEM TYPE A (DFDD:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Heating Start/Stop		SF_HD	CR1	1						
1.2	Supply Fan Heating Status		SF_HD_S	V					1		
1.3	Supply Fan Heating Program		SF_HD_PG	PG					1		
1.4	Supply Fan Heating Trendlog		SF_HD_TL	TL					1	SF_HD,SF_HD_ASD,HDT,HDP	
1.5	Supply Fan Heating Run Hours		SF_HD_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan Heating ASD		SF_HD_ASD	DDC			1				
2.1	Supply Fan Cooling Start/Stop		SF_CD	CR1	1						
2.2	Supply Fan Cooling Status		SF_CD_S	V					1		
2.3	Supply Fan Cooling Program		SF_CD_PG	PG					1		
2.4	Supply Fan Cooling Trendlog		SF_CD_TL	TL					1	SF_CD,SF_CD_ASD,CDT,CDP	
2.5	Supply Fan Cooling Run Hours		SF_CD_TZ	TZ					1		
2.6	Supply Fan Cooling ASD		SF_CD_ASD	DDC			1				
3.1	Return Fan Start/Stop		RF	CR1	1						
3.2	Return Fan Program		RF_PG	PG					1		
3.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,RF_ASD	
3.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.5	Return Fan ASD		RF_ASD	DDC			1				
4.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use:CDT:CDT_SP	
	Mixed Air Damper Ramp		RAMP	V					1		
4.2	Mixed Air Program		MAD_PG	PG					1		
4.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_CD,FRZ,MAD,MAT	
5.1	Exhaust Air Damper		EAD	DA2			1				
	Exhaust Air Damper Controller		EAD_CO	CO					1	use EAP:EAP_SP	
5.2	Exhaust Air Pressure		EAP	DPS				1			
5.3	Exhaust Air Pressure Setpoint		EAP_SP	V					1		
5.4	Exhaust Air Damper Program		EAP_PG	PG					1		
5.5	Exhaust Air Damper Trendlog		EAD_TL	TL					1	EAD,EAP,BSP,EAP_SP	
6.1	Gas Valve		GV	DDC			1				
	Gas Valve Controller		GV_CO	CO					1	use HDT:HDT_SP	
6.2	Heating Program		HD_PG	PG					1		
6.3	Gas Valve Trendlog		GV_TL	TL					1	GV,HDT,HDT_SP	
	Cooling Mode		CLG_MODE	V					1		
7.1	Stage 1-DX		DX1	CV3			1				
7.2	DX1 Run Hours		DX1_TZ	TZ					1		
7.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX____	CV3						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
8.1	Evaporative Cooling		EC	CR1	1						
8.2	Evaporative Cooling Program		EC_PG	PG					1		
8.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
9.1	Return Air Temperature		RAT	DTS2				1			
10.1	Mixed Air Temperature		MAT	DTS1				1			
11.1	Freeze Control		FRZ	FRZ		1					
12.1	Room Temperature Minimum		RT_MIN	V					1		
12.2	Room Temperature Average		RT_AVG	V					1		
12.3	Room Temperature Maximum		RT_MAX	V					1		
12.4	Room Temperature Setpoint		RT_SP	V					1		
12.5	Room Temperature Trendlog		RT_TL	TL					1	MIN,AVG,MAX	
12.6	Building Pressure		BSP	DPS				1			
12.7	Building Pressure Setpoint		BSP_SP	V					1		
13.1	Supply Air Hot Deck Temp		HDT	DTS2				1			
13.2	Supply Air HD Temp Setpoint		HDT_SP	V					1		
13.2	Supply Air HD Temp Program		HDT_PG	PG					1		
14.1	Supply Air HD Pressure		HDP	DPS				1			
14.2	Supply Air HD Pres Setpoint		HDP_SP	V					1		
14.3	Supply Air HD Pres Program		HDP_PG	PG					1		
	Supply Air HD Pres Controller		HDP_CO	CO					1	use HDP:HDP_SP	
15.1	Supply Air Cold Deck Temp		CDT	DTS2				1			
15.2	Supply Air CD Temp Setpoint		CDT_SP	V					1		
15.3	Supply Air CD Temp Program		CDT_PG	PG					1		
16.1	Supply Air CD Pressure		CDP	DPS				1			
16.2	Supply Air CD Pres Setpoint		CDP_SP	V					1		
16.3	Supply Air CD Pres Program		CDP_PG	PG					1		
	Supply Air CD Pres Controller		CDP_CO	CO					1	use CDP:CDP_SP	
	Total				4	1	7	8	44		

PMA DUAL FAN DUAL DUCT TYPE A (DFDD:A) GRAPHIC



GENERIC START UP LOGIC

1.3/2.3 **Supply Fan (SF_PG)** *2 reqd HD/CD*
IF RF ON-FOR 30 SEC THEN
START SF
ELSE STOP SF
IF SAP > 30 THEN SF_S = ON
ELSE SF_S = OFF

[Supply Fan ASD] *2 reqd HD/CD*
IF SF ON THEN SF_ASD = HDP_CO
ELSE SF_ASD = 0

3.2 **Return Fan (RF_PG)**
IF WS ON OR RT_AVG < 14 THEN START RF
IF WS OFF AND RT_AVG > 16 THEN STOP RF
[Return Fan ASD]
IF RF ON THEN
RF_ASD = SF_CD_ASD - (BSP_SP - BSP)
ELSE RF_ASD = 0

4.2 **Mixed Air Damper (MAD_PG)**
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_CD OFF THEN RAMP = 0%
IF RAMP > 100% THEN RAMP = 100% END DO
IF SF_CD_S ON AND WS ON AND FRZ OFF THEN
IF CLG_MODE ON THEN
IF RAT < OAT THEN MAD = MAD_MIN
ELSE MAD = 100%
ELSE MAD = MAX(MAD_MIN, MAD_CO)
MAD = MIN(MAD, RAMP)
ELSE MAD = 0

5.4 **Exhaust Air Damper (EAD_PG)**
EAP_SP = _____ *DEFAULT = 5 Pa*
IF SF_HD_S AND SF_CD_S ON THEN
EAD = EAD_CO ELSE EAD = 0

6.2 **Modulating Gas (GV_PG)**
IF SF_HD ON THEN
GV = GV_CO
ELSE GV = 0

7.3 **Cooling (CLG_PG)**
IF SF_CD_S ON THEN
IF RT_AVG > RT_SP + 1.3 OR
RT_MAX > RT_SP + 2 THEN
CLG_MODE = ON, START DX1
IF RT_AVG < RT_SP + 0.8 AND
RT_MAX < RT_SP + 1.5 THEN
CLG_MODE = OFF, STOP DX1
ELSE CLG_MODE = OFF, STOP DX1
[Cooling Stage 2]
IF SF_CD_S ON THEN
IF RT_AVG > RT_SP + 1.5 OR
RT_MAX > RT_SP + 2.3 OR
DX1 ON-FOR 15 MIN THEN START DX2
IF RT_AVG < RT_SP + 1.0 AND
RT_MAX < RT_SP + 1.7 THEN STOP DX2
ELSE STOP DX2

8.2 **Evaporative (EC_PG)**
IF SF_CD_S ON AND CLG_MODE OFF THEN
IF RT_AVG > RT_SP + 0.5 THEN
START EC
IF RT_AVG < RT_SP + 0.1 THEN
STOP EC
ELSE STOP EC

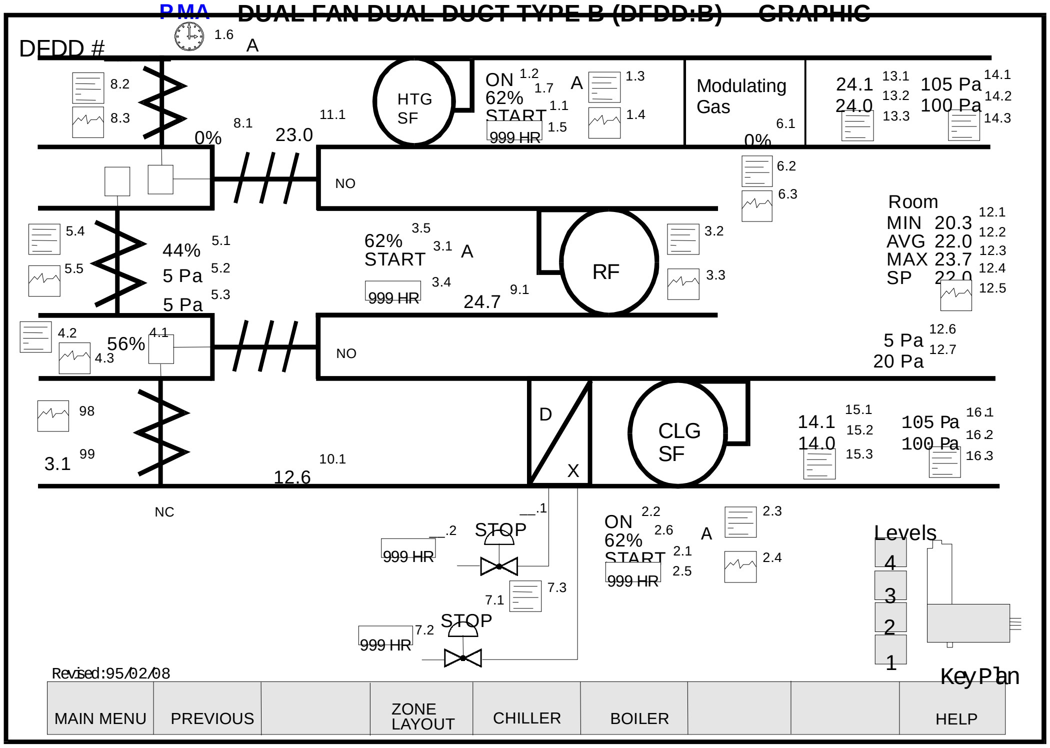
13.3 **Hot Deck Temp (HDT_PG)**
HDT_SP = 22 + ((22 - MIN) * 8)
IF HDT_SP > 60 THEN HDT_SP = 60

14.3 **Hot Deck Pressure (HDP_PG)**
HDP_SP = ____ *DEFAULT = 100 Pa*

15.3 **Cold Deck Temp (CDT_PG)**
CDT_SP = 18 + ((RT_MAX - 22) * 4)
IF CDT_SP < 13 THEN CDT_SP = 13

16.3 **Cold Deck Pressure (CDP_PG)**
CDP_SP = ____ *DEFAULT = 100 Pa*

RMA DUAL FAN DUAL DUCT TYPE B (DFDD:B) GRAPHIC



GENERIC START UP LOGIC

1.3/2.3 **Supply Fan (SF_PG)** *2 reqd HD/CD*
IF RF ON-FOR 30 SEC THEN
    START SF
ELSE STOP SF
IF SAP > 30 THEN SF_S = ON
    ELSE SF_S = OFF

[Supply Fan ASD] *2 reqd HD/CD*
IF SF ON THEN SF_ASD = HDP_CO
ELSE SF_ASD = 0

3.2 **Return Fan (RF_PG)**
IF WS ON OR RT_AVG < 14 THEN START RF
IF WS OFF AND RT_AVG > 16 THEN STOP RF
[Return Fan ASD]
IF RF ON THEN
    RF_ASD = SF_CD_ASD - (BSP_SP - BSP)
ELSE RF_ASD = 0

4.2 **Cold Duct Mixed Air Damper (CD_MAD_PG)**
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_CD OFF THEN RAMP = 0%
IF RAMP > 100% THEN RAMP = 100% END DO
IF SF_CD_S ON AND WS ON THEN
    IF CLG_MODE ON THEN
        IF RAT < OAT THEN MAD = MAD_MIN
        ELSE MAD = 100%
    ELSE MAD = MAX(MAD_MIN, MAD_CO)
    MAD = MIN(MAD, RAMP)
ELSE MAD = 0

5.4 **Exhaust Air Damper (EAD_PG)**
EAP_SP = _____ *DEFAULT = 5 Pa*
IF SF_HD_S AND SF_CD_S ON THEN
EAD = EAD_CO ELSE EAD = 0

6.2 **Modulating Gas (GV_PG)**
IF SF_HD ON THEN
    GV = GV_CO
ELSE GV = 0

7.3 **Cooling (CLG_PG)**
IF SF_CD_S ON THEN
    IF RT_AVG > RT_SP + 1.3 OR
    RT_MAX > RT_SP + 2 THEN
        CLG_MODE = ON, START DX1
    IF RT_AVG < RT_SP + 0.8 AND
    RT_MAX < RT_SP + 1.5 THEN
        CLG_MODE = OFF, STOP DX1
ELSE CLG_MODE = OFF, STOP DX1
[Cooling Stage 2]
IF SF_CD_S ON THEN
    IF RT_AVG > RT_SP + 1.5 OR
    RT_MAX > RT_SP + 2.3 OR
    DX1 ON-FOR 15 MIN THEN START DX2
    IF RT_AVG < RT_SP + 1.0 AND
    RT_MAX < RT_SP + 1.7 THEN STOP DX2
ELSE STOP DX2

8.2 **Hot Duct Mixed Air Damper (HD_MAD_PG)**
HD_MAD = 0

13.3 **Hot Duct Temp (HDT_PG)**
HDT_SP = 22 + ((22 - MIN) * 8)
IF HDT_SP > 60 THEN HDT_SP = 60

14.3 **Hot Duct Pressure (HDP_PG)**
HDP_SP = ____ *DEFAULT = 100 Pa*

15.3 **Cold Duct Temp (CDT_PG)**
CDT_SP = 18 + ((RT_MAX - 22) * 4)
IF CDT_SP < 13 THEN CDT_SP = 13

16.3 **Cold Duct Pressure (CDP_PG)**
CDP_SP = ____ *DEFAULT = 100 Pa*

5.E PRE-APPROVED 100% MAKEUP AIR SYSTEM TYPES

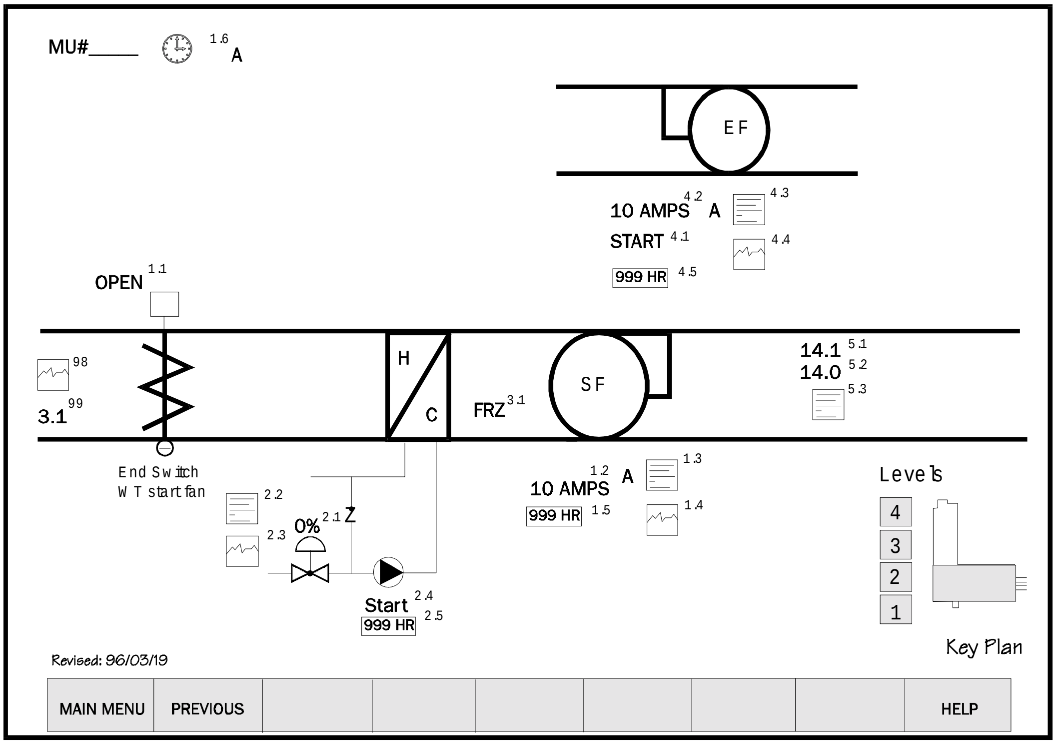
System Type	Exhaust Fan	Modulating Heating	Heat Recovery	Status	Updated
A		X		No	
B		X	X	No	
C	X	X		Yes	96/06/10
D	X	X	X	No	
E		X - GAS		No	
F		X - GAS	X	No	
G		X - GAS		No	
H		X - GAS	X	No	

Custom
5_VY1 Variable volume with heat recovery with heating and cooling, evaporative cooling on exhaust (BCCDC)
5_VX1 Variable volume with heating and cooling (BCCDC)
5_VV1 Constant volume with heating and cooling and standby air system (animal room) (BCCDC)
5_VU1 Constant volume with heating and cooling, standby air system and fume hood (BCCDC)

PMA 100% MAKE UP AIR SYSTEM TYPE (E:C) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Outdoor Air Damper		SF_OAD	CR1	1					Wire end switch to SF	
	Damper Actuator			DA4/A							
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF_S,SF_AMP,SAP,SAP_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
2.2	Heating Program		HTG_PG	PG					1		
2.3	Heating Trendlog		HTG_TL	TL					1	HCV,SAT_SP,SAT,HCP	
2.4	Heating Coil Pump		HCP	CR1	1						
2.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
3.1	Freeze Control		FRZ	FRZ		1					
4.1	Exhaust Fan Start/Stop		EF	CR1	1						
4.2	Exhaust Fan Amps		EF_AMP	CS1				1			
	Exhaust Fan Status		EF_S	V					1		
4.3	Exhaust Fan Program		EF_PG	PG					1		
4.4	Exhaust Fan Trendlog		EF_TL	TL					1	EF,EF_AMP	
4.5	Exhaust Fan Run Hours		EF_TZ	TZ					1		
5.1	Supply Air Temperature		SAT	DTS2				1			
5.2	Supply Air Temp Setpoint		SAT_SP	V					1		
5.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	1	3	15		

BCBC 100% MAKE UP AIR SYSTEM TYPE (E:C) - GRAPHIC



GENERIC START UP LOGIC

1.3 **Supply Fan (SF_PG)**

```
IF FRZ OFF AND WS ON THEN
    OPEN SF_OAD
ELSE
    CLOSE SF_OAD
IF SF_AMP > 2 THEN
    SF_S = ON
ELSE
    SF_S = OFF
```

2.2 **Heating (HTG_PG)**

```
HCV = HCV_CO
```

Heating Coil Pump

```
IF HCV > 35 OR SAT < 3 THEN
    START HCP
IF HCV < 10 OR SAT_SP + 5 THEN
    STOP HCP
```

4.3 **Exhaust Fan (EF_PG)**

```
IF SF_S ON THEN
    START EF
ELSE
    STOP EF
IF EF_AMP > 2 THEN
    EF_S = ON
ELSE
    EF_S = OFF
```

5.3 **Supply Air Temp (SAT_PG)**

```
SAT_SP = 14
```

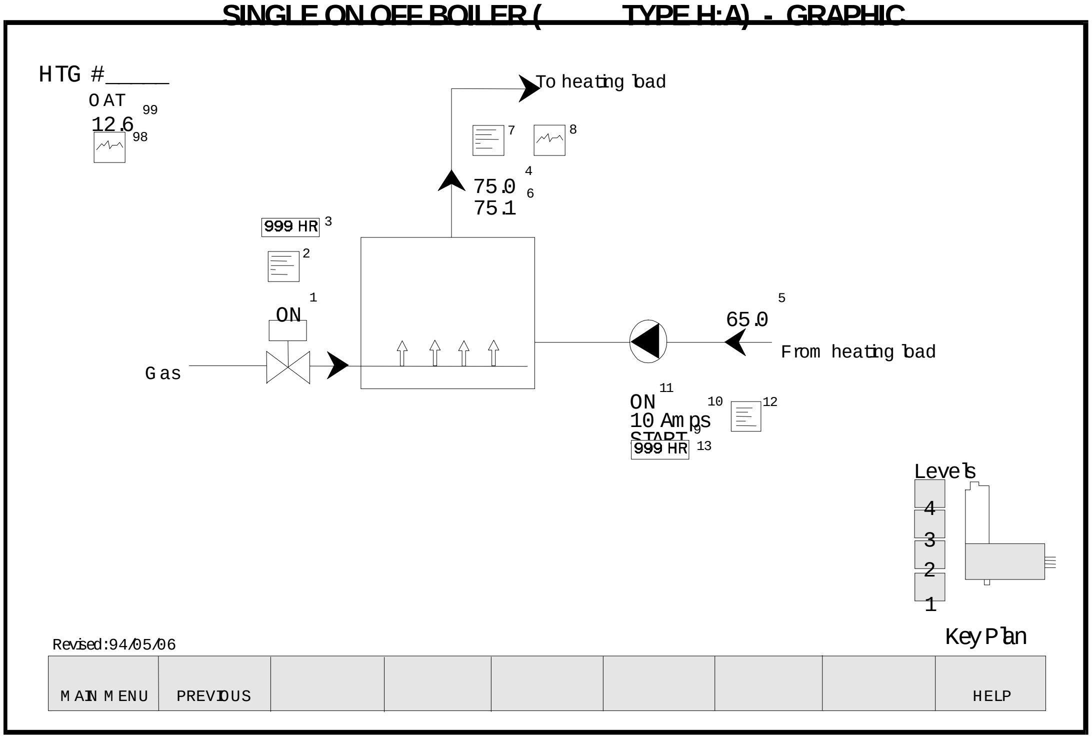
5.H PRE-APPROVED HEATING SYSTEM TYPES

System Type	Description	Status	Updated
H:A	Single ON OFF boiler	Approved	94/10/12
H:B	SIngle HIGH LOW OFF boiler	No	
H:C	Single modulating boiler	No	
H:D	Multiple ON OFF boilers c/w pump ASD	Approved	94/10/26
H:E	Multiple HIGH LOW OFF boilers	No	
H:F	Multiple modulating boilers	Approved	95/06/08
H:G	Multiple ON OFF boilers	Approved	95/08/01
H:H	Multiple reset boilers	Approved	95/08/25

SINGLE ON OFF BOILER (BCBC TYPE H:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Boiler Gas Valve		BLR_GV	CR1	1						
2	Boiler Control Program		BLR_PG	PG					1		
3	Boiler Run Hours		BLR_TZ	TZ					1		
4	Supply Water Temperature		SWT	PTS1				1			
5	Return Water Temperature		RWT	PTS1				1			
6	Supply Water Setpoint		SWT_SP	V					1		
7	Supply Water Program		SWT_PG	PG					1		
8	Heating System Trendlog		TL	TL					1	SWT,SWT_SP,RWT,OAT	
9	Heating Pump Control		P1	CR1	1						
10	Heating Pump Amps		P1_AMP	CS1				1			
11	Heating Pump Status		P1_S	V					1		
12	Heating Pump Program		P1_PG	PG					1		
13	Heating Pump Run Hours		P1_TZ	TZ					1		
	Total				2	0	0	3	8		

SINGLE ON OFF BOILER (TYPE H:A) - GRAPHIC



GENERIC START UP LOGIC

2 **Boiler (BLR_PG)**

IF SWT < SWT_SP AND P1_S ON THEN
    START BLR_GV
IF SWT > SWT_SP + 5 OR P1_S OFF THEN
    STOP BLR_GV

7 **Supply Water Temperature (SWT_PG)**

SWT_SP = 80 - OAT
IF SWT_SP > 94 THEN
    SWT_SP = 94
IF SWT_SP < 60 THEN
SWT_SP = 60

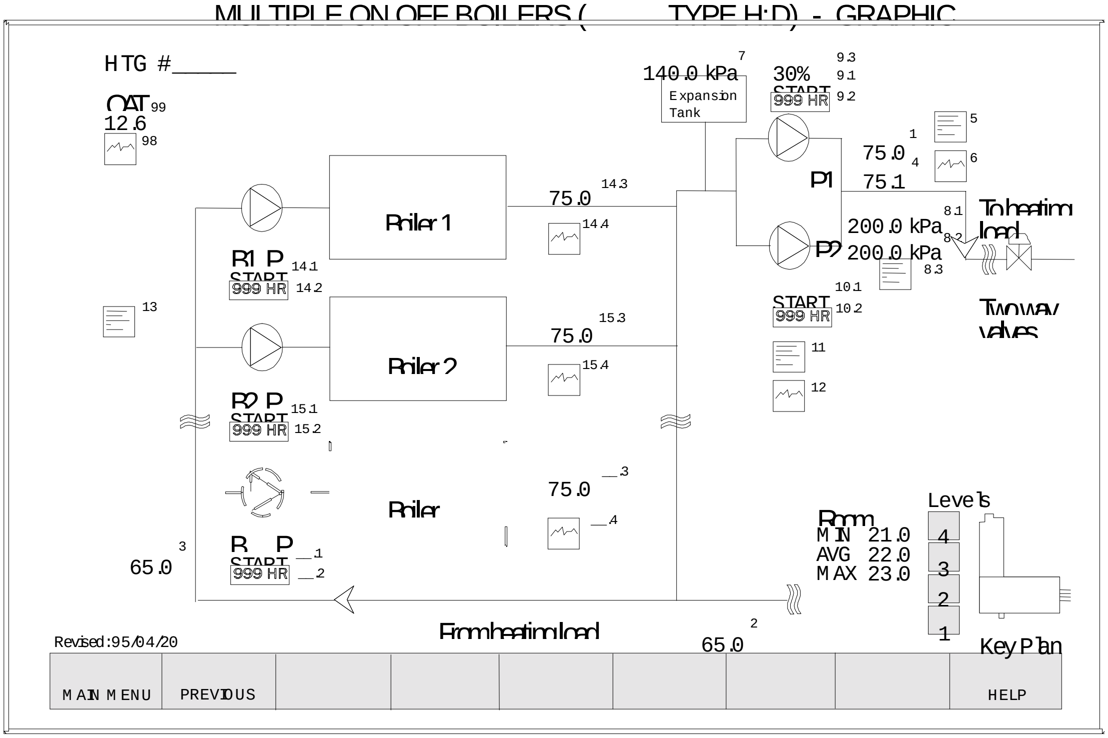
12 **Heating Pump (P1_PG)**

IF OAT < 13 THEN
    START P1
IF OAT > 16 THEN
    STOP P1
IF P1_AMP > 3 THEN
    P1_S = ON
ELSE
    P1_S = OFF

MULTIPLE ON OFF BOILERS (PMA TYPE H:D) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Heating Supply Water Temp		SWT	PTS1				1			
2	Heating Return Water Temp		RWT	PTS1				1			
3	Boiler Return Water Temp		B_RWT	PTS1				1			
4	Heating Supply Water Setpoint		SWT_SP	V					1		
5	Heating Supply Water Program		SWT_PG	PG					1		
6	Heating Supply Water Trendlog		SWT_TL	TL					1	SWT,SWT_SP,RWT,OAT	
7	Fuel Tank Level		FT_LV	LV1				1			
8.1	System Pressure		SYS_PSP	PS1				1			
8.2	System Pressure Setpoint		SYS_PSP_SP	V					1		
8.3	System Pressure Program		SYS_PSP_PG	PG					1		
9.1	Heating Pump 1 Control		P1	CR1	1						
9.2	Heating Pump 1 Run Hours		P1_TZ	TZ					1	use P1	
9.3	Heating Pump 1 ASD		P1_ASD	DDC			1				
	ASD Controller		P1_ASD_CO	CO					1	use SYS_PSP:SYS_PSP_SP	
10.1	Heating Pump 2 Control		P2	CR1	1						
10.2	Heating Pump 2 Run Hours		P2_TZ	TZ					1	use P2	
11	Heating Pump Program		P_PG	PG					1		
12	Heating Pump Trendlog		P_TL	TL					1	P1_ASD,SYS_PSP,SYS_PSP_SP	
13	Boiler Control Program		BLR_PG	PG					1		
14.1	Boiler 1 Pump Control		BLR1_P	CR1	1						
14.2	Boiler 1 Pump Run Hours		BLR1_P_TZ	TZ					1		
14.3	Boiler 1 Supply Water Temp		BLR1_SWT	PTS1				1			
14.4	Boiler 1 SWT Trendlog		BLR1_SWT_TL	TL					1	RWT,BLR1_P,BLR1_SWT	
15.1	Boiler 2 Pump Control		BLR2_P	CR1	1						
15.2	Boiler 2 Pump Run Hours		BLR2_P_TZ	TZ					1		
15.3	Boiler 2 Supply Water Temp		BLR2_SWT	PTS1				1			
15.4	Boiler 2 SWT Trendlog		BLR2_SWT_TL	TL					1	RWT,BLR2_P,BLR2_SWT	
__.1	Boiler Pump Control		BLR _P	CR1						As Required	
__.2	Boiler Pump Run Hours		BLR _P_TZ	TZ						As Required	
__.3	Boiler Supply Water Temp		BLR _SWT	PTS1						As Required	
__.4	Boiler SWT Trendlog		BLR _SWT_TL	TL						As Required	
	Total				4	0	1	7	15		

MULTIPLE ON OFF BOILERS (TYPE H:D) - GRAPHIC



GENERIC START UP LOGIC

5 Supply Water Temperature (SWT PG)
SWT SP = 80 - OAT
IF SWT SP > 94 THEN
SWT SP = 94
IF SWT SP < 60 THEN
SWT SP = 60

8.3 System Pressure (SYS PSP PG)
SYS PSP SP = DEFAULT = 200 KPa

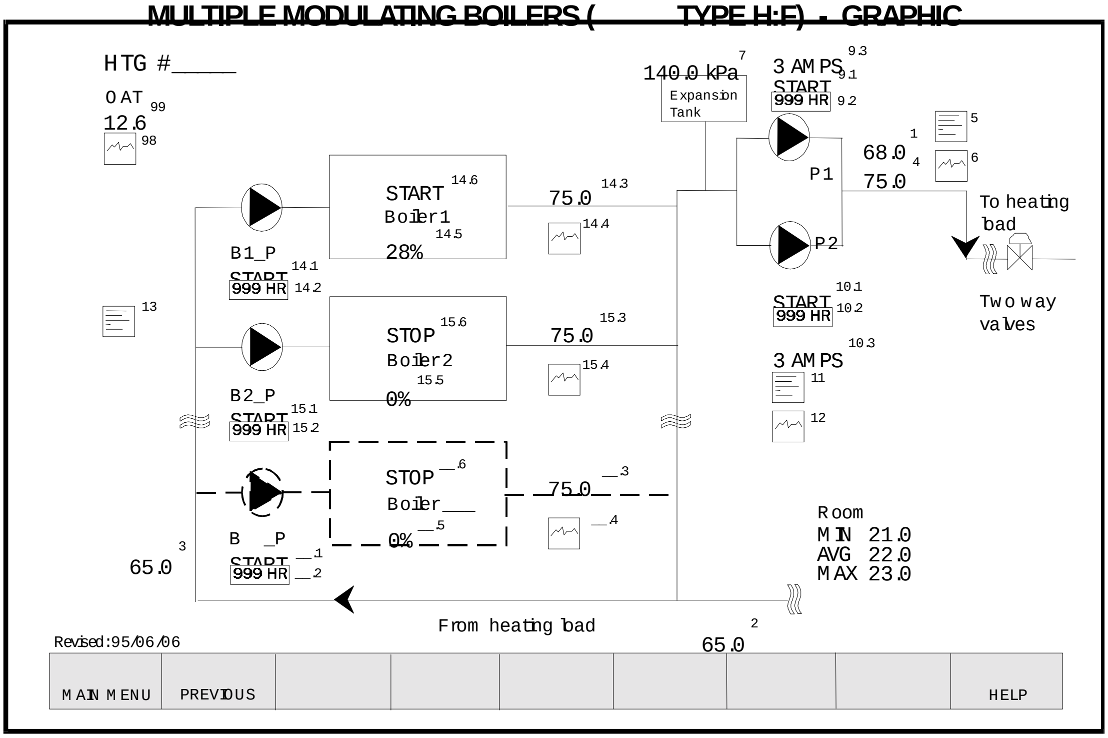
11 Heating Pump (P PG)
IF OAT < 13 THEN
START P1
IF OAT > 16 THEN
STOP P1
IF P1 S ON THEN
ASD = ASD CO
ELSE
ASD = 0
[Pump 2]
IF OAT < 2 THEN
START P2
IF OAT > 5 THEN
STOP P2

13 Boiler (BLR PG)
IF SWT < SWT SP AND SYS PSP > 25 THEN
START BLR1 P
IF SWT > SWT SP + 3 OR SYS PSP < 5 THEN
STOP BLR1 P
[Boiler 2 PG]
IF SWT < SWT SP - 4 AND SYS PSP > 25 THEN
START BLR2 P
IF SWT > SWT SP - 1 OR SYS PSP < 5 THEN
STOP BLR2 P
[Boiler PG]
IF SWT < SWT SP - 6 AND SYS PSP > 25 THEN
START BLR P
IF SWT > SWT SP - 3 OR SYS PSP < 5 THEN
STOP BLR P

MULTIPLE MODULATING BOILERS (PMA TYPE H:F) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Heating Supply Water Temp		SWT	PTS1				1			
2	Heating Return Water Temp		RWT	PTS1				1			
3	Boiler Return Water Temp		B_RWT	PTS1				1			
4	Heating Supply Water Setpoint		SWT_SP	V					1		
5	Heating Supply Water Program		SWT_PG	PG					1		
6	Heating Supply Water Trendlog		SWT_TL	TL					1	SWT,SWT_SP,RWT,OAT	
7	Expansion Tank Pressure		XT_PSP	PS__				1			
	Heating Water Controller		SWT_CO	CO					1	use SWT:SWT_SP	
9.1	Heating Pump 1 Control		P1	CR1	1						
9.2	Heating Pump 1 Run Hours		P1_TZ	TZ					1		
9.3	Heating Pump 1 Amps		P1_AMP	CS1				1			
	Heating Pump 1 Status		P1_S	V					1		
10.1	Heating Pump 2 Control		P2	CR1	1						
10.2	Heating Pump 2 Run Hours		P2_TZ	TZ					1		
10.3	Heating Pump 2 Amps		P2_AMP	CS1				1	1		
	Heating Pump 2 Status		P2_S	V					1		
11	Heating Pump Program		P_PG	PG					1		
12	Heating Pump Trendlog		P_TL	TL					1	P1_AMP,P2_AMP,P1,P2	
13	Boiler Control Program		BLR_PG	PG					1		
14.1	Boiler 1 Pump Control		BLR1_P	CR1	1						
14.2	Boiler 1 Pump Run Hours		BLR1_P_TZ	TZ					1		
14.3	Boiler 1 Supply Water Temp		BLR1_SWT	PTS1				1			
14.4	Boiler 1 SWT Trendlog		BLR1_SWT_TL	TL					1	RWT,BLR1_P,BLR1_SWT,BLR1_GV	
14.5	Boiler 1 Gas Valve		BLR1_GV	DDC			1				
	Boiler 1 Controller		BLR1_CO	CO					1	use BLR1_SWT:95	
	Boiler 1 Ramp		RAMP1	V					1		
14.6	Boiler 1 Control		BLR1_ENBL	CR1	1						
15.1	Boiler 2 Pump Control		BLR2_P	CR1	1						
15.2	Boiler 2 Pump Run Hours		BLR2_P_TZ	TZ					1		
15.3	Boiler 2 Supply Water Temp		BLR2_SWT	PTS1				1			
15.4	Boiler 2 SWT Trendlog		BLR2_SWT_TL	TL					1	RWT,BLR2_P,BLR2_SWT,BLR2_GV	
15.5	Boiler 2 Gas Valve		BLR2_GV	DDC			1		1		
	Boiler 2 Controller		BLR2_CO	CO					1	use BLR2_SWT:95	
	Boiler 2 Ramp		RAMP2	V					1		
15.6	Boiler 2 Control		BLR2_ENBL	CR1	1						
__.1	Boiler Pump Control		BLR _P	CR1						As Required	
__.2	Boiler Pump Run Hours		BLR _P_TZ	TZ						As Required	
__.3	Boiler Supply Water Temp		BLR _SWT	PTS1						As Required	
__.4	Boiler SWT Trendlog		BLR _SWT_TL	TL						As Required	
__.5	Boiler Gas Valve		BLR _GV	DDC						As Required	
	Boiler Controller		BLR _CO	V						As Required	
	Boiler Ramp		RAMP___	V						As Required	
__.6	Boiler Control		BLR _ENBL	CR1						As Required	
	Total										

MULTIPLE MODULATING BOILERS (TYPE H:F) - GRAPHIC



GENERIC START UP LOGIC

5 **Supply Water Temperature (SWT_PG)**

SWT_SP = 80 - OAT
IF SWT_SP > 91 THEN
    SWT_SP = 91
IF SWT_SP < 75 THEN
    SWT_SP = 75

11 **Heating Pump (P_PG)**

IF OAT < 13 THEN
    START P1
IF OAT > 16 THEN
    STOP P1
IF P1_AMP > 2 THEN
    P1_S = ON
ELSE
    P1_S = OFF
[Pump 2]
IF (P1 ON-FOR 30 SEC AND P1_S = OFF) OR
OAT < 2 THEN
    START P2
IF OAT > 5 AND P1_S = ON THEN
    STOP P2
IF P2_AMP > 2 THEN
    P2_S = ON
ELSE
    P2_S = OFF

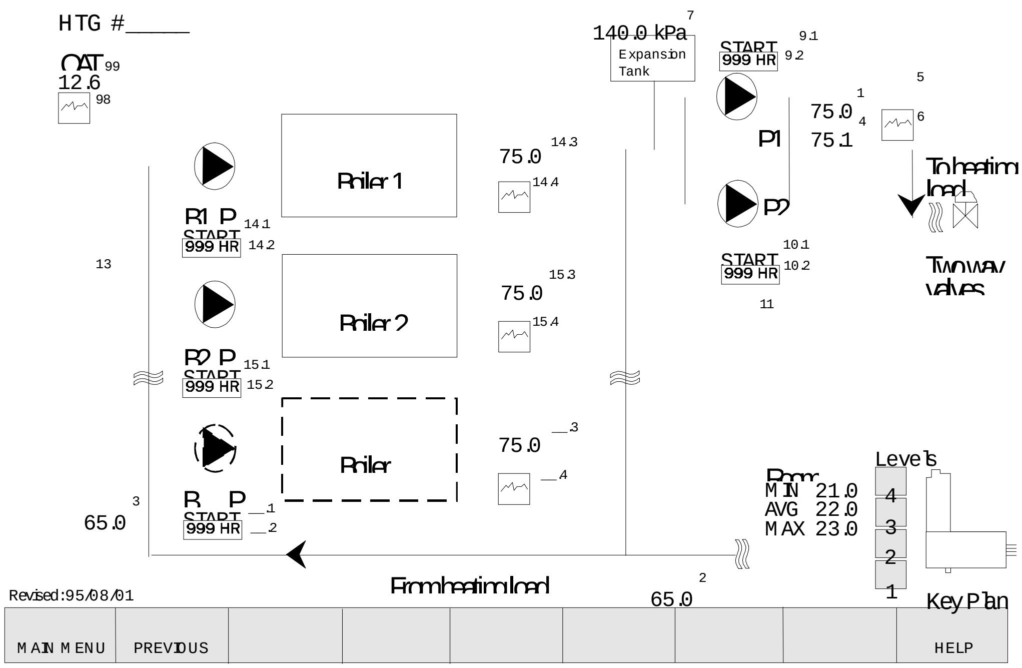
13 **Boiler (BLR_PG)**

IF (P1_S OR P2_S) AND SWT_CO > 40 THEN
    START BLR1_P, START BLR1_ENBL
IF BLR1_ENBL THEN
    DO EVERY 10 SEC
RAMP1 = RAMP1 + 1
IF RAMP1 > 100 THEN
    RAMP1 = 100
ENDDO
BLR1_GV = MIN(RAMP1,BLR1_CO)
IF SWT_CO < 10 THEN
    STOP BLR1_ENBL, BLR1_GV = 0, RAMP1 = 0
IF BLR1_ENBL OFF-FOR 20 M THEN
    STOP BLR1_P
[Boiler 2_PG]
IF (P1_S OR P2_S) AND SWT_CO > 60 THEN
    START BLR2_P, START BLR2_ENBL
IF BLR2_ENBL THEN
    DO EVERY 10 SEC
RAMP2 = RAMP2 + 1
IF RAMP2 > 100 THEN
    RAMP2 = 100
ENDDO
BLR2_GV = MIN(RAMP2,BLR2_CO)
IF SWT_CO < 30 THEN
    STOP BLR2_ENBL, BLR2_GV = 0, RAMP2 = 0
IF BLR2_ENBL OFF-FOR 20 M THEN
    STOP BLR2_P
[Boiler _PG]
IF (P1_S OR P2_S) AND SWT_CO > 80 THEN
    START BLR _P, START BLR _ENBL
IF BLR _ENBL THEN
    DO EVERY 10 SEC
RAMP_ = RAMP_ + 1
IF RAMP_ > 100 THEN
    RAMP_ = 100
ENDDO
BLR _GV = MIN(RAMP_,BLR _CO)
IF SWT _CO < 50 THEN
    STOP BLR _ENBL, BLR _GV = 0, RAMP_ = 0
IF BLR _ENBL OFF-FOR 20 M THEN
    STOP BLR _P

PMA MULTIPLE ON OFF BOILERS (PMA TYPE H:G) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Heating Supply Water Temp		SWT	PTS1				1			
2	Heating Return Water Temp		RWT	PTS1				1			
3	Boiler Return Water Temp		B_RWT	PTS1				1			
4	Heating Supply Water Setpoint		SWT_SP	V					1		
5	Heating Supply Water Program		SWT_PG	PG					1		
6	Heating Supply Water Trendlog		SWT_TL	TL					1	SWT,SWT_SP,RWT,OAT	
7	Expansion Tank Pressure		XT_PSP	PS1				1			
9.1	Heating Pump 1 Control		P1	CR1	1						
9.2	Heating Pump 1 Run Hours		P1_TZ	TZ					1	use P1	
10.1	Heating Pump 2 Control		P2	CR1	1						
10.2	Heating Pump 2 Run Hours		P2_TZ	TZ					1	use P2	
11	Heating Pump Program		P_PG	PG					1		
13	Boiler Control Program		BLR_PG	PG					1		
14.1	Boiler 1 Pump Control		BLR1_P	CR1	1						
14.2	Boiler 1 Pump Run Hours		BLR1_P_TZ	TZ					1		
14.3	Boiler 1 Supply Water Temp		BLR1_SWT	PTS1				1			
14.4	Boiler 1 SWT Trendlog		BLR1_SWT_TL	TL					1	RWT,BLR1_P,BLR1_SWT	
15.1	Boiler 2 Pump Control		BLR2_P	CR1	1						
15.2	Boiler 2 Pump Run Hours		BLR2_P_TZ	TZ					1		
15.3	Boiler 2 Supply Water Temp		BLR2_SWT	PTS1				1			
15.4	Boiler 2 SWT Trendlog		BLR2_SWT_TL	TL					1	RWT,BLR2_P,BLR2_SWT	
__.1	Boiler Pump Control		BLR _P	CR1						As Required	
__.2	Boiler Pump Run Hours		BLR _P_TZ	TZ						As Required	
__.3	Boiler Supply Water Temp		BLR _SWT	PTS1						As Required	
__.4	Boiler SWT Trendlog		BLR _SWT_TL	TL						As Required	
	Total				4	0	0	6	11		

MULTIPLE ON OFF BOILERS (PMA TYPE H:G) - GRAPHIC



GENERIC START UP LOGIC

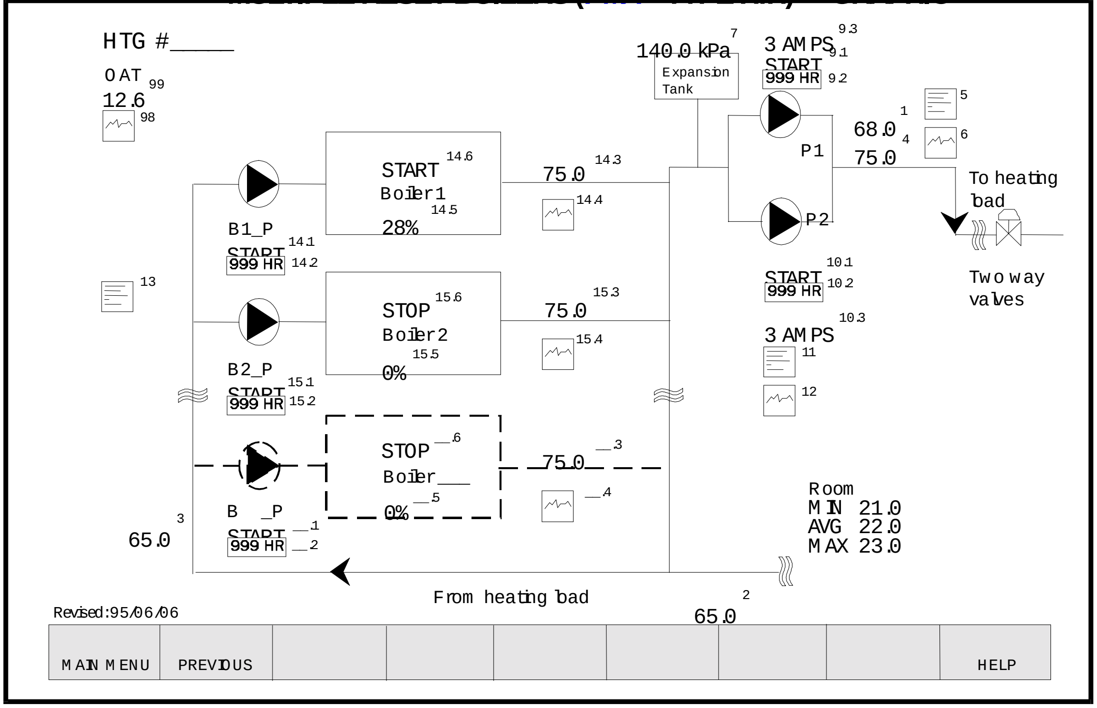
Supply Water Temperature (SWT PG)
SWT SP = 80 - O

Boiler (BLR PG)
IF SWT < SWT SP THEN
START BLR1 P
IF SWT > SWT SP + 3 THEN
STOP BLR1 P
[Boiler 2 PG]
IF SWT < SWT SP - 4 THEN
START BLR2 P
IF SWT > SWT SP - 1 THEN
STOP BLR2 P
[Boiler PG]
IF SWT < SWT SP - 6 THEN
START BLR P
IF SWT > SWT SP - 3 THEN
STOP BLR P

PMA MULTIPLE RESET BOILERS (PMA TYPE H:H) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Heating Supply Water Temp		SWT	PTS1				1			
2	Heating Return Water Temp		RWT	PTS1				1			
3	Boiler Return Water Temp		B_RWT	PTS1				1			
4	Heating Supply Water Setpoint		SWT_SP	V					1		
5	Heating Supply Water Program		SWT_PG	PG					1		
6	Heating Supply Water Trendlog		SWT_TL	TL					1	SWT,SWT_SP,RWT,OAT	
7	Expansion Tank Pressure		XT_PSP	PS__				1			
	Heating Water Controller		SWT_CO	CO					1	use SWT:SWT_SP	
9.1	Heating Pump 1 Control		P1	CR1	1						
9.2	Heating Pump 1 Run Hours		P1_TZ	TZ					1		
9.3	Heating Pump 1 Amps		P1_AMP	CS1				1			
	Heating Pump 1 Status		P1_S	V					1		
10.1	Heating Pump 2 Control		P2	CR1	1						
10.2	Heating Pump 2 Run Hours		P2_TZ	TZ					1		
10.3	Heating Pump 2 Amps		P2_AMP	CS1				1	1		
	Heating Pump 2 Status		P2_S	V					1		
11	Heating Pump Program		P_PG	PG					1		
12	Heating Pump Trendlog		P_TL	TL					1	P1_AMP,P2_AMP,P1,P2	
13	Boiler Control Program		BLR_PG	PG					1		
14.1	Boiler 1 Pump Control		BLR1_P	CR1	1						
14.2	Boiler 1 Pump Run Hours		BLR1_P_TZ	TZ					1		
14.3	Boiler 1 Supply Water Temp		BLR1_SWT	PTS1				1			
14.4	Boiler 1 SWT Trendlog		BLR1_SWT_TL	TL					1	RWT,BLR1_P,BLR1_SWT,BLR1_RESET	
14.5	Boiler 1 Reset		BLR1_RESET	DDC			1				
	Boiler 1 Controller		BLR1_CO	CO					1	use BLR1_SWT:95	
	Boiler 1 Ramp		RAMP1	V					1		
14.6	Boiler 1 Control		BLR1_ENBL	CR1	1						
15.1	Boiler 2 Pump Control		BLR2_P	CR1	1						
15.2	Boiler 2 Pump Run Hours		BLR2_P_TZ	TZ					1		
15.3	Boiler 2 Supply Water Temp		BLR2_SWT	PTS1				1			
15.4	Boiler 2 SWT Trendlog		BLR2_SWT_TL	TL					1	RWT,BLR2_P,BLR2_SWT,BLR2_RESET	
15.5	Boiler 2 Reset		BLR2_RESET	DDC			1		1		
	Boiler 2 Controller		BLR2_CO	CO					1	use BLR2_SWT:95	
	Boiler 2 Ramp		RAMP2	V					1		
15.6	Boiler 2 Control		BLR2_ENBL	CR1	1						
__.1	Boiler Pump Control		BLR _P	CR1						As Required	
__.2	Boiler Pump Run Hours		BLR _P_TZ	TZ						As Required	
__.3	Boiler Supply Water Temp		BLR _SWT	PTS1						As Required	
__.4	Boiler SWT Trendlog		BLR _SWT_TL	TL						As Required	
__.5	Boiler Reset		BLR _RESET	DDC						As Required	
	Boiler Controller		BLR _CO	V						As Required	
	Boiler Ramp		RAMP___	V						As Required	
__.6	Boiler Control		BLR _ENBL	CR1						As Required	
	Total										

MULTIPLE RESET BOILERS (PMA TYPE H:H) - GRAPHIC



GENERIC START UP LOGIC

5 **Supply Water Temperature (SWT_PG)**

SWT_SP = 80 - OAT
IF SWT_SP > 91 THEN
    SWT_SP = 91
IF SWT_SP < 75 THEN
    SWT_SP = 75

11 **Heating Pump (P_PG)**

IF OAT < 13 THEN
    START P1
IF OAT > 16 THEN
    STOP P1
IF P1_AMP > 2 THEN
    P1_S = ON
ELSE
    P1_S = OFF
[Pump 2]
IF (P1 ON-FOR 30 SEC AND P1_S = OFF) OR
OAT < 2 THEN
    START P2
IF OAT > 5 AND P1_S = ON THEN
    STOP P2
IF P2_AMP > 2 THEN
    P2_S = ON
ELSE
    P2_S = OFF

13 **Boiler (BLR_PG)**

IF (P1_S OR P2_S) AND SWT_CO > 40 THEN
    START BLR1_P, START BLR1_ENBL
IF BLR1_ENBL THEN
    DO EVERY 10 SEC
RAMP1 = RAMP1 + 1
IF RAMP1 > 100 THEN
    RAMP1 = 100
ENDDO
BLR1_RESET = MIN(RAMP1,BLR1_CO)
IF SWT_CO < 10 THEN
    STOP BLR1_ENBL, BLR1_RESET = 0, RAMP1 = 0
IF BLR1_ENBL OFF-FOR 20 M THEN
    STOP BLR1_P
[Boiler 2_PG]
IF (P1_S OR P2_S) AND SWT_CO > 60 THEN
    START BLR2_P, START BLR2_ENBL
IF BLR2_ENBL THEN
    DO EVERY 10 SEC
RAMP2 = RAMP2 + 1
IF RAMP2 > 100 THEN
    RAMP2 = 100
ENDDO
BLR2_RESET = MIN(RAMP2,BLR2_CO)
IF SWT_CO < 30 THEN
    STOP BLR2_ENBL, BLR2_RESET = 0, RAMP2 = 0
IF BLR2_ENBL OFF-FOR 20 M THEN
    STOP BLR2_P
[Boiler _PG]
IF (P1_S OR P2_S) AND SWT_CO > 80 THEN
    START BLR _P, START BLR _ENBL
IF BLR _ENBL THEN
    DO EVERY 10 SEC
RAMP_ = RAMP_ + 1
IF RAMP_ > 100 THEN
    RAMP_ = 100
ENDDO
BLR _RESET = MIN(RAMP_,BLR _CO)
IF SWT _CO < 50 THEN
    STOP BLR _ENBL, BLR _RESET = 0, RAMP_ = 0
IF BLR _ENBL OFF-FOR 20 M THEN
    STOP BLR _P

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

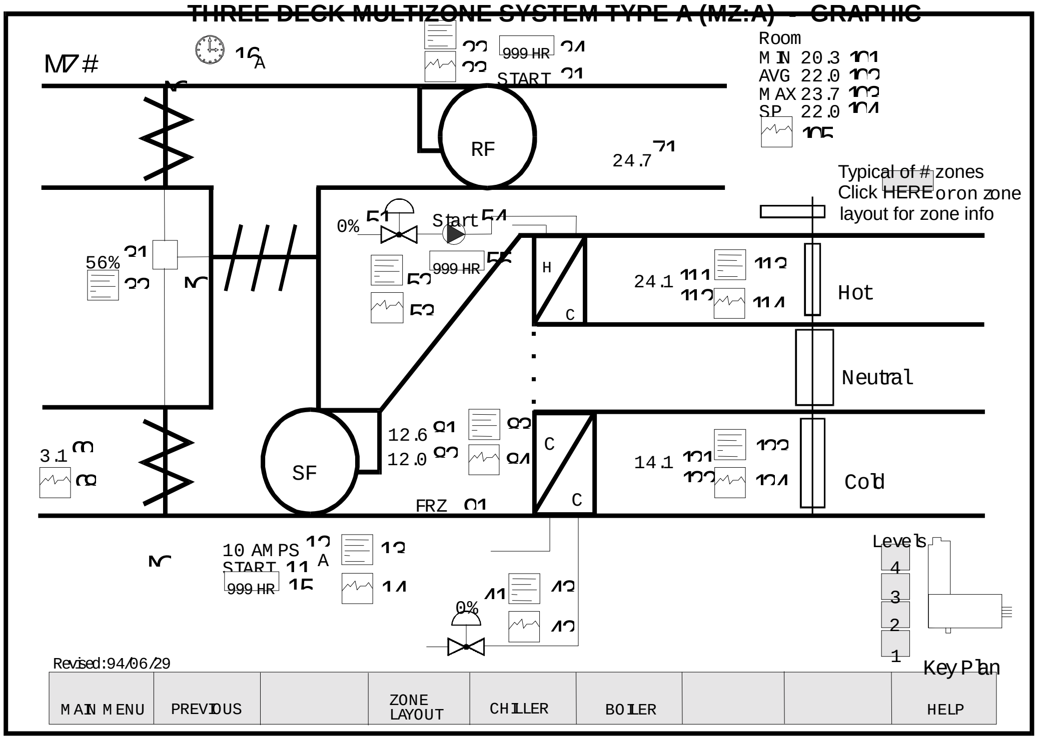
5.M PRE-APPROVED MULTIZONE SYSTEM TYPES

System Type	Description	Status	Updated
M:A	Three Deck Multizone	Approved	94/10/31

PMA THREE DECK MULTIZONE SYSTEM TYPE A (MZ:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,MAT	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use MAT:MAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use CDT:CDT_SP	
4.2	Cooling Coil Trendlog		CCV_TL	TL					1	CCV,CDT_SP,CDT,MAT	
4.3	Cooling Program		CLG_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use HDT:HDT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,HDT_SP,HDT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
8.2	Mixed Air Temp Setpoint		MAT_SP	V					1		
8.3	Mixed Air Temp Program		MAT_PG	PG					1		
8.4	Mixed Air Temp Trendlog		MAT_TL	TL					1	MAT,MAD,RAT,OAT	
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	RT_MIN,RT_AVG,RT_MAX	
11.1	Supply Air Temp Hot Deck		HDT	DTS2				1			
11.2	Supply Air Temp HD Setpoint		HDT_SP	V					1		
11.3	Supply Air Temp HD Program		HDT_PG	PG					1		
11.4	Supply Air Temp HD Trendlog		HDT_TL	TL					1	HDT,HCV,RT_MIN,RT_AVG	
12.1	Supply Air Temp Cold Deck		CDT	DTS2				1			
12.2	Supply Air Temp CD Setpoint		CDT_SP	V					1		
12.3	Supply Air Temp CD Program		CDT_PG	PG					1		
12.4	Supply Air Temp CD Trendlog		CDT_TL	TL					1	CDT,CCV,RT_MAX,RT_AVG	
	Total				3	1	3	5	35		

THREE DECK MULTIZONE SYSTEM TYPE A (MZ:A) - GRAPHIC



GENERIC START UP LOGIC

1.3 **Supply Fan (SF_PG)**

```
IF RF ON-FOR 30 SEC THEN
    START SF
ELSE
    STOP SF
IF SF AMP>2 THEN
    SF S=ON
ELSE
    SF S=OFF
```

2.2 **Return Fan (RF_PG)**

```
IF WS ON OR RT AVG<14 THEN
    START RF
IF WS OFF AND RT AVG>16 THEN
    STOP RF
```

3.2 **Mixed Air Damper (MAD_PG)**

```
MAD MIN=        DEFAULT=30%
DO EVERY 3 S RAMP=RAMP+1%
IF SF S OFF THEN
    RAMP=0%
IF RAMP>100% THEN
    RAMP=100% END DO
IF SF S ON AND WS ON AND FRZ OFF THEN
    IF CLG MODE ON THEN
        IF RAT<OAT THEN
            MAD=MAD MIN
        ELSE
            MAD=100%
    ELSE
        MAD=MAX(MAD MIN, MAD CO)
        MAD=MIN(MAD, RAMP)
ELSE MAD=0
```

4.3 **Cooling (CLG_PG)**

```
IF SF S ON THEN
    IF RT MAX>RT SP+2 THEN
        CLG MODE=ON, CCV=CCV CO
    IF RT MAX<RT SP+1.5 THEN
        CLG MODE=OFF, CCV=0
ELSE CLG MODE=OFF, CCV=0
```

5.2 **Heating (HTG_PG)**

```
IF SF S ON OR MAT<3 THEN
    IF RT AVG<RT SP-1 OR
    RT MIN<RT SP-1.5 OR MAT<3 THEN
        HTG MODE=ON, HCV=HCV CO
    IF RT AVG>RT SP-0.5 AND
    RT MIN>RT SP-1 AND MAT>7 THEN
        HTG MODE=OFF, HCV=0
IF SF S OFF AND MAT>7 THEN
        HCV=0
[Heating Coil Pump]
IF HCV>15 OR MAT<3 THEN
    START HCP
IF HCV<2 AND MAT>7 THEN
    STOP HCP
```

8.3 **Mixed Air Temp (MAT_PG)**

```
MAT SP=22+((22-AVG)*8)
IF MAT SP<13 THEN MAT SP=13
```

11.3 **Hot Deck Temp (HDT_PG)**

```
HDT SP=22+((22-MIN)*8)
IF HDT SP>60 THEN HDT SP=60
```

12.3 **Cold Deck Temp (CDT_PG)**

```
CDT SP=18-((RT MAX-22)*4)
IF CDT SP<13 THEN CDT SP=13
```

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.O OTHER REQUIRED FORMS

	Description	Status	Updated
O2	Miscellaneous Points List Outdoor Air - No Fire Alarm	Approved	95/09/01
O2A	Miscellaneous Points List Outdoor Air - Fire Alarm	Approved	95/10/04
O2B	Miscellaneous Points List Outdoor Air - Fire Alarm - Energy Metering	Yes	95/10/10
O3	Non DDC Points List	Approved	95/09/01
O4	Emergency/Safety Points List	Approved	95/09/01

CLIENT COMFORT SYSTEM - MISCELLANEOUS POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
97	Outside Air Temp Program		OAT_PG	PG					1	OAT=MIN(OAS...)	
98	Outside Air Temp Trendlog		OAT_TL	TL					1	OAT,OAS1,OAS2	
99	Outside Air Temperature		OAT	V					1		
	Outside Air Temperature		OAS1	OTS				1			
	Total										

CLIENT COMFORT SYSTEM - MISCELLANEOUS POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
	Fire Alarm		FIRE	CRS		1				Input to CCS Alarm	
97	Outside Air Temp Program		OAT_PG	PG					1	OAT=MIN(OAS...)	
98	Outside Air Temp Trendlog		OAT_TL	TL					1	OAT,OAS1,OAS2	
99	Outside Air Temperature		OAT	V					1		
	Outside Air Temperature		OAS1	OTS				1			
	Total										

CLIENT COMFORT SYSTEM - MISCELLANEOUS POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
	Fire Alarm		FIRE	CRS		1				Input to CCS Alarm	
97	Outside Air Temp Program		OAT_PG	PG					1	OAT=MIN(OAS...)	
98	Outside Air Temp Trendlog		OAT_TL	TL					1	OAT,OAS1,OAS2	
99	Outside Air Temperature		OAT	V					1		
	Outside Air Temperature		OAS1	OTS				1			
	Energy Metering:										
	Electrical Meter		ELEC_PUL	CRS		1				Calc from pulse	
	Electrical kW		ELEC_KW	V					1	15 minute average	
	Electrical kW Trend		ELEC_KW_TL	TL					1	kW 15 min 200 samples	
	Electrical Daily kWh		ELEC_KWH	V					1	Accumulate kW	
	Electrical Daily kWh Trend		ELEC_DAY_TL	TL					1	kWh 24 hr 200 samples	
	Gas Meter		GAS_PUL	CRS		1				Calc from pulse	
	Gas MJ/GJ		GAS_MJ	V					1	Average	
	Gas MJ Trend		GAS_MJ_TL	TL					1	MJ 15 min 200 samples	
	Gas Daily MJ		GAS_DAY_MJ	V					1	Accumulate MJ	
	Gas Daily MJ Trend		GAS_DAY_TL	TL					1	MJ 24 hr 200 samples	
	Total										

CLIENT COMFORT SYSTEM - NON DDC POINTS LIST

It is not necessary that the following points be DDC. Contractor may change at their option.

Project Number:	Project Name:		
System Description	Location	Device Type	Notes
Total			

CLIENT COMFORT SYSTEM - EMERGENCY/SAFETY POINTS LIST

It is mandatory that the following equipment be hardwired and not included as part of the DDC system.

Project Number:	Project Name:		
System Description	Location	Device Type	Notes
Total			

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

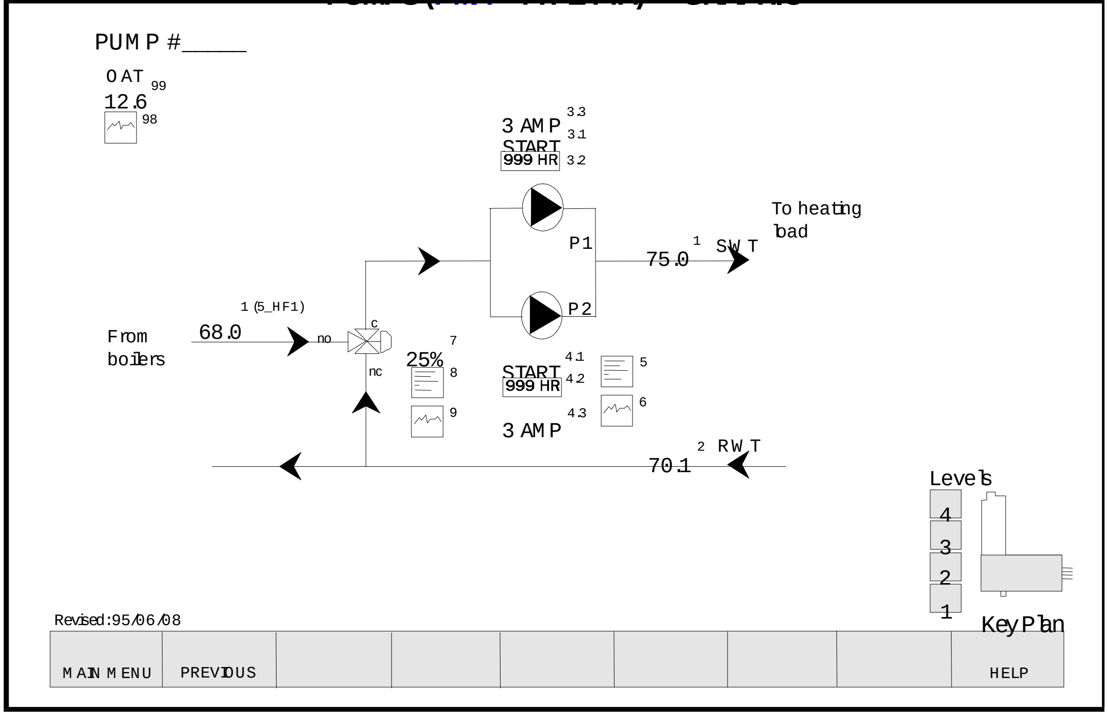
5.P PUMPS

System Type	Description	Status	Updated
P:A	Secondary Pumps with Three Way Valve	Approved	95/06/08

PUMPS (PMA TYPE P:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Hot Water Supply Temp		SWT	PTS1				1			
2	Return Water Supply Temp		RWT	PTS1				1			
3.1	Heating Pump 1 Control		P1	CR1	1						
3.2	Heating Pump 1 Run Hours		P1_TZ	TZ					1	use P1	
3.3	Heating Pump 1 Amps		P1_AMP	CS1				1			
	Heating Pump 1 Status		P1_S	V					1		
4.1	Heating Pump 2 Control		P2	CR1	1						
4.2	Heating Pump 2 Run Hours		P2_TZ	TZ					1	use P2	
4.3	Heating Pump 2 Amps		P2_AMP	CS1				1	1		
	Heating Pump 2 Status		P2_S	V					1		
5	Heating Pump Program		P_PG	PG					1		
6	Heating Pump Trendlog		P_TL	TL					1	P1_AMP,P2_AMP,P1,P2	
7	Supply Water Control Valve		SWT_V	__	1						
	Supply Water Valve Controller		SWT_V_CO	CO					1	use SWT:SWT_SP	
8	Supply Water Valve Program		SWT_V_PG	PG					1		
9	Supply Water Valve Trendlog		SWT_V_TL	TL					1	SWT,SWT_SP,SWT_V,RWT	
	Total				3	0	0	4	10		

PUMPS (PMA   TYPE P:A) - GRAPHIC



GENERIC START UP LOGIC

5 **Heating Pump (P_PG)**
IF OAT < 13 THEN
    START P1
IF OAT > 16 THEN
    STOP P1
IF P1_AMP > 2 THEN
    P1_S = ON
ELSE
    P1_S = OFF
[Pump 2]
IF (P1 ON-FOR 30 SEC AND P1_S = OFF)
OR OAT < 2 THEN
    START P2
IF OAT > 5 AND P1_S ON THEN
    STOP P2
IF P2_AMP > 2 THEN
    P2_S = ON
ELSE
    P2_S = OFF

8 **Supply Water Temperature Control Valve (SWT_V_PG)**
SWT_SP = 80 - OAT
IF P1 OR P2 THEN
    SWT_V = SWT_V_CO
IF P1 = STOP AND P2 = STOP THEN
    SWT_V = 0

5.S PRE-APPROVED SINGLE ZONE/TERMINAL REHEAT AIR SYSTEM TYPES

Assumption:
All systems have one supply fan and a full outside air economizer mixed air section.

System Type	Return Fan	Modulating Heating	On Off Cooling	Modulating Cooling	Evaporative Cooling	Status	Updated
A						Approved	94/10/28
B			X			Approved	94/10/28
C				X		Approved	94/10/28
D				X	X	Approved	94/10/28
E		X				Approved	94/10/31
F		X	X			Approved	94/10/31
G		X		X		Approved	94/10/31
H		X		X	X	Approved	94/10/31
I	X					Approved	94/10/28
J	X		X			Approved	94/10/28
K	X			X		Approved	95/10/10
L	X			X	X	Approved	94/10/31
M	X	X				Approved	94/10/31
N	X	X	X			Approved	95/08/01
O	X	X		X		Approved	94/10/31
P	X	X		X	X	Approved	94/10/31
Q		X - GAS				No	
R	X	X - GAS	X			No	

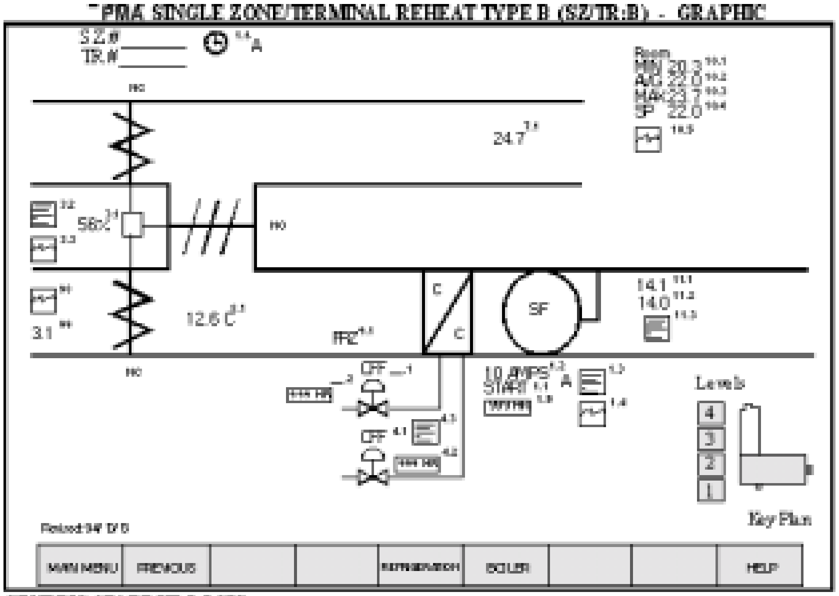
PMA SINGLE ZONE/TERMINAL REHEAT TYPE A (SZ/TR:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				1	1	1	4	17		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE B (SZ/TR:B) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX__	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	1	4	20		

PWA SINGLE ZONE/TERMINAL REHEAT TYPE B (SZ/TR:B) - GRAPHIC



GENERIC START UP LOGIC

1.3 Supply Fan (SF_PG)

```
IF WS ON OR RT_AVG < 14 THEN
    START SF
IF WS OFF AND RT_AVG > 16 THEN
    STOP SF
IF SF_AMP > 2 THEN
    SF_S = ON
ELSE
    SF_S = OFF
```

3.2 Mixed Air Damper (MAD_PG)

```
MAD_MIN = _____ DEFAULT = 30%
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_S OFF THEN
    RAMP = 0%
IF RAMP > 100% THEN
    RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
    IF CLG_MODE ON THEN
        IF RAT < OAT THEN
            MAD = MAD_MIN
        ELSE
            MAD = 100%
    ELSE
        MAD = MAX(MAD_MIN, MAD_CO)
        MAD = MIN(MAD, RAMP)
ELSE MAD = 0
```

4.5 Cooling (CLG_PG)

```
IF SF_S ON THEN
    IF RT_AVG > RT_SP + 1.3 OR
    RT_MAX > RT_SP + 2 THEN
        CLG_MODE = ON, START DX1
    IF RT_AVG < RT_SP + 0.8 AND
    RT_MAX < RT_SP + 1.5 THEN
        CLG_MODE = OFF, STOP DX1
ELSE CLG_MODE = OFF, STOP DX1
[Cooling Stage 2]
IF SF_S ON THEN
    IF RT_AVG > RT_SP + 1.5 OR
    RT_MAX > RT_SP + 2.3 OR
    DX1 ON-FOR 15 MIN THEN START DX2
    IF RT_AVG < RT_SP + 1.0 AND
    RT_MAX < RT_SP + 1.7 THEN STOP DX2
ELSE STOP DX2
```

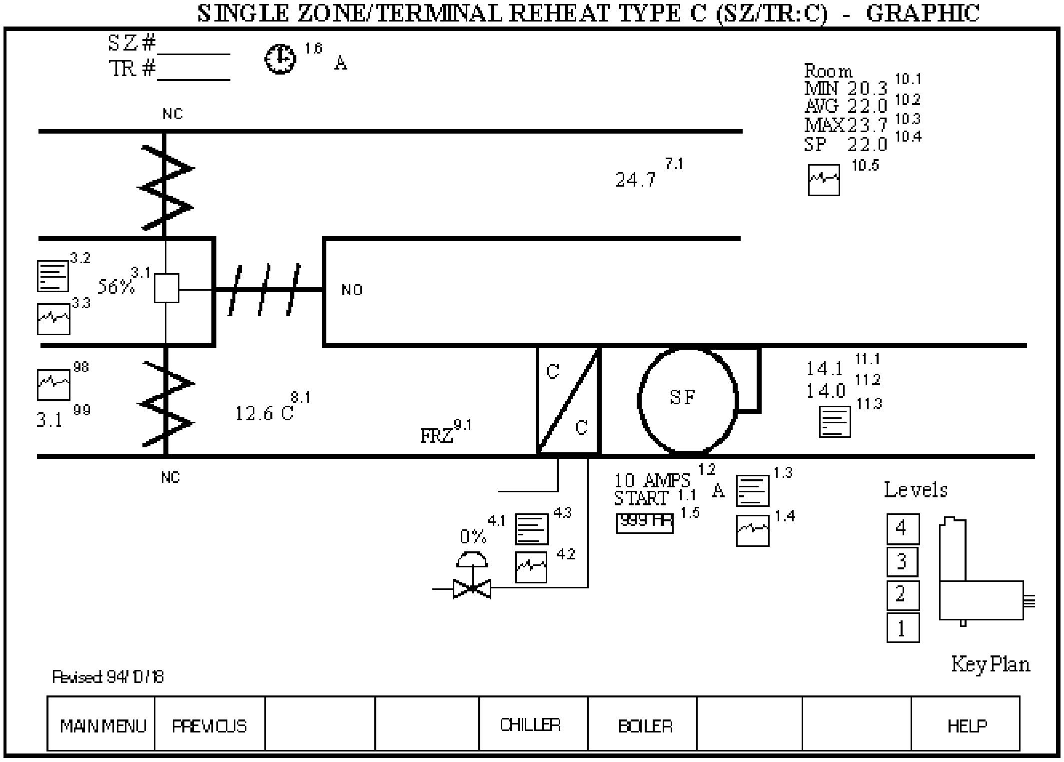
11.3 Supply Air Temp (SAT_PG)

```
RT_SP = ____ DEFAULT = 22
SAT_SP = 18 -((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE C (SZ/TR:C) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Program		CLG_PG	PG					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				1	1	2	4	21		

SINGLE ZONE/TERMINAL REHEAT TYPE C (SZ/TR:C) - GRAPHIC



GENERIC START UP LOGIC

1.3 **Supply Fan (SF_PG)**
IF WS ON OR RT_AVG < 14 THEN
START SF
IF WS OFF AND RT_AVG > 16 THEN
STOP SF
IF SF_AMP > 2 THEN
SF_S = ON
ELSE
SF_S = OFF

4.3 **Cooling (CLG_PG)**
IF SF_S ON THEN
IF RT_AVG > RT_SP + 1.3 OR
RT_MAX > RT_SP + 2 THEN
CLG_MODE = ON, CCV = CCV_CO
IF RT_AVG < RT_SP + 0.8 AND
RT_MAX < RT_SP + 1.5 THEN
CLG_MODE = OFF, CCV = 0
ELSE CLG_MODE = OFF, CCV = 0

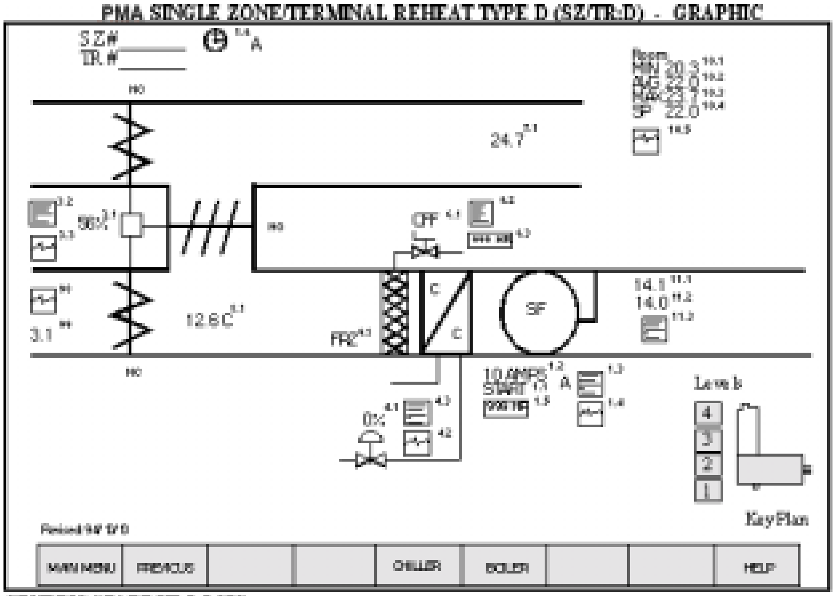
3.2 **Mixed Air Damper(MAD_PG)**
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_S OFF THEN
RAMP = 0%
IF RAMP > 100% THEN
RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
IF CLG_MODE ON THEN
IF RAT < OAT THEN
MAD = MAD_MIN
ELSE
MAD = 100%
ELSE
MAD = MAX(MAD_MIN, MAD_CO)
MAD = MIN(MAD, RAMP)
ELSE MAD = 0

11.3 **Supply Air Temp (SAT_PG)**
RT_SP = ____ *DEFAULT = 22*
SAT_SP = 18 - ((RT_AVG - RT_SP) *4)

PMA SINGLE ZONE/TERMINAL REHEAT TYPE D (SZ/TR:D) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Program		CLG_PG	PG					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	2	4	23		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE D (SZ/TR:D) - GRAPHIC



GENERIC START UP LOGIC

1.3 Supply Fan (SF_PG)
IF WS ON OR RT_AVG < 14 THEN
START SF
IF WS OFF AND RT_AVG > 16 THEN
STOP SF
IF SF_AMP > 2 THEN
SF_S = ON
ELSE
SF_S = OFF

4.0 Cooling (CLG_PG)
IF SF_S ON THEN
IF RT_AVG > RT_SP + 1.3 OR
RT_MAX > RT_SP + 2 THEN
CLG_MODE = ON, CCV = CCV_CO
IF RT_AVG < RT_SP + 0.8 AND
RT_MAX < RT_SP + 1.5 THEN
CLG_MODE = OFF, CCV = 0
ELSE CLG_MODE = OFF, CCV = 0

3.2 Mixed Air Damper (MAD_PG)
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_S OFF THEN
RAMP = 0%
IF RAMP > 100% THEN
RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
IF CLG_MODE ON THEN
IF RAT < OAT THEN
MAD = MAD_MIN
ELSE
MAD = 100%
ELSE
MAD = MAX(MAD_MIN, MAD_CO)
MAD = MIN(MAD, RAMP)
ELSE MAD = 0

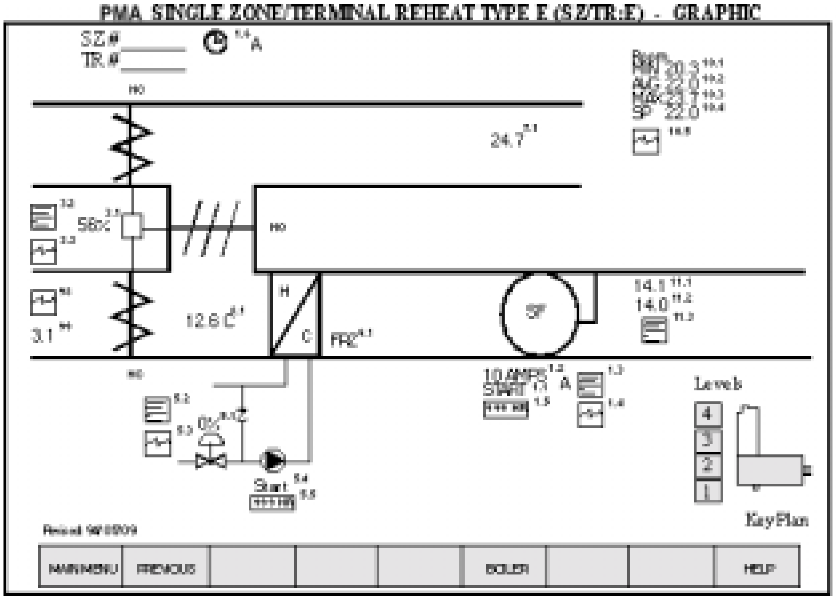
6.2 Evaporative (EC_PG)
IF SF_S ON AND CLG_MODE OFF THEN
IF RT_AVG > RT_SP + 0.5 THEN
START EC
IF RT_AVG < RT_SP + 0.1 OR CLG_MODE ON THEN
STOP EC
ELSE STOP EC

11.0 Supply Air Temp (SAT_PG)
RT_SP = ____ *DEFAULT = 22*
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

PMA SINGLE ZONE/TERMINAL REHEAT TYPE E (SZ/TR:E) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	2	4	22		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE E (SZ/TR:E) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF
```

```
3.4 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF RAT < OAT OR HTG_MODE ON THEN
            MAD = MAD_MIN
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

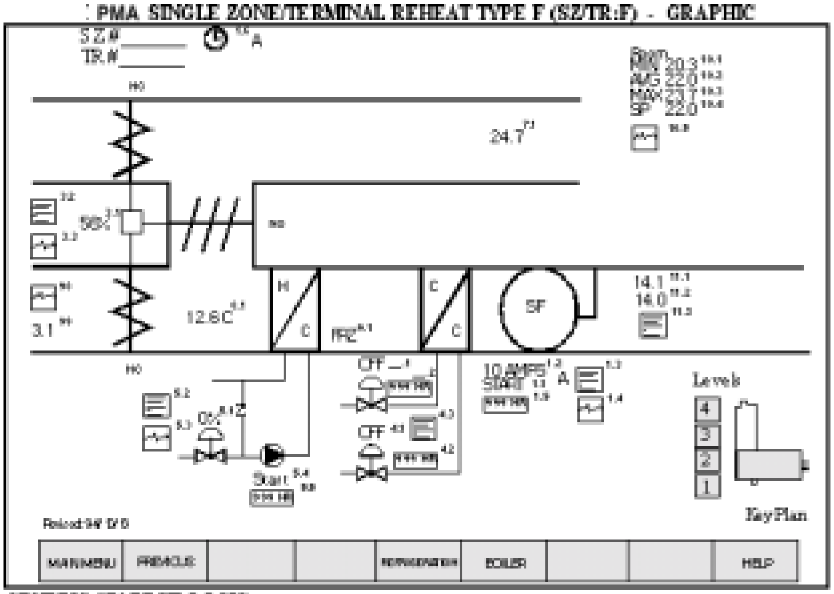
```
5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP - 0.5 AND
        RT_MIN > RT_SP - 1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
```

```
11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE F (SZ/TR:F) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX__	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	2	4	25		

: PMA SINGLE ZONE/TERMINAL REHEAT TYPE F (SZ/TR:F) - GRAPHIC



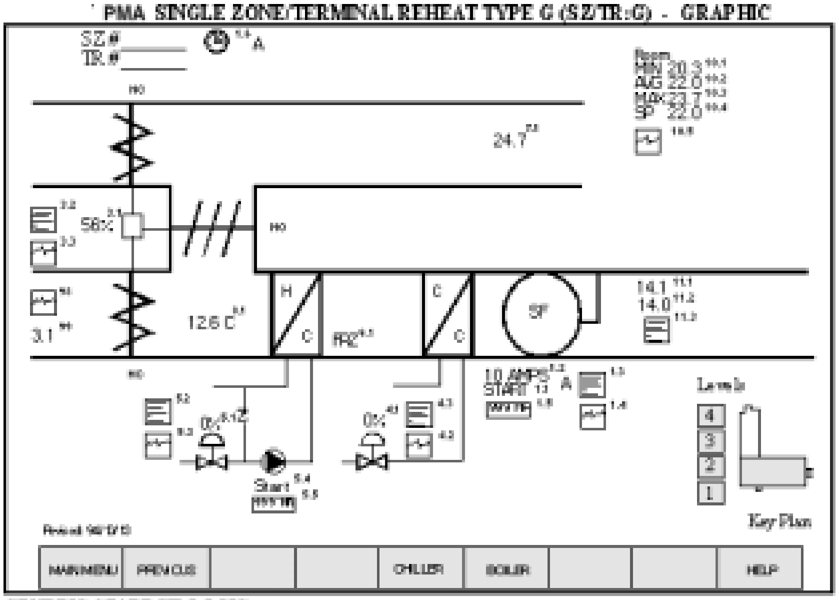
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

3.8 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, STOP DX1
    ELSE CLG_MODE = OFF, STOP DX1
    [Cooling Stage 2]
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON-FOR 15 MIN THEN START DX2
        IF RT_AVG < RT_SP + 1.0 AND
        RT_MAX < RT_SP + 1.7 THEN STOP DX2
    ELSE STOP DX2

5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP -1 OR
        RT_MIN < RT_SP -1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP -0.5 AND
        RT_MIN > RT_SP -1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 -((RT_AVG -RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE G (SZ/TR:G) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Program		CLG_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	3	4	26		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE G (SZ/TR:G) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE CLG_MODE = OFF, CCV = 0

5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP - 0.5 AND
        RT_MIN > RT_SP - 1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 -((RT_AVG -RT_SP) * 4)
```

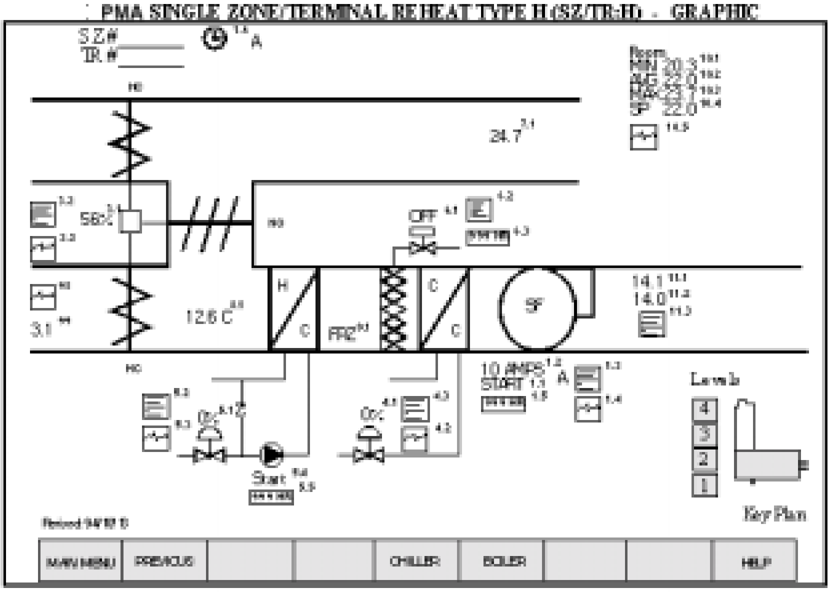
PMA SINGLE ZONE/TERMINAL REHEAT TYPE H (SZ/TR:H) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Program		CLG_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	3	4	28		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE I (SZ/TR:I) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	1	4	20		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE H (SZ/TR:H) - GRAPHIC



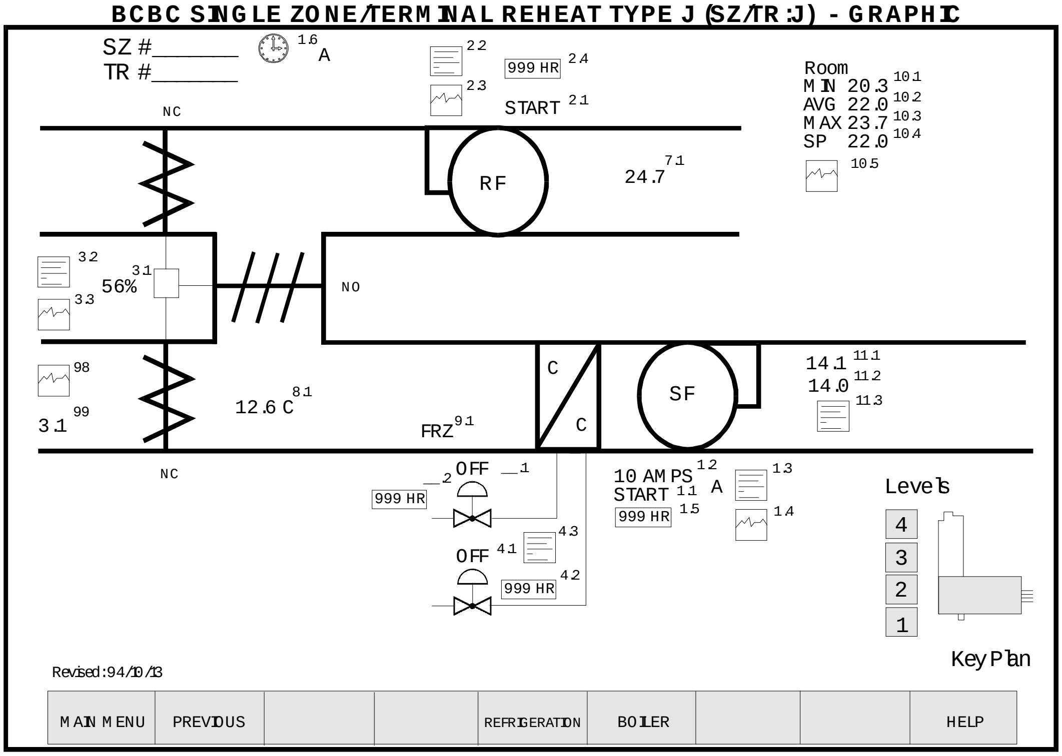
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP - 0.5 AND
        RT_MIN > RT_SP - 1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
6.2 Evaporative (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC
11.3 Supply Air Temp (SAT_PG)
    RT_SP = _____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE J (SZ/TR:J) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX__	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	1	4	23		

BCBC SINGLE ZONE/TERMINAL REHEAT TYPE J (SZ/TR:J) - GRAPHIC



GENERIC START UP LOGIC

13 **Supply Fan (SF_PG)**

IF RF ON-FOR 30 SEC THEN
  START SF
ELSE
  STOP SF
IF SF_AMP > 2 THEN
  SF_S = ON
ELSE
  SF_S = OFF

22 **Return Fan (RF_PG)**

IF WS ON OR RT_AVG < 14 THEN
  START RF
IF WS OFF AND RT_AVG > 16 THEN
  STOP RF

32 **Mixed Air Damper (MAD_PG)**

MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_S OFF THEN
  RAMP = 0%
IF RAMP > 100% THEN
  RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
  IF CLG_MODE ON THEN
    IF RAT < OAT THEN
      MAD = MAD_MIN
    ELSE
      MAD = 100%
  ELSE
    MAD = MAX(MAD_MIN, MAD_CO)
    MAD = MIN(MAD, RAMP)
ELSE MAD = 0

43 **Cooling (CLG_PG)**

IF SF_S ON THEN
  IF RT_AVG > RT_SP + 1.3 OR
  RT_MAX > RT_SP + 2 THEN
    CLG_MODE = ON, START DX1
  IF RT_AVG < RT_SP + 0.8 AND
  RT_MAX < RT_SP + 1.5 THEN
    CLG_MODE = OFF, STOP DX1
ELSE CLG_MODE = OFF, STOP DX1
[Cooling Stage 2]
IF SF_S ON THEN
  IF RT_AVG > RT_SP + 1.5 OR
  RT_MAX > RT_SP + 2.3 OR
  DX1 ON-FOR 15 MIN THEN START DX2
  IF RT_AVG < RT_SP + 1.0 AND
  RT_MAX < RT_SP + 1.7 THEN STOP DX2
ELSE STOP DX2

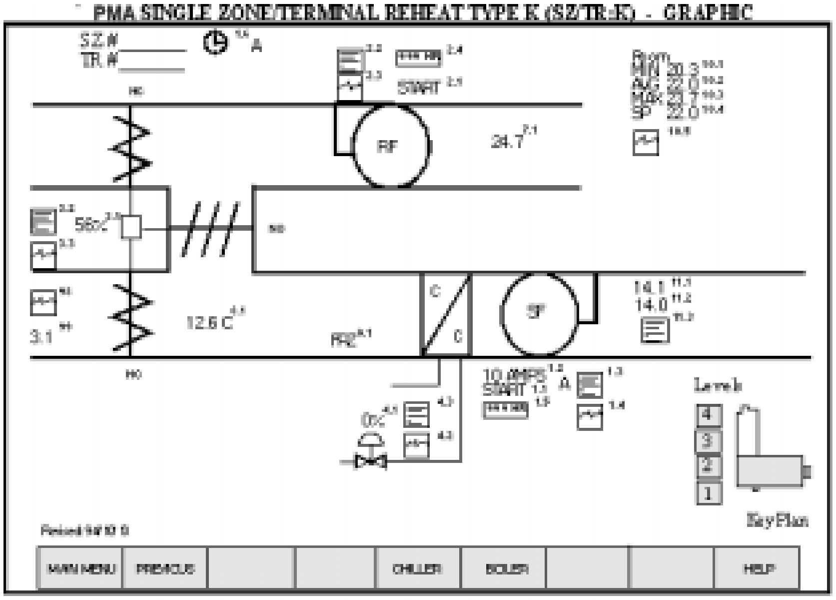
113 **Supply Air Temp (SAT_PG)**

RT_SP = ____ *DEFAULT = 22*
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

PMA SINGLE ZONE/TERMINAL REHEAT TYPE K (SZ/TR:K) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Program		CLG_PG	PG					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				2	1	2	4	24		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE K (SZ/TR:K) - GRAPHIC



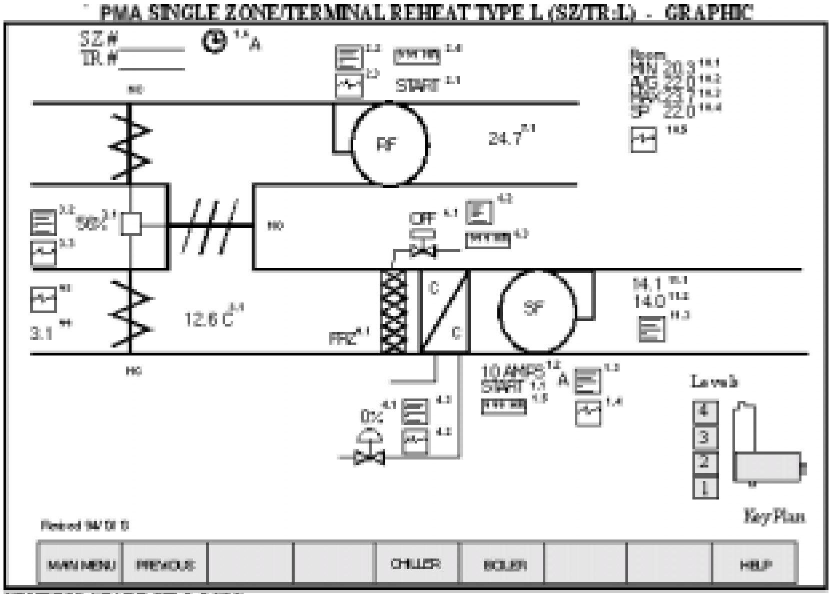
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON THEN
            IF RAT < OAT THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE CLG_MODE = OFF, CCV = 0

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE L (SZ/TR:L) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Program		CLG_PG	PG					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	2	4	26		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE L (SZ/TR:L) - GRAPHIC



GENERIC START UP LOGIC

1.3 Supply Fan (SF_PG)
```
IF RF ON-FOR 30 SEC THEN
    START SF
ELSE
    STOP SF
IF SF_AMP > 2 THEN
    SF_S = ON
ELSE
    SF_S = OFF
```

2.2 Return Fan (RF_PG)
```
IF WS ON OR RT_AVG < 14 THEN
    START RF
IF WS OFF AND RT_AVG > 16 THEN
    STOP RF
```

3.2 Mixed Air Damper (MAD_PG)
```
MAD_MIN = _____ DEFAULT = 30%
DO EVERY 3 S RAMP = RAMP + 1%
IF SF_S OFF THEN
    RAMP = 0%
IF RAMP > 100% THEN
    RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
    IF CLG_MODE ON THEN
        IF RAT < OAT THEN
            MAD = MAD_MIN
        ELSE
            MAD = 100%
    ELSE
        MAD = MAX(MAD_MIN, MAD_CO)
        MAD = MIN(MAD, RAMP)
ELSE MAD = 0
```

4.3 Cooling (CLG_PG)
```
IF SF_S ON THEN
    IF RT_AVG > RT_SP + 1.3 OR
    RT_MAX > RT_SP + 2 THEN
        CLG_MODE = ON, CCV = CCV_CO
    IF RT_AVG < RT_SP + 0.8 AND
    RT_MAX < RT_SP + 1.5 THEN
        CLG_MODE = OFF, CCV = 0
ELSE CLG_MODE = OFF, CCV = 0
```

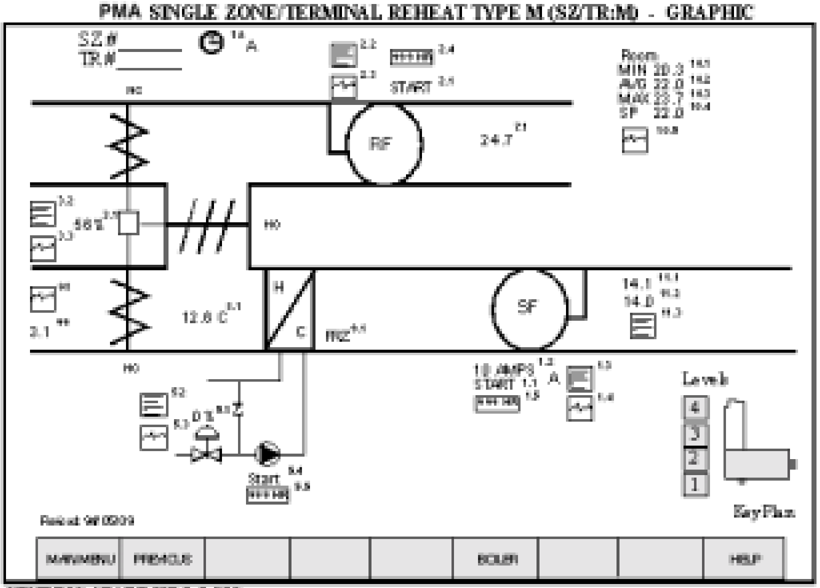
6.2 Evaporative (EC_PG)
```
IF SF_S ON AND CLG_MODE OFF THEN
    IF RT_AVG > RT_SP + 0.5 THEN
        START EC
    IF RT_AVG < RT_SP + 0.1 THEN
        STOP EC
ELSE STOP EC
```

11.3 Supply Air Temp (SAT_PG)
```
RT_SP = ____ DEFAULT = 22
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE M (SZ/TR:M) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	2	4	25		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE M (SZ/TR:M) - GRAPHIC



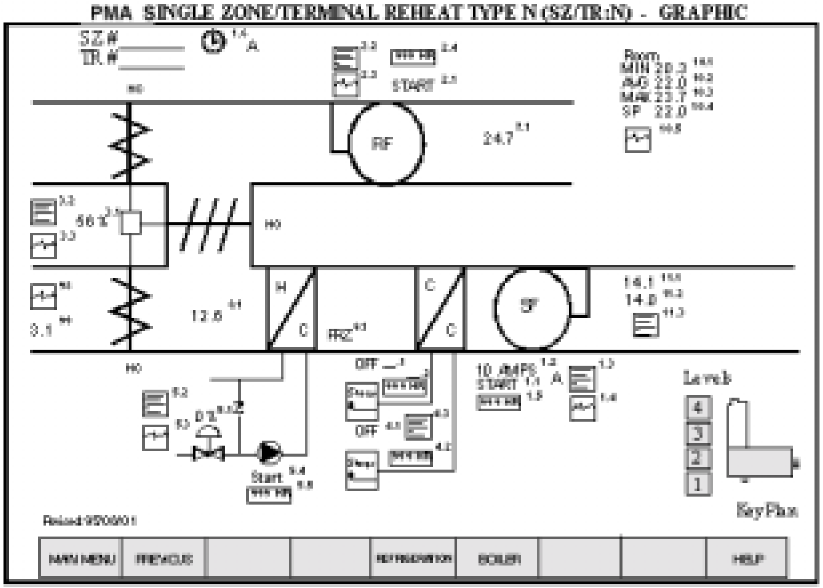
GENERIC START UP LOGIC

```
1.1 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF

3.4 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF RAT < OAT OR HTG_MODE ON THEN
            MAD = MAD_MIN
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP -1 OR
        RT_MIN < RT_SP -1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP -0.5 AND
        RT_MIN > RT_SP -1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE N (SZ/TR:N) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX__	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				4	1	2	4	28		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE N (SZ/TR:N) - GRAPHIC



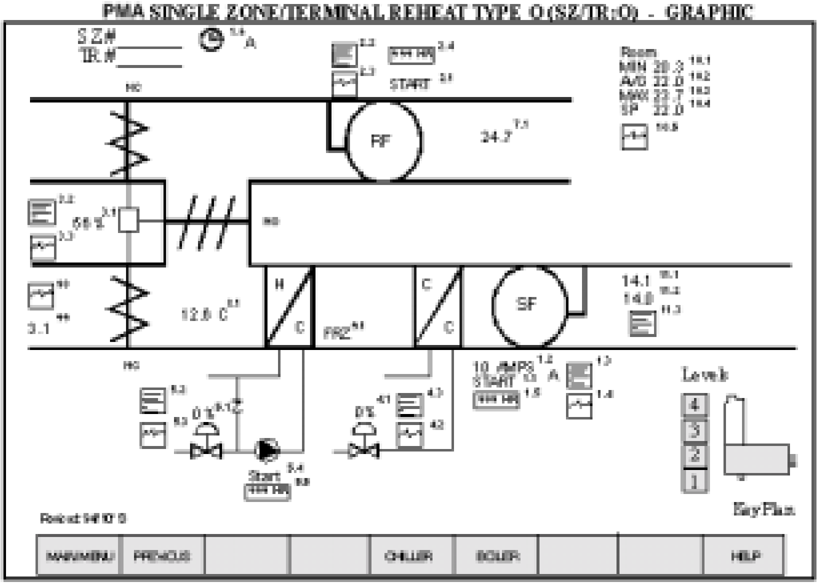
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, STOP DX1
    ELSE CLG_MODE = OFF, STOP DX1
    [Cooling Stage 2]
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON-FOR 15 MIN THEN START DX2
        IF RT_AVG < RT_SP + 1.0 AND
        RT_MAX < RT_SP + 1.7 THEN STOP DX2
    ELSE STOP DX2

5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP - 0.5 AND
        RT_MIN > RT_SP - 1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22°
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE O (SZ/TR:O) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Program		CLG_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				3	1	3	4	29		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE O (SZ/TR:O) - GRAPHIC



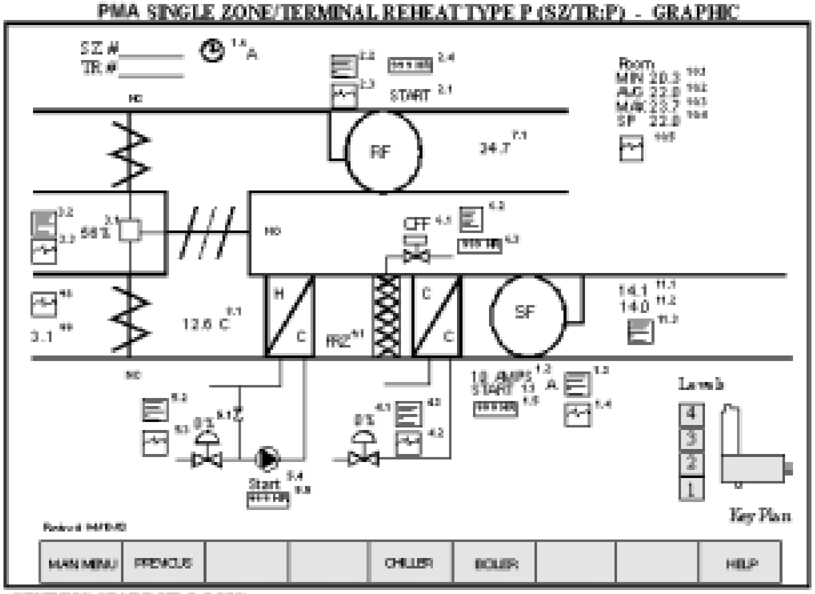
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE CLG_MODE = OFF, CCV = 0

5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP -0.5 AND
        RT_MIN > RT_SP -1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMA SINGLE ZONE/TERMINAL REHEAT TYPE P (SZ/TR:P) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Amps		SF_AMP	CS1				1			
	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_AMP,SAT,SAT_SP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trend Log		RF_TL	TL					1	RF,RAT,OAT	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Program		CLG_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SAT_SP	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Status		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
	Total				4	1	3	4	31		

PMA SINGLE ZONE/TERMINAL REHEAT TYPE P (SZ/TR:P) - GRAPHIC



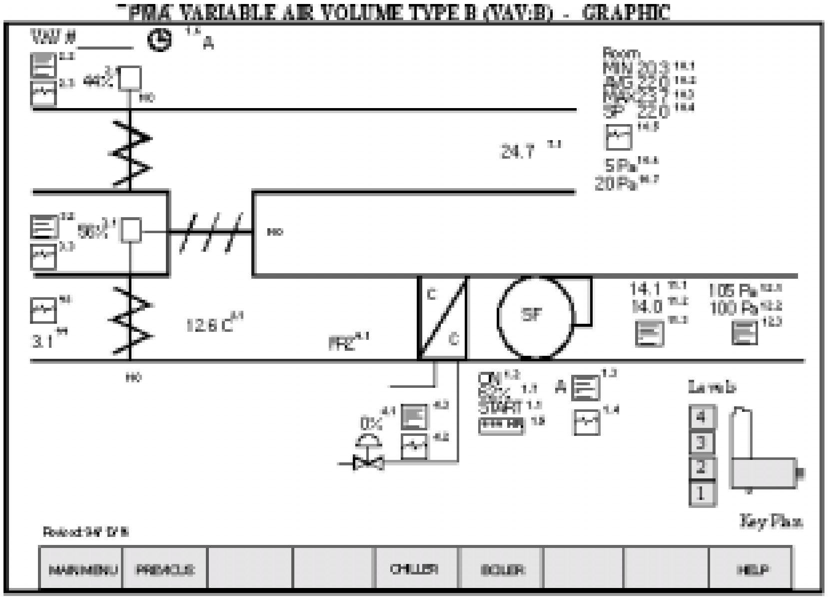
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE
        STOP SF
    IF SF_AMP > 2 THEN
        SF_S = ON
    ELSE
        SF_S = OFF

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF_S OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SF_S ON OR MAT < 3 THEN
        IF RT_AVG < RT_SP - 1 OR
        RT_MIN < RT_SP - 1.5 OR MAT < 3 THEN
            HTG_MODE = ON, HCV = HCV_CO
        IF RT_AVG > RT_SP - 0.5 AND
        RT_MIN > RT_SP - 1 AND MAT > 7 THEN
            HTG_MODE = OFF, HCV = 0
    IF SF_S OFF AND MAT > 7 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
6.2 Evaporative (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC
11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
```

PMa VARIABLE AIR VOLUME TYPE B (VAV:B) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	V					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Coil Program		CCV_PG	PG					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				1	1	4	5	27		

TYPICAL VARIABLE AIR VOLUME TYPE B (VAV:B) - GRAPHIC



GENERIC START UP LOGIC

1.0 Supply Fan (SF_PG)
IF WS ON OR RT_AVG < 14 THEN
START SF
IF WS OFF AND RT_AVG > 16 THEN
STOP SF
IF SAP > 30 THEN SF_S = ON
ELSE SF_S = OFF
[Supply Fan ASD]
IF SF ON THEN
SF_ASD = SAP_CO
ELSE SF_ASD = 0

2.0 Exhaust Air Damper (EAD_PG)
BSP_SP = _____ *DEFAULT = 20 Pa*
EAD = MAD -(BSP_SP -BSP)

3.0 Mixed Air Damper (MAD_PG)
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF OFF THEN
RAMP = 0%
IF RAMP > 100% THEN
RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
IF CLG_MODE ON THEN
IF RAT < OAT THEN
MAD = MAD_MIN
ELSE MAD = 100%
ELSE
MAD = MAX(MAD_MIN, MAD_CO)
MAD = MIN(MAD, RAMP)
ELSE MAD = 0

4.0 Cooling (CLG_PG)
IF SF_S ON THEN
IF RT_AVG > RT_SP + 1.3 OR
RT_MAX > RT_SP + 2 THEN
CLG_MODE = ON, CCV = CCV_CO
IF RT_AVG < RT_SP + 0.8 AND
RT_MAX < RT_SP + 1.5 THEN
CLG_MODE = OFF, CCV = 0
ELSE
CLG_MODE = OFF, CCV = 0

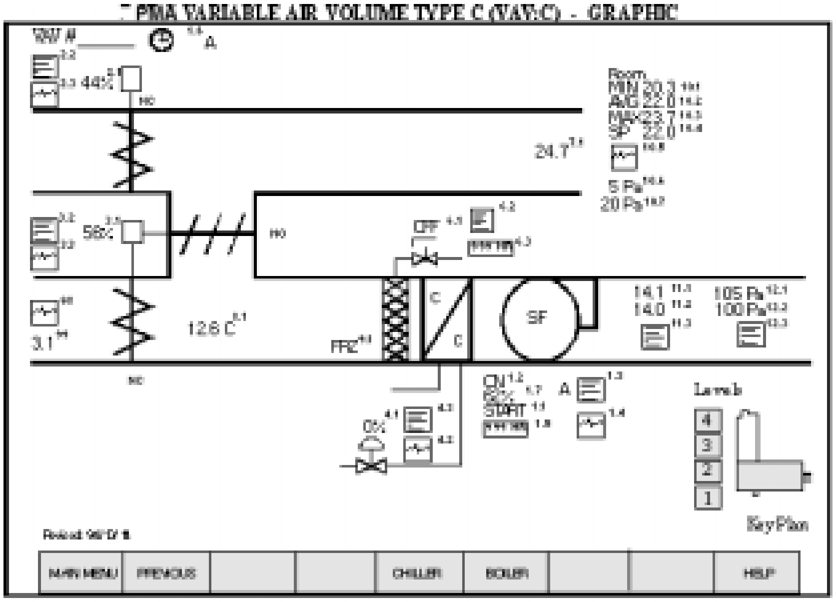
11.0 Supply Air Temp (SAT_PG)
RT_SP = ____ *DEFAULT = 22*
SAT_SP = 18 -((RT_AVG -RT_SP) * 4)

12.0 Supply Air Pressure (SAP_PG)
SAP_SP = ____ *DEFAULT = 100 Pa*

PMA VARIABLE AIR VOLUME TYPE C (VAV:C) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	V					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Coil Program		CCV_PG	PG					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				2	1	4	5	29		

7 PMA VARIABLE AIR VOLUME TYPE C (VAV:C) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0

3.2 Exhaust Air Damper (EAD_PG)
    BSP_SP = DEFAULT = 20 Pa
    EAD = MAD - (BSP_SP - BSP)

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON THEN
            IF RAT < OAT THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0

6.2 Evaporative Cooling (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 OR
        RT_HIGH > RT_SP + 1 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

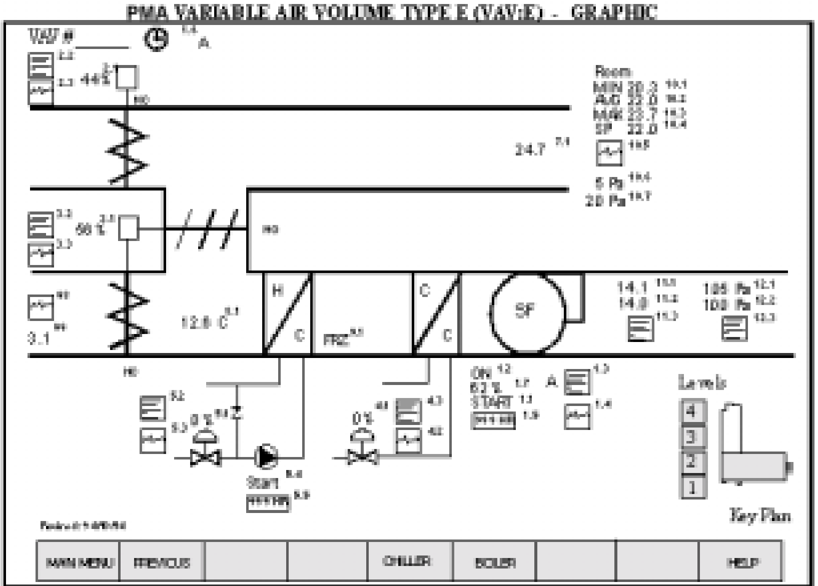
PMA VARIABLE AIR VOLUME TYPE D (VAV:D) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	V					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX___	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				3	1	4	5	31		

PMA VARIABLE AIR VOLUME TYPE E (VAV:E) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	V					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Coil Program		CCV_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				2	1	5	5	32		

PMA VARIABLE AIR VOLUME TYPE E (VAV:E) - GRAPHIC



GENERIC START UP LOGIC

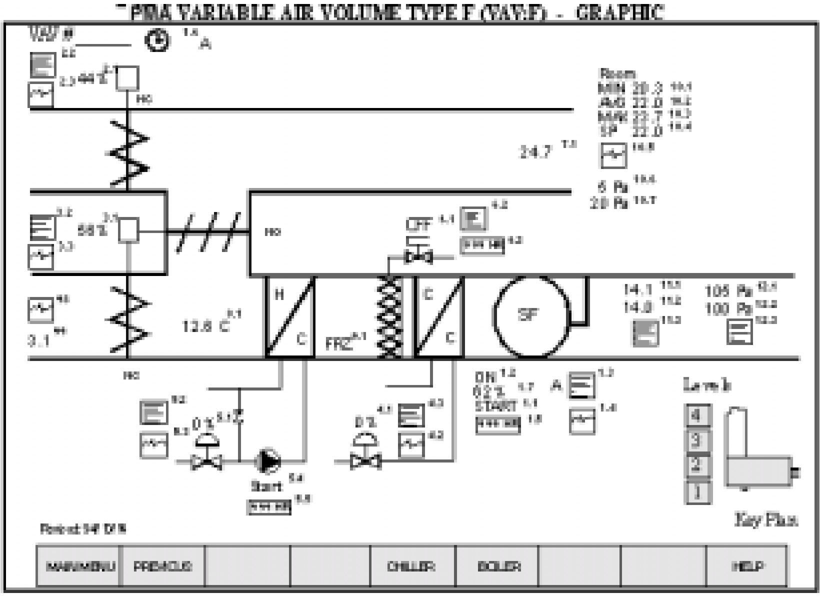
```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF

    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0

2.3 Exhaust Air Damper (EAD_PG)
    BSP_SP = ______ DEFAULT = 20 Pa
    EAD = MAD - (BSP_SP - BSP)

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = ______ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

```
4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0

5.2 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = _____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = _____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE F (VAV:F) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	V					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Coil Program		CCV_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				3	1	5	5	34		

PMA VARIABLE AIR VOLUME TYPE F (VAV:F) - GRAPHIC



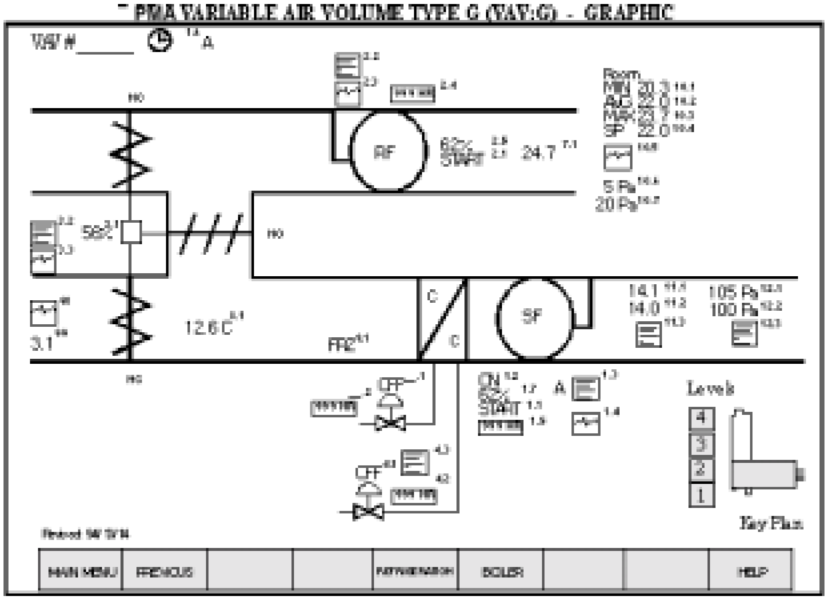
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
3.2 Exhaust Air Damper (EAD_PG)
    BSP_SP = _____ DEFAULT = 20 Pa
    EAD = MAD - (BSP_SP - BSP)

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
6.2 Evaporative Cooling (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 OR
        RT_HIGH > RT_SP + 1 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC
11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE G (VAV:G) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX___	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				3	1	3	5	27		

PMA VARIABLE AIR VOLUME TYPE G (VAV:G) - GRAPHIC



GENERIC START UP LOGIC

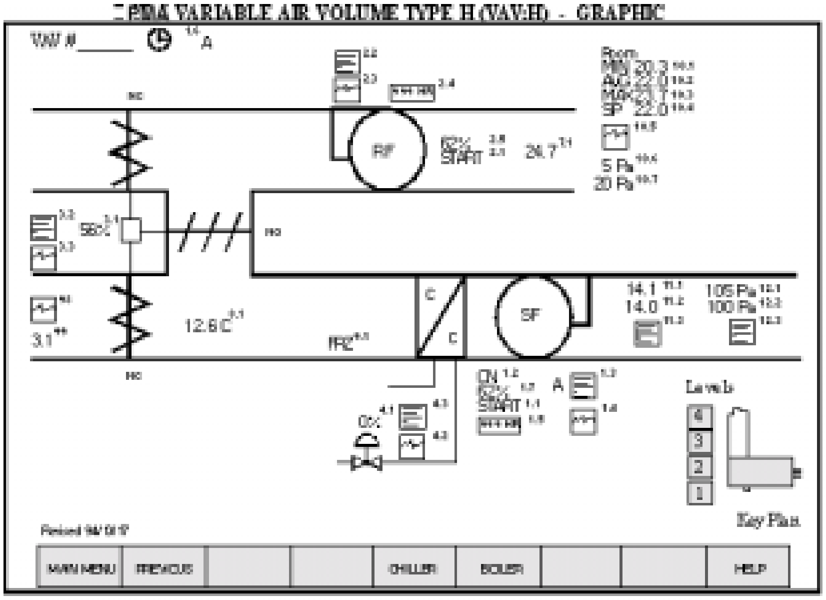
```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD -(BSP_SP - BSP)
    ELSE RF_ASD = 0
5.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON THEN
            IF RAT < OAT THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

```
4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, STOP DX1
    ELSE CLG_MODE = OFF, STOP DX1
    [Cooling Stage 2]
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON-FOR 15 MIN THEN START DX2
        IF RT_AVG < RT_SP + 1.0 AND
        RT_MAX < RT_SP + 1.7 THEN STOP DX2
    ELSE STOP DX2

15.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 16 - ((RT_AVG - RT_SP) * 4)

17.1 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE H (VAV:H) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Coil Program		CCV_PG	PG					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				2	1	4	5	28		

[illegible] VARIABLE AIR VOLUME TYPE H (VAV:H) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
         START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
         ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
         SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
         START RF
    IF WS OFF AND RT_AVG > 16 THEN
         STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
         RF_ASD = SF_ASD - (BSP_SP - BSP)
    ELSE RF_ASD = 0
3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
         RAMP = 0%
    IF RAMP > 100% THEN
         RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
         IF CLG_MODE ON THEN
              IF RAT < OAT THEN
                   MAD = MAD_MIN
              ELSE MAD = 100%
         ELSE
              MAD = MAX(MAD_MIN, MAD_CO)
              MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

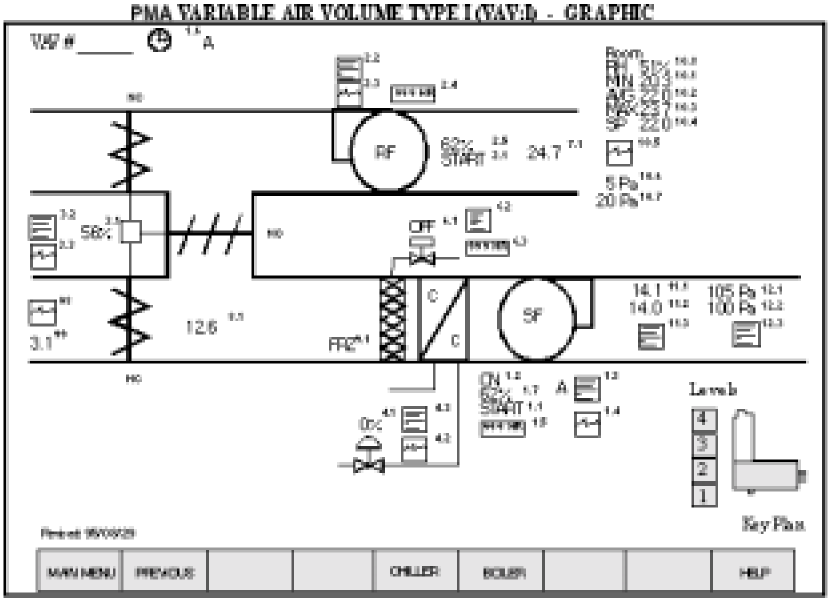
```
4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
         IF RT_AVG > RT_SP + 1.3 OR
         RT_MAX > RT_SP + 2 THEN
              CLG_MODE = ON, CCV = CCV_CO
         IF RT_AVG < RT_SP + 0.8 AND
         RT_MAX < RT_SP + 1.5 THEN
              CLG_MODE = OFF, CCV = 0
    ELSE
         CLG_MODE = OFF, CCV = 0
```

```
11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE I (VAV:I) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Coil Program		CCV_PG	PG					1		
	Evaporative Mode		EVAP_MODE	V					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evap Cooling Program		EC_PG	PG					1		
6.3	Evap Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
10.8	Room Relative Humidity		RRH	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				3	1	4	5	32		

PMA VARIABLE AIR VOLUME TYPE I (VAV:I) - GRAPHIC



GENERIC START UP LOGIC

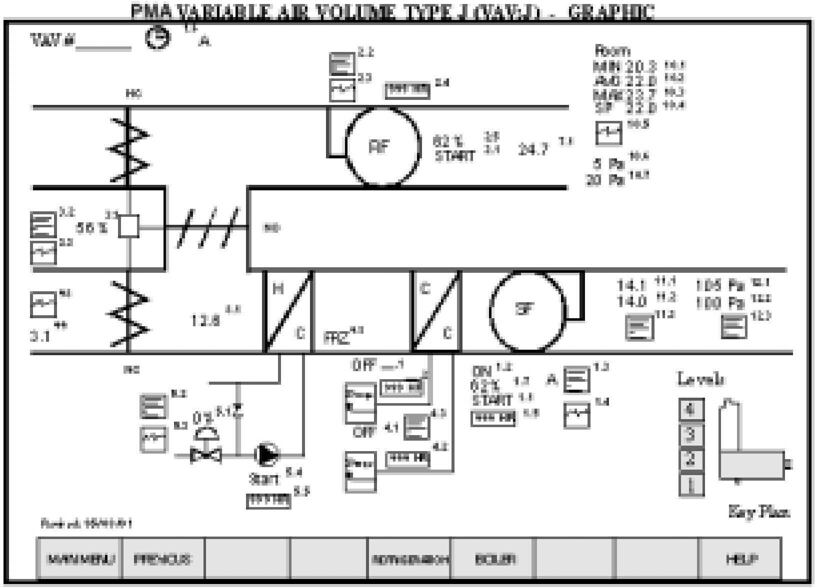
```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD -(BSP_SP -BSP)
    ELSE RF_ASD = 0
3.3 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR EVAP_CLG ON THEN
            IF RAT < OAT AND EVAP_CLG OFF THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

```
4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0

5.2 Evaporative Cooling (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 OR
        RT_HIGH > RT_SP + 1 THEN
            EVAP_MODE = ON
        IF RT_AVG < RT_SP + 0.1 THEN
            EVAP_MODE = OFF
    ELSE EVAP_MODE = OFF
    IF EVAP_MODE = ON AND SAT > SAT_SP AND
    RRH < 60 THEN
        START EC
    IF EVAP_MODE = OFF OR SAT < SAT_SP - 1 OR
    RRH > 65 THEN
        STOP EC

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22°
    SAT_SP = 18 -((RT_AVG -RT_SP) * 4)

12.4 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE J (VAV:J) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX___	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				4	1	4	5	32		

PMA VARIABLE AIR VOLUME TYPE J (VAV-J) - GRAPHIC



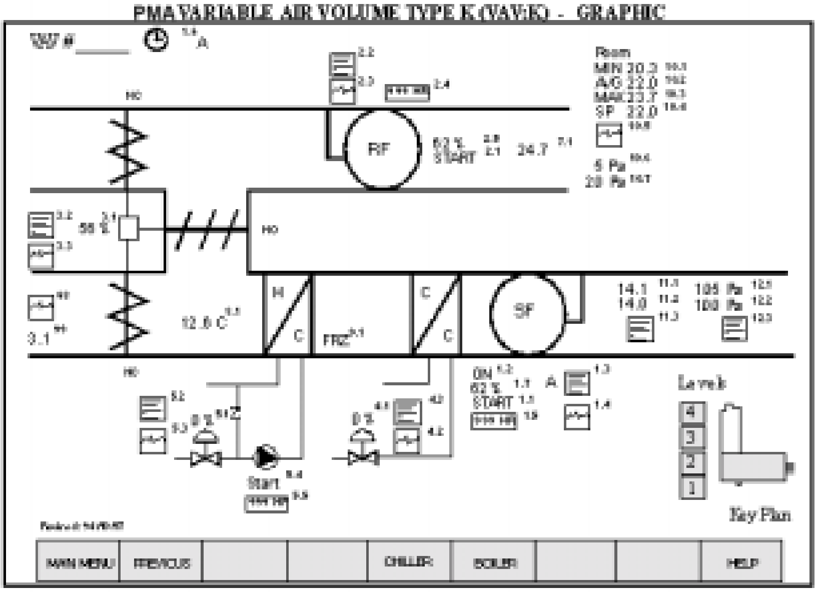
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0

2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD - (BSP_SP - BSP)
    ELSE RF_ASD = 0

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, STOP DX1
    ELSE CLG_MODE = OFF, STOP DX1
    [Cooling Stage 2]
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON-FOR 15 MIN THEN START DX2
        IF RT_AVG < RT_SP + 1.0 AND
        RT_MAX < RT_SP + 1.7 THEN STOP DX2
    ELSE STOP DX2

5.3 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.5 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE K (VAV:K) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.4	Return Fan Run Hours		RF_TZ	TZ					1		
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT	
4.3	Cooling Coil Program		CCV_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				3	1	5	5	33		

PMA VARIABLE AIR VOLUME TYPE K (VAV:K) - GRAPHIC



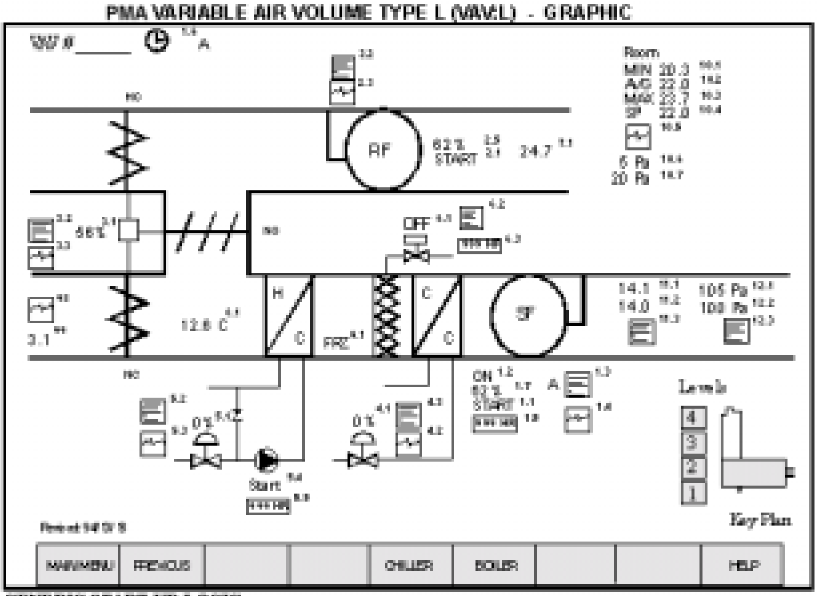
GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD - (BSP_SP - BSP)
    ELSE RF_ASD = 0
3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP

10.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.1 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE L (VAV:L) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Return Fan Start/Stop		RF	CR1	1						
2.2	Return Fan Program		RF_PG	PG					1		
2.3	Return Fan Trendlog		RF_TL	TL					1	RF,RAT,BSP,ASD	
2.5	Return Fan ASD		RF_ASD	DDC			1				
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Cooling Coil Valve		CCV	CV3			1				
	Cooling Coil Controller		CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog		CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Coil Program		CCV_PG	PG					1		
	Heating Mode		HTG_MODE	V					1		
5.1	Heating Coil Valve		HCV	CV3			1				
	Heating Coil Controller		HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program		HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog		HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump		HCP	CR1	1						
5.5	Heating Coil Pump Run Hours		HCP_TZ	TZ					1		
6.1	Evaporative Cooling		EC	CR1	1						
6.2	Evaporative Cooling Program		EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours		EC_TZ	TZ					1		
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				4	1	5	5	34		

PMA VARIABLE AIR VOLUME TYPE L (VAV:L) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 20 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD - (BSP_SP - BSP)
    ELSE RF_ASD = 0
3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
6.2 Evaporative Cooling (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 OR
        RT_HIGH > RT_SP + 1 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC
11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.T PRE-APPROVED TERMINAL UNIT CONTROLLER (TUC) CATEGORIES - INDEX

System Type	Description
T:DD	Dual duct
T:FC	Fan coil
T:FP	Fan powered
T:HP	Heat pump
T:MZ	Multizone
T:TR	Terminal reheat coil
T:UC	Unit cooler
T:UH	Unit heater
T:V	Variable volume

PMA VARIABLE AIR VOLUME TERMINAL REHEAT (TYPE TR-C) - POINTS LIST

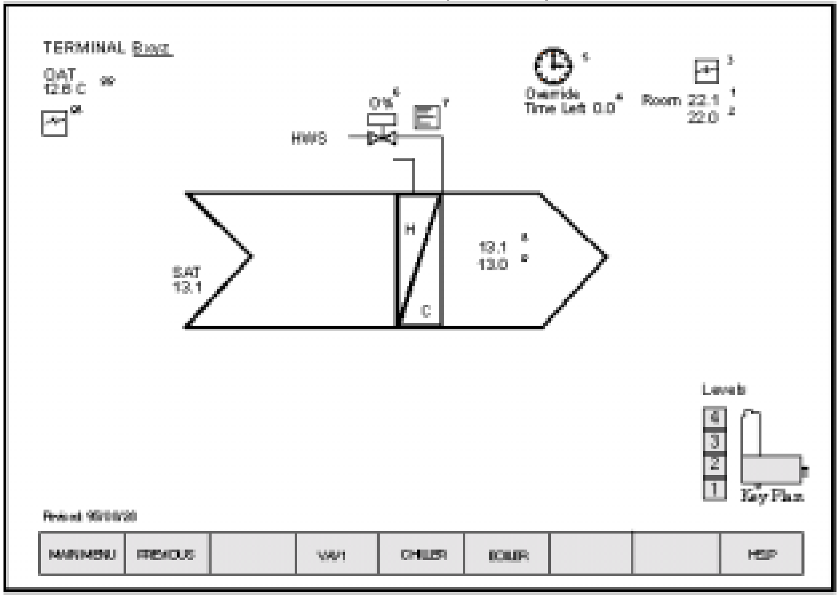
Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Room Temperature		BxyzRT	RTS1				1			
2	Room Temperature Setpoint		BxyzRT_SP	V					1		
3	Room Trendlog		BxyzRT_TL	TL					1	RT,RT_SP,RCV,RCV_CO	
	Room Override		BxyzOR	RTS1		1					
4	Room Override Time Left		BxyzOR_T	V					1	Set 60 min	
5	Room Weekly Schedule		BxyzWS	WS						See Spec 15925	
6	Reheat Coil Valve		BxyzRCV	CV3			1				
	Reheat Coil Valve Controller		BxyzRCV_CO	CO					1	use SAT:SAT_SP	
7	Reheat Coil Valve Program		BxyzRCV_PG	PG					1		
8	Supply Air Temperature		BxyzSAT	DTS1				1			
9	Supply Air Temp Setpoint		BxyzSAT_SP	V					1		
	Room Temperature Controller		BxyzRT_CO	CO					1	use RT:RT_SP	
	Total				0	1	1	2	7		

NOTE: x = Floor #

yz = Box # of Floor #

For VAV# and Box # see mechanical schedule

TPWA TERMINAL REHEAT (TYPE TR-C) - GRAPHIC



GENERIC START UP LOGIC

7 **Reheat Coil Program BxyzRCV_PG**

```
BxyzRT_SP = 22.0
BxyzSAT_SP = 13 + ((40 - 13) * BxyzRT_CO/100))
BxyzRCV = BxyzRCV_CO
IF BxyzOR THEN BxyzOR_T = 60.0
DO EVERY 1 MIN
BxyzOR_T = BxyzOR_T - 1.0
IF BxyzOR_T < 0 THEN BxyzOR_T = 0
END_DO
```

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.T:V PRE-APPROVED DUAL DUCT TUC TYPES

All dual duct boxes will have supply air temperature sensors.

	Damper Control			Flow		Status	Updated
	Digital	Floating	Analog	Measurement	Window		
T:DD-A			X	Outlet		Approved	95/04/07
T:DD-B			X	Inlet		Approved	95/04/07

PMA DUAL DUCT TUC (TYPE DD-B) - POINTS LIST

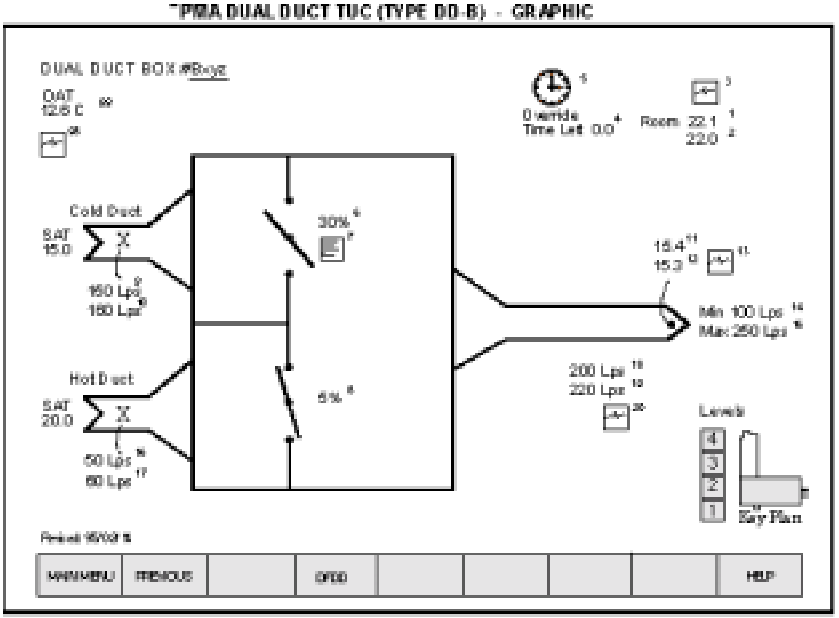
Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Room Temperature		BxyzRT	RTS1				1			
2	Room Temperature Setpoint		BxyzRT_SP	V					1		
3	Room Trendlog		BxyzRT_TL	TL					1	RT,RT_SP,F,SAT	
	Room Override		BxyzOR	RTS1		1				Button on sensor	
4	Room Override Time Left		BxyzOR_T	V					1	Set 60 min	
5	Room Weekly Schedule		BxyzWS	WS						See Spec 15925	
6	Cold Duct Damper		BxyzCDD	DA1			1				
7	Box Program		Bxyz_PG	PG					1		
8	Hot Duct Damper		BxyzHDD	DA1			1				
9	Cold Duct Flow		BxyzCDF	VS2				1			
10	Cold Duct Flow Setpoint		BxyzCDF_SP	V					1		
11	Box Supply Air Temperature		BxyzSAT	DTS2				1			
12	Box Supply Air Temp Setpoint		BxyzSAT_SP	V					1		
13	Box Supply Air Trendlog		BxyzSAT_TL	TL					1	HDSAT,CDSAT,SAT,SAT_SP	
14	Minimum Flow Setpoint		BxyzFMIN_SP	V					1		
15	Maximum Flow Setpoint		BxyzFMAX_SP	V					1		
	Temperature Controller		BxyzRT_CO	CO					1	use RT:RT_SP	
	Flow Controller		BxyzF_CO	CO					1	use F:F_SP	
	Hot Duct Temp Controller		BxyzHDT_CO	CO					1	use SAT:SAT_SP	
	Hot Duct Flow Controller		BxyzHDF_CO	CO					1	use F:FMAX_SP	
16	Hot Duct Flow		BxyzHDF	VS2				1			
17	Hot Duct Flow Setpoint		BxyzHDF_SP	V					1		
18	Total Box Flow		BxyzF	V					1		
19	Total Box Flow Setpoint		BxyzF_SP	V					1		
20	Box Flow Trendlog		Bxyz_TL	V					1	HDF,CDF,F,F_SP	
	Total				0	1	2	4	17		

NOTE: x = Floor #

yz = Box # of Floor #

For VAV# and Box # see mechanical schedule

TPWA DUAL DUCT TUC (TYPE DD-B) - GRAPHIC



GENERIC START UP LOGIC

7 **Box Program Bxyz_PG**

```
BxyzRT_SP = 22.0
IF BxyzOR THEN BxyzOR_T = 60.0
DO EVERY 1 M
BxyzOR_T = BxyzOR_T - 1.0
IF BxyzOR_T < 0 THEN BxyzOR_T = 0
END_DO
BxyzCDD = BxyzF_CO
IF BxyzOR_T > 1 OR BxyzWS ON THEN
     BxyzF_SP = BxyzFMIN_SP + ((BxyzFMAX_SP - BxyzFMIN_SP) * (BxyzRT_CO/100))
ELSE
     BxyzF_SP = 0
BxyzSAT_SP = LIMIT((40 - BxyzRT_CO) 0, 40)
IF BxyzF_SP = BxyzFMIN_SP AND
BxyzRT < BxyzRT_SP - 0.8 THEN
     BxyzHDD = MIN(BxyzHDT_CO, BxyzHDF_CO)
IF BxyzF_SP > BxyzFMIN_SP OR
BxyzRT > BxyzRT_SP - 0.3 OR WS OFF THEN
     BxyzHDD = 0
BxyzF = BxyzHDF + BxyzCDF
BxyzF_SP = BxyzHDF_SP + BxyzCDF_SP
```

PMA DUAL DUCT TUC (TYPE DD-A) - POINTS LIST

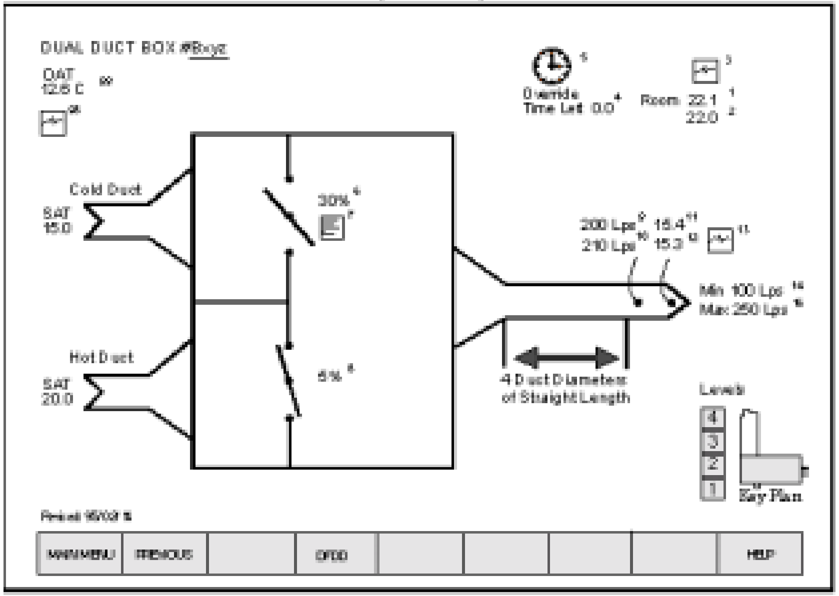
Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Room Temperature		BxyzRT	RTS1				1			
2	Room Temperature Setpoint		BxyzRT_SP	V					1		
3	Room Trendlog		BxyzRT_TL	TL					1	RT,RT_SP,F,SAT	
	Room Override		BxyzOR	RTS1		1				Button on sensor	
4	Room Override Time Left		BxyzOR_T	V					1	Set 60 min	
5	Room Weekly Schedule		BxyzWS	WS						See Spec 15925	
6	Cold Duct Damper		BxyzCDD	DA1			1				
7	Box Program		Bxyz_PG	PG					1		
8	Hot Duct Damper		BxyzHDD	DA1			1				
9	Flow		BxyzF	VS2				1			
10	Flow Setpoint		BxyzF_SP	V					1		
11	Box Supply Air Temperature		BxyzSAT	DTS2				1			
12	Box Supply Air Temp Setpoint		BxyzSAT_SP	V					1		
13	Box Supply Air Trendlog		BxyzSAT_TL	TL					1	HDSAT,CDSAT,SAT,SAT_SP	
14	Minimum Flow Setpoint		BxyzFMIN_SP	V					1		
15	Maximum Flow Setpoint		BxyzFMAX_SP	V					1		
	Temperature Controller		BxyzRT_CO	CO					1	use RT:RT_SP	
	Flow Controller		BxyzF_CO	CO					1	use F:F_SP	
	Hot Duct Temp Controller		BxyzHDT_CO	CO					1	use SAT:SAT_SP	
	Hot Duct Flow Controller		BxyzHDF_CO	CO					1	use F:FMAX_SP	
	Total				0	1	2	3	13		

NOTE: x = Floor #

yz = Box # of Floor #

For VAV# and Box # see mechanical schedule

"PMA DUAL DUCT TUC (TYPE DD-A) - GRAPHIC



GENERIC START UP LOGIC

7 **Box Program Bxyz_PG**

```
BxyzRT_SP = 22.0
IF BxyzOR THEN BxyzOR_T = 60.0
DO EVERY 1 M
BxyzOR_T = BxyzOR_T - 1.0
IF BxyzOR_T < 0 THEN BxyzOR_T = 0
END_DO
BxyzCDD = BxyzF_CO
IF BxyzOR_T > 1 OR BxyzWS ON THEN
    BxyzF_SP = BxyzFMIN_SP + ((BxyzFMAX_SP - BxyzFMIN_SP) * (BxyzRT_CO/100))
ELSE
    BxyzF_SP = 0
BxyzSAT_SP = LIMIT((40 - BxyzRT_CO) 0, 40)
IF BxyzF_SP = BxyzFMIN_SP AND
BxyzRT < BxyzRT_SP - 0.8 THEN
    BxyzHDD = MIN(BxyzHDT_CO, BxyzHDF_CO)
IF BxyzF_SP > BxyzFMIN_SP OR
BxyzRT > BxyzRT_SP - 0.3 OR WS OFF THEN
    BxyzHDD = 0
```

PMA CLIENT COMFORT SYSTEMS (CCS) - DESIGN MANUAL

5.V PRE-APPROVED VARIABLE AIR VOLUME AIR SYSTEM TYPES

Assumption:
All systems have one supply fan with an ASD and a full outside air economizer mixed air section.

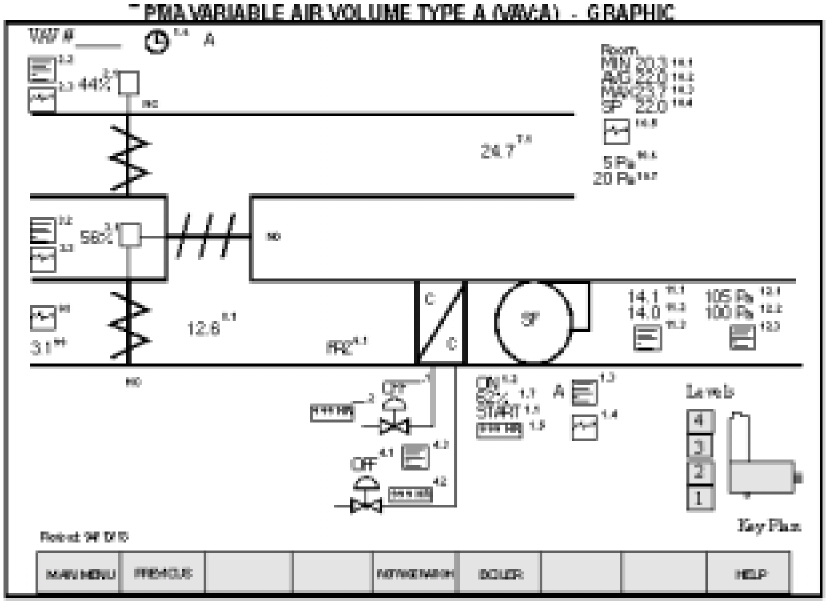
System Type	Return Fan	Modulating Heating	On Off Cooling	Modulating Cooling	Evaporative Cooling	Status	Updated
A			X			Approved	94/10/31
B				X		Approved	94/10/31
C				X	X	Approved	94/10/31
D		X	X			Approved	94/10/31
E		X		X		Approved	94/10/31
F		X		X	X	Approved	94/10/31
G	X		X			Approved	94/10/31
H	X			X		Approved	94/10/31
I	X			X	X	Approved	95/08/29
J	X	X	X			Approved	94/10/31
K	X	X		X		Approved	94/10/31
L	X	X		X	X	Approved	94/10/31
M	X	X				Approved	95/08/25

Custom
Z Same as Type B except non ducted relief damper (Q Lot) Approved 95/09/14

PMA VARIABLE AIR VOLUME TYPE A (VAV:A) - POINTS LIST

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop		SF	CR1	1						
1.2	Supply Fan Status		SF_S	V					1		
1.3	Supply Fan Program		SF_PG	PG					1		
1.4	Supply Fan Trendlog		SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours		SF_TZ	TZ					1		
1.6	Weekly Schedule		WS	WS					1		
1.7	Supply Fan ASD		SF_ASD	DDC			1				
2.1	Exhaust Air Damper		EAD	DA2			1				
2.2	Exhaust Air Damper Program		EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog		EAD_TL	TL					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper		MAD	DA2			1				
	Mixed Air Damper Controller		MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum		MAD_MIN	V					1		
	Mixed Air Damper Ramp		RAMP	V					1		
3.2	Mixed Air Program		MAD_PG	PG					1		
3.3	Mixed Air Trendlog		MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode		CLG_MODE	V					1		
4.1	Stage 1-DX		DX1	CR1	1						
4.2	DX1 Run Hours		DX1_TZ	TZ					1		
4.3	DX Program		CLG_PG	PG					1		
__.1	Stage -DX		DX__	CR1						As Required	
__.2	DX Run Hours		DX _TZ	TZ						As Required	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				2	1	3	5	26		

PMA VARIABLE AIR VOLUME TYPE A (VAV-A) - GRAPHIC



GENERIC START UP LOGIC

```
1.3 Supply Fan (SF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START SF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE
        SF_ASD = 0
2.2 Exhaust Air Damper (EAD_PG)
    BSP_SP = _____ DEFAULT = 20 Pa
    EAD = MAD - (BSP_SP - BSP)

3.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON THEN
            IF RAT < OAT THEN
                MAD = MAD_MIN
            ELSE
                MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0
```

```
4.3 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, STOP DX1
    ELSE
        CLG_MODE = OFF, STOP DX1
    [Cooling Stage 2]
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON FOR 15 MIN THEN
            START DX2
        IF RT_AVG < RT_SP + 1.0 AND
        RT_MAX < RT_SP + 1.7 THEN
            STOP DX2
    ELSE
        STOP DX2

11.3 Supply Air Temp (SAT_PG)
    RT_SP = ____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
12.3 Supply Air Pressure (SAP_PG)
    SAP_SP = ____ DEFAULT = 100 Pa
```

6.0 NAMING CONVENTION

System Type	Description	Status	Updated
SZ	Single Zone Air System	Approved	95/04/20
MZ	Multi-Zone Air System	Approved	95/04/20
DD	Dual Duct Air System	Approved	95/04/20
TR	Terminal Reheat Air System	Approved	95/04/20
VAV	Variable Volume Air System	Approved	95/04/20
BLR	Boiler System	Approved	95/04/20
HTG	Heating Water Systems	Approved	95/04/20
CLR	Chilled Water System	Approved	95/04/20
HP	Water Loop Heat Pump System	Approved	95/04/20
TP	Temperature Predictor	Approved	95/04/20

Property Management Agency. - CCS POINT NAMING CONVENTIO

(SZ) SINGLE ZONE AIR SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
SZ*			Single Zone System*	SZ, SZI
	SF		Supply Fan	SZ1_SF
	RF		Return Fan	SZ1_RF
	EF		Exhaust Fan	SZ1_EF
	SAT		Supply Air Temperature	SZ1_SAT
	RAT		Return Air Temperature	SZ1_RAT
	MAT		Mixed Air Temperature	SZ1_MAT
	SAH		Supply Air Humidity	SZ1_SAH
	RAH		Return Air Humidity	SZ1_RAH
	MAD		Mixed Air Dampers	SZ1_MAD
	OAD		Outside Air Dampers	SZ1_OAD
	EAD		Exhaust Air Dampers	SZ1_EAD
	CCV		Cooling Coil Valve	SZ1_CCV
	CLG		Cooling System	SZ1_CLG
	HCV		Heating Coil Valve	SZ1_HCV
	HTG		Heating System	SZ1_HTG
	PCV		Preheat Coil Valve	SZ1_PCV
	DX		Direct Expansion Valve	SZ3_DX2
	CCP		Cooling Coil Pump	SZ1_CCP
	HCP		Heating Coil Pump	SZ1_HCP
	PCP		Preheat Coil Pump	SZ1_PCP
	ECP		EvaporativeCooling Pump	SZ1_ECP
	FRZ		Freeze Detection	SZ1_FRZ
	RT		Room Temperature	SZ1_RT1
		S	Status	SZ1_PCP3_S
		SP	Setpoint	SZ1_SAT_SP
		CO	Controller	SZ1_SAT_CO
		HL	High Limit	SZ1_SAT_HL
		LL	Low Limit	SZ1_MAT_LL
		TZ	Totalizer	SZ1_SF_TZ
		TL	Trend Log	SZ1_TL
		MODE	Mode	SZ1_HTG_MODE
		PG	Program	SZ1_PG
		AL	Alarm	SZ1_SAT_AL

(MZ) MULTI-ZONE AIR SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
MZ*			Multi-Zone System*	MZ,MZ1
	SF		Supply Fan	MZ1_SF
	RF		Return Fan	MZ1_RF
	EF		Exhaust Fan	MZ1_EF
	RAT		Return Air Temperature	MZ1_RAT
	MAT		Mixed Air Temperature	MZ1_MAT
	CDT		Cold Deck Temperature	MZ1_CDT
	HDT		Hot Deck Temperature	MZ1_HDT
	SAH		Supply Air Humidity	MZ1_SAH
	RAH		Return Air Humidity	MZ1_RAH
	MAD		Mixed Air Dampers	MZ1_MAD
	OAD		Outside Air Dampers	MZ1_OAD
	EAD		Exhaust Air Damper	MZ1_EAD
	CCV		Cooling Coil Valve	MZ1_CCV
	CLG		Cooling System	MZ1_CLG
	HCV		Heating Coil Valve	MZ1_HCV
	HTG		Heating System	MZ1_HTG
	PCV		Preheat Coil Valve	MZ1_PCV
	DX		Direct Expansion Valve	MZ1_DX2
	CCP		Cooling Coil Pump	MZ1_CCP
	HCP		Heating Coil Pump	MZ1_HCP
	PCP		Preheat Coil Pump	MZ1_PCP
	ECP		Evaporative Cooling Pump	MZ1_ECP
	FRZ		Freeze Detection	MZ1_FRZ
	Z***		Zone *** Control	MZ1_Z8
	|---->	D	Deck Mixing Dampers	MZ1_Z8D
	|---->	RT	Room Temperature	MZ1_Z8_RT
	|---->	SAT	Supply Air Temp.	MZ1_Z4_SAT
		S	Status	MZ1_PCP4_S
		SP	Setpoint	MZ1_SAT_SP
		CO	Controller	MZ1_Z8_CO
		MIN	Minimum	MZ1_RT_MIN
		AVG	Average	MZ1_RT_AVG
		MAX	Maximum	MZ1_ZD_MAX
		TZ	Totalizer	MZ1_SF_TZ
		TL	Trend Log	MZ1_TL
		MODE	Mode	MZ1_CLG_MODE
		PG	Program	MZ1_MAD_PG
		AL	Alarm	MZ1_MAT_AL

(DD) DUAL DUCT AIR SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
DD*			Dual Duct System*	DD,DD1
	SF		Supply Fan	DD1_SF
	RF		Return Fan	DD1_RF
	EF		Exhaust Fan	DD1_EF
	SAT		Supply Air Temperature	DD1_SAT
	RAT		Return Air Temperature	DD1_RAT
	MAT		Mixed Air Temperature	DD1_MAT
	CDT		Cold Deck Temperature	DD1_CDT
	HDT		Hot Deck Temperature	DD1_HDT
	SAH		Supply Air Humidity	DD1_SAH
	RAH		Return Air Humidity	DD1_RAH
	MAD		Mixed Air Dampers	DD1_MAD
	OAD		Outside Air Dampers	DD1_OAD
	EAD		Exhaust Air Dampers	DD1_EAD
	CCV		Cooling Coil Valve	DD1_CCV
	DX		D X Cooling Stage	DD1_DX1
	CLG		Cooling System	DD1_CLG
	HCV		Heating Coil Valve	DD1_HCV
	PCV		Preheat Coil Valve	DD1_PCV
	HTG		Heating System	DD1_HTG
	CCP		Cooling Coil Pump	DD1_CCP
	HCP		Heating Coil Pump	DD1_HCP
	PCP		Preheat Coil Pump	DD1_PCP
	FRZ		Freeze Detection	DD1_FRZ
		B	Box *** Terminal Equip	DD1_B216
	|---->	D	Box Dampers	DD1_B216D
	|---->	RT	Room Temperature	DD1_B216_RT
		S	Status	DD1_PCP_S
		SP	Setpoint	DD1_SAT_SP
		CO	Controller	DD1_B216_CO
		MIN	Minimum	DD1_RT_MIN
		AVG	Average	DD1_D_AVG
		MAX	Maximum	DD1_RT_MAX
		MODE	Mode	DD1_CLG_MODE
		TZ	Totalizer	DD1_SF_TZ
		TL	Trend Log	DD1_TL
		PG	Program	DD1_PG
		AL	Alarm	DD1_SF_AL

(TR) TERMINAL REHEAT AIR SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
TR*			Term Reheat Sys*	TR,TR1
	SF		Supply Fan	TR1_SF
	RF		Return Fan	TR1_RF
	EF		Exhaust Fan	TR1_EF
	SAT		Supply Air Temperature	TR1_SAT
	RAT		Return Air Temperature	TR1_RAT
	MAT		Mixed Air Temperature	TR1_MAT
	SAH		Supply Air Humidity	TR1_SAH
	RAH		Return Air Humidity	TR1_RAH
	MAD		Mixed Air Dampers	TR1_MAD
	OAD		Outside Air Dampers	TR1_OAD
	EAD		Exhaust Air Dampers	TR1_EAD
	CCV		Cooling Coil Valve	TR1_CCV
	CLG		Cooling System	TR1_CLG
	HCV		Heating Coil Valve	TR1_HCV
	HTG		Heating System	TR1_HTG
	PCV		Preheat Coil Valve	TR1_PCV
	CCP		Cooling Coil Pump	TR1_CCP
	HCP		Heating Coil Pump	TR1_HCP
	PCP		Preheat Coil Pump	TR1_PCP
	DX		Direct Expansion Valve	TR1_DX2
	ECP		Evaporative Cooling Pump	TR1_ECP
	FRZ		Freeze Detection	TR1_FRZ
	RT		Room Temperature	TR1_RT5
	Z***		Zone *** Terminal Equip	TR1_Z8
	|---->		Reheat Coil Valve	TR1_Z8_RCV
	|---->		Room Temperature	TR1_Z8_RT
	|---->		Perim Rad Valve	TR1_Z8_RAD
	|---->		Perim Panel Valve	TR1_Z8_PAN
		S	Status	TR1_PCP_S
		SP	Setpoint	TR1_SAT_SP
		CO	Controller	TR1_Z8_CO
		LL	Low Limit	TR1_MAT_LL
		TZ	Totalizer	TR1_SF_TZ
		TL	Trend Log	TR1_TL
		MODE	Mode	TR1_CLG_MODE
		PG	Program	TR1_MAD_PG
		AL	Alarm	TR1_DX2_AL

(VV) VARIABLE VOLUME AIR SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
VAV			VAV System*	VAV,VAV1
V**			VAV System For # > 9	V12
	EF		Exhaust Fan	VAV1_EF
	SF		Supply Fan	VAV1_SF
	SFV		Supply Fan Vanes	VAV1_SFV
	SF_ASD		Supply Fan Variable Speed	VAV1_SF_ASD
	RF		Return Fan	VAV1_RF
	RFV		Return Fan Vanes	VAV1_RFV
	RF-ASD		Return Fan Variable Speed	VAV1_RF_ASD
	SVP		Supply Velocity Press	VAV1_SVP
	RVP		Return Velocity Press	VAV1_RVP
	DSP		Duct Static Pressure	VAV1_DSP
	BSP		Building Static Pressure	VAV1_BSP
	SAT		Supply Air Temperature	VAV1_SAT
	RAT		Return Air Temperature	VAV1_RAT
	MAT		Mixed Air Temperature	VAV1_MAT
	SAH		Supply Air Humidity	VAV1_SAH
	RAH		Return Air Humidity	VAV1_RAH
	MAD		Mixed Air Dampers	VAV1_MAD
	OAD		Outside Air Dampers	VAV1_OAD
	EAD		Exhaust Air Dampers	VAV1_EAD
	CCV		Cooling Coil Valve	VAV1_CCV
	CLG		Cooling System	VAV1_CLG
	HCV		Heating Coil Valve	VAV1_HCV
	HTG		Heating System	VAV1_HTG
	PCV		Preheat Coil Valve	VAV1_PCV
	DX		Direct Expansion Valve	VAV1_DX3
	CCP		Cooling Coil Pump	VAV1_CCP
	HCP		Heating Coil Pump	VAV1_HCP
	PCP		Preheat Coil Pump	VAV1_PCP
	ECP		Evaporative Cooling Pump	VAV1_ECP
	FRZ		Freeze Detection	VAV1_FRZ
	B***		Box *** Term Equip Ctrl	VAV1_B216
	|---->	D	VAV Box Dampers	VAV1_B216D
	|---->	F	VAV Box Flow Rate	VAV1_B101F
	|---->	RT	VAV Room Temperature	VAV1_B216_RT
	|---->	V	VAV Heating Valve	V12_B216V
	|---->	RAD	VAV Rad Control	V12_B216_RAD
		S	Status	V12_PCP_S
		SP	Setpoint	V12_SAT_SP
		CO	Controller	V12_HCV_CO
		TZ	Totalizer	V12_SF_TZ
		TL	Trend Log	V12_TL
		MODE	Mode	V12_HTG_MODE
		PG	Program	V12_PG
		AL	Alarm	V12_FRZ_AL

Updated 950420 AEF

(BLR) BOILER SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
BLR			Boiler System	BLR, BLR1
HTG			Heating System	HTG_P
	ENBL		Enable	BLR_ENBL
	SWT		Supply Water Temp	BLR_SWT
	RWT		Return Water Temp	BLR_RWT
	GV		Gas Valve	BLR-GV
	LO		Low Fire gas or oil	BLR_LO
	HI		High Fire gas or oil	BLR_HI
	EL		Electric Boiler Stage	BLR_EL1
	P		Pump	BLR_P4
	FS		Flow Switch	BLR_FS
		S	Status	BLR_P4_S
		SP	Setpoint	BLR_SWT_SP
		CO	Controller	BLR_GV_CO
		TZ	Totalizer	BLR_TZ
		TL	Trend Log	BLR_TL
		PG	Program	BLR_PG
		MODE	Mode	HTG_MODE
		AL	Alarm	BLR_AL

HEATING WATER SYSTEMS

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	SYS. POINT	FUNC.		
HTG			Heating	HTG
RAD			Radiation System	RAD
RHT			Reheat System	RHT
PHT			Preheat System	PHT
PAN			Radiant Panel System	PAN
GLY			Glychol System	GLY
DHW			Domestic Hot Water System	DHW
	SWT		Supply Water Temp	RAD_SWT
	RWT		Return Water Temp	HTG_RWT
	SWT		Supply Glycol Temp	GLY_SWT
	RGT		Return Glycol Temp	GLY_RWT
	V		Control Valve	PAN_V
	P		Pump	DHW_P5
	FS		Flow Swich	HTG_FS
		S	Status	RAD_P4_S
		SP	Setpoint	RHT_SWT_SP
		CO	Controller	RAD_SWT_CO
		TZ	Totalizer	PHT_P2_TZ
		TL	Trend Log	RAD_TL
		MODE	Mode	HTG_MODE
		PG	Program	DHW_PG
		AL	Alarm	RAD_P4_AL

CHILLED WATER SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
CLR			Chiller System	CLR,CLR1
CT			Cooling Tower	CT
CLG			Cooling System	CLG
	ENBL		Enable	CLR_ENBL
	SWT		Supply Water Temp	CT_SWT
	RWT		Return Water Temp	CT_RWT
	BPV		Bypass Valve	CT_BPV
	V		Valve	CLG_V
	CR		Chiller Reset	CLR_CR
	CL		Chiller Limit	CLR_CL
	CS		Compressor Stage	CLR_CS1
	VANE		Chiller Vanes	CLR_VANE
	P		Pump	CLG_P3
	D		Damper	CT_D
	P_ASD		Variable Speed Pump	CLG_P_ASD
	F		Fan	CT_FAN1
	DV		Dump Valve	CT_DV
	FS		Flow Swich	CLR_FS
		S	Status	CLG_P4_S
		SP	Setpoint	CLR_VANE_SP
		CO	Controller	CLG_V_CO
		TZ	Totalizer	CLR_CS1_TZ
		TL	Trend Log	CT_TL
		PG	Program	CT_PG
		MODE	Mode	CLG_MODE
		AL	Alarm	CLR_CS1_AL

Property Management Agency. - CCS POINT NAMING CONVENTIO

WATER LOOP

(HP) HEAT PUMP SYSTEM

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
HP*			Heat Pump System*	HP
	CTF		Cooling Tower Fan	HP_CTF
	CTP		Cooling Tower Pump	HP_CTP
	P		Pump	HP_P1
	SWT		Loop Supply Temperature	HP_SWT
	RWT		Loop Return Temperature	HP_RWT
	CV		Cooling Valve	HP_CV
	HV		Heating Valve	HP_HV
	BLR		Boiler	HP_BLR
			Ht.Pump *** Terminal Equip	HP216
	|---->	C	Compressor	HP216_C
	|---->	F	Fan Control	HP216_F
	|---->	RT	Room Temperature	HP216_RT
	|---->	REV	Mode (HTG/CLG)	HP216_REV
	|---->	SAT	Supply Air Temp	HP216_SAT
		S	Status	HP_P1_S
		SP	Setpoint	HP_SWT_SP
		CO	Controller	HP_RWT_CO
		MIN	Minimum	HP_RT_MIN
		AVG	Average	HP_RT_AVG
		MAX	Maximum	HP_RT_MAX
		TZ	Totalizer	HP_P1_TZ
		TL	Trend Log	HP_TL
		PG	Program	HP_PG
		AL	Alarm	HP_RT_MIN_AL

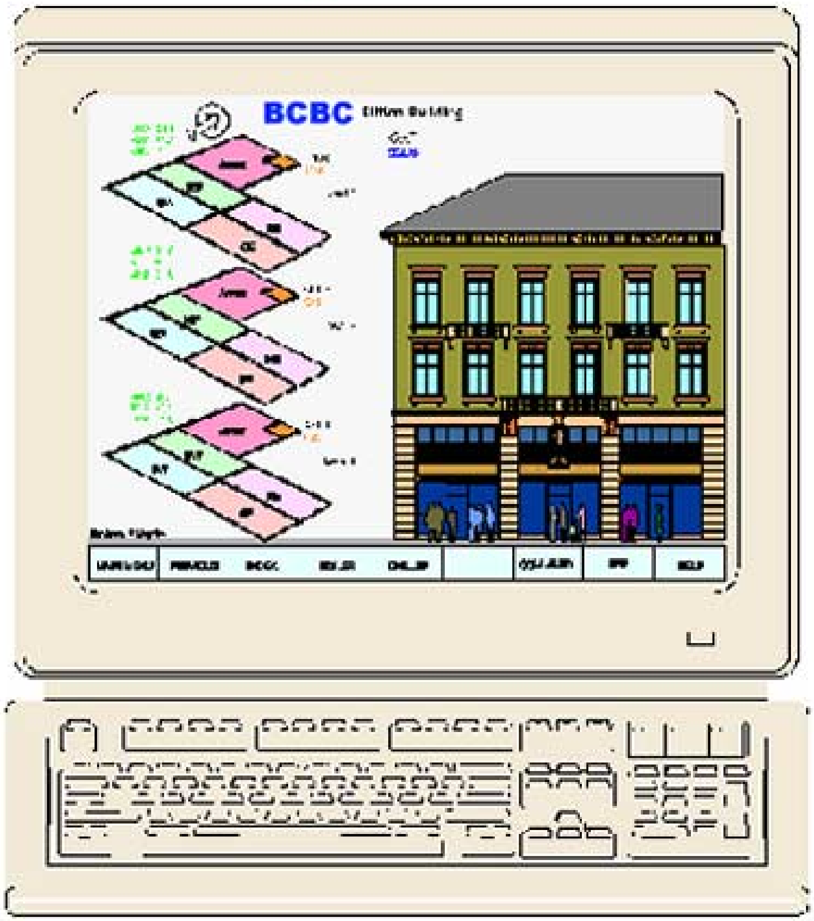
NOTE: Position of reversing valve will be as per units.
ie, Point Name = hp216_rev ,Units = heat or cool

(TP) TEMPERATURE PREDICTOR

MNEMONIC			MNEMONIC DESCRIPTION	EXAMPLES
SYS.	POINT	FUNC.		
TP			Temperature Predictor	TP
	OAS		Outside Air Sensor	TP_OAS
	OAT		Outside Air Temp	TP_OAT
	PHT		Predicted High Temp	TP_PHT
	PLT		Predicted Low Temp	TP_PLT
	DH		Day's High Temperature	TP_DH
	DL		Day's Low Temperature	TP_DL
	YTD		Yesterday's Temp Diff	TP_YTD
	BOT		Building Objective Temp.	TP_BOT
	HDH		Hour of Day's High	TP_HDH
	HDL		Hour of Day's Low	TP_HDL
	SUN		Hour of Sunrise	TP_SUN
		PG	Program	TP_PG

PROPERTY MANAGEMENT AGENCY

CLIENT COMFORT SYSTEM
GRAPHICS GUIDELINES



Guideline Contents

1. *Introduction*

These graphic guidelines have been developed to provide standardization in concepts and quality for the computerized color graphics that are part of the Client Comfort Systems.

This document should in no way impede your creative side to generate custom graphics for each project. Its purpose is to provide guidelines as to the minimum requirements of your graphic set and to standardize graphic controlled hot spots and how we move through the graphic set.

The general concepts graphically presented in Section 2 provide the basis of the guidelines. Please forward your perceptions and comments on any aspect of the guideline so that we may consider inclusion in future updates. Please fax all your comments to Director, Energy and Environment 387-1878.

General Concepts

The following overview shows the inter-relationship of mandatory graphics. The guideline is intended to provide conventions for movement and symbolism for graphics. Since the graphic set will be operated in the Windows environment use of left upper corner should be left blank for access to pull down menus. Vendor operating systems also use this area. The right corner should be left blank as several systems use this area to display the time. Avoid putting any information or active icons close to the edge of the screen as this may cause problems when sizing windows and or problems with screen setup with various monitors. Determine where vendors display their alarm lines and avoid conflict. Most alarm lines overwrite existing graphics so display is not a major concern, but active icons are if they appear under the alarm line.

<u>Mandatory Requirements</u>

Graphic Title - The graphic title will be located at the top of each screen.

Date - Each graphic will be dated with the last update.

Key Plan - A key plan will be provided in the lower right hand corner with each graphic screen showing the related floor area plus the number of floors or levels. The shaded area will depict the area served by this graphic. Clicking on the level or floor number will present the corresponding location on that floor graphic. Clicking on the non-shaded areas will present the graphic representing that area on the same floor.

Menu Bar - The menu bar will be located at the bottom of each screen, not to interfere with the alarming line. The bar must be placed exactly in the same location on each screen to allow browsing through the system by clicking on the buttons without moving the mouse.

MAIN MENU The return to the Main Menu must always be in the furthest left location of the bar on all graphics.

PREVIOUS The Previous graphic button must be second from the left on all graphics.

Special Custom button(s) Commands particular to the graphic screen.

COMMAND The Command mode button must be third from the right on main menu only.

BYE Sign off will always be the second from the far right on main menu and index.

HELP Help will always be on the far right of the menu bar on all graphics.

The above is to standardize movement throughout the graphic set.

<u>Point Convention</u>
The actual point will be located as close as possible to the graphical representation of actual location. If the point has an associated setpoint this point will be located directly below the actual point and be in a different colour.

<u>ON OFF Status Convention</u>
Status point of equipment will be defined as ON or OFF and located on top of command points.

<u>Command Points</u>
Command points should be defined as Start/Stop or Enable/Disable, etc, but not as ON/OFF.

<u>Weekly Schedules</u>
Weekly schedules will be symbolized by a clock icon. Access will be from every time controlled system plus the Index. The Index will take you to a screen of all time schedules whereas time controlled points on a particular system graphic will take you only to the controlling schedule.

<u>Trend Data/Graphs</u>

Trend graphs will be symbolized by a box with a graph line icon. Icon will be placed near the actual analog point that will be trended. On floor graphic, the sensor symbol will become an icon to access trend data for that zone.

<u>OCL Programs</u>
Will be symbolized by a box with a horizontal lines icon and will be accessed from every output. This concept will tie in with the Corporation's concept of output oriented code.

<u>Runtime Hours</u>
Runtime hours will be symbolized by 999 HR in a box. This icon will be placed as close as possible to the actual point being totalized. The actual total hours will replace the 999 HR on the screen. Clicking on the icon will provide more information.

<u>Text Size</u>
Text size should be large enough to be easily read. If you must reduce text size to get all information in you need a further zoom graphic. Use a pleasing color contrast between lettering and background.

<u>Use Of Colour</u>
- Avoid using too much color. Without planning you could over use color and actually detract from the visual impact, as well as causing eye strain.

- Attempt to match the visual impact of color with the importance of the information.

Eg:
- bright red or yellow for alarm information;
- next brightest color for dynamic information such as temperature and status;
- next brightest color for action items such as icons;
- darker color for passive, but important information such as schematic lines;
- pastel color for passive, less important information such as backgrounds.

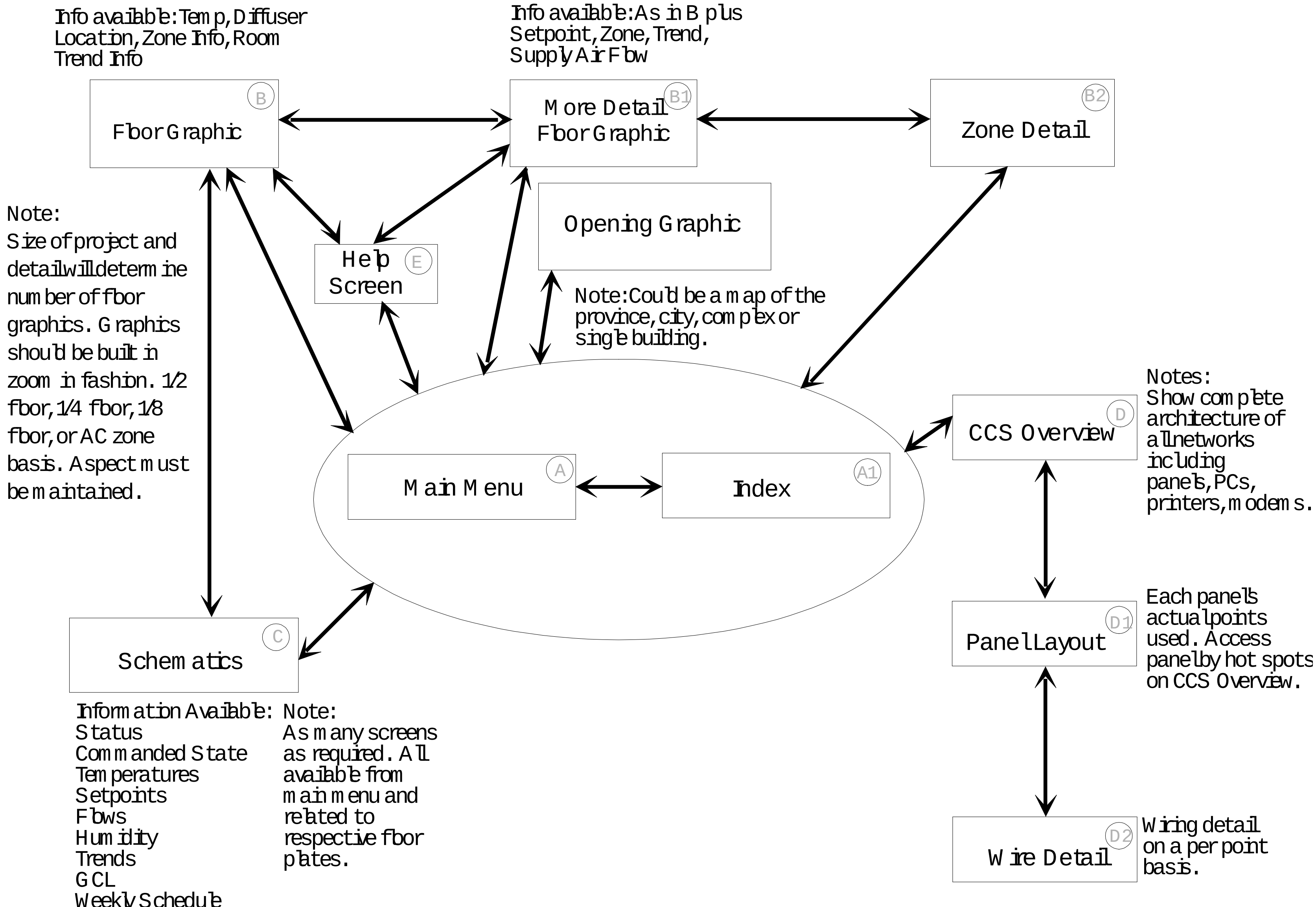
- Attempt to maintain color consistency, ie all air systems similar, all hot water lines the same color, all chilled water lines the same.

The examples in these guidelines show one way of interpreting the use of color following these suggestions.

2. *Graphic Concepts*

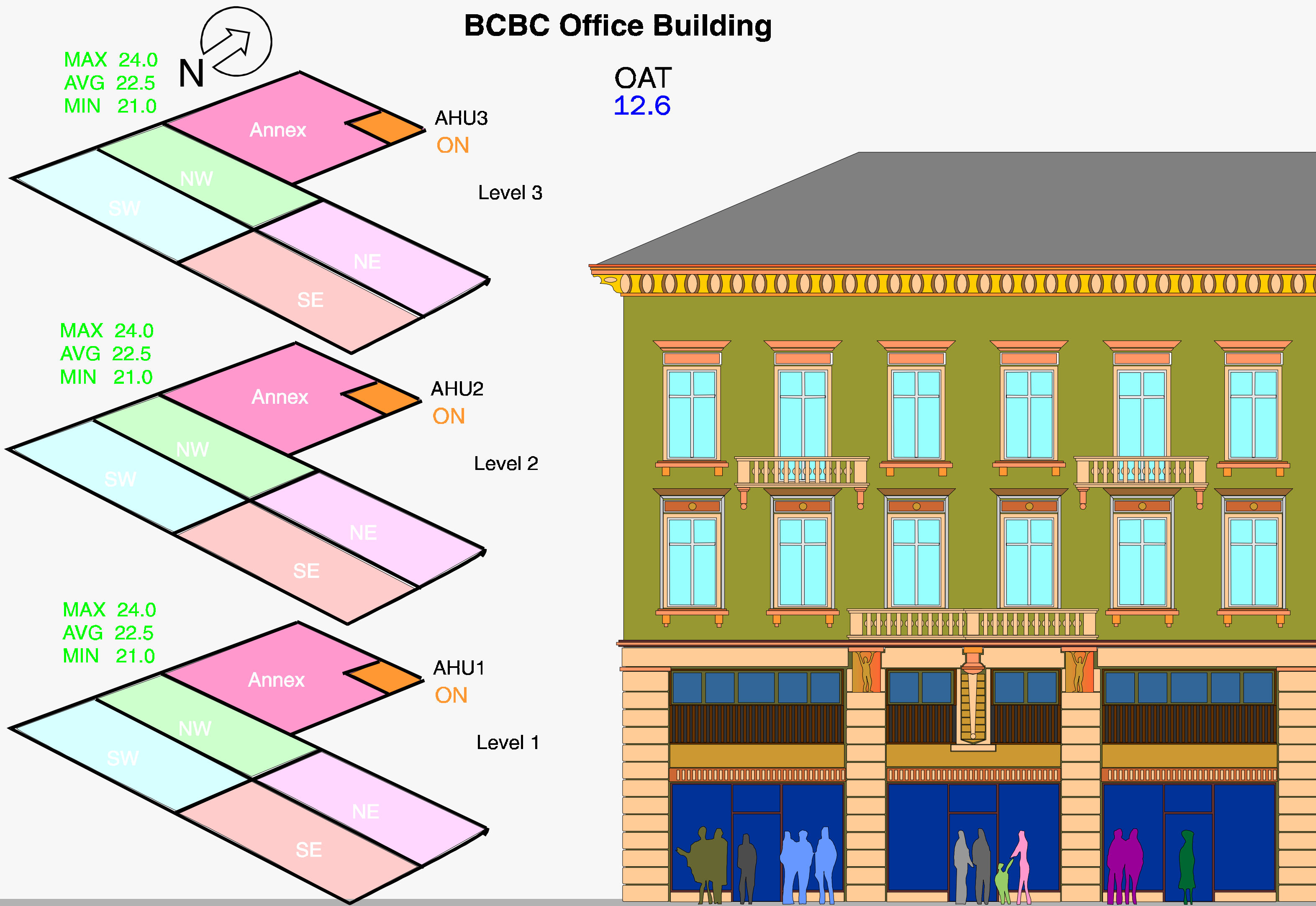
.1 Graphic Overview of Inter-relationships
.2 Main Menu Graphic - A
.3 Index Graphic - A1
.3 Floor Graphic - B
.4 Details Floor Graphic B1
.4 AHU Graphic - C
.5 CCS Graphic - D
.6 Help Graphic - E

GRAPHICS OVERVIEW



NOTE: ALL GRAPHICS RETURN TO MAIN MENU

BCBC Office Building



A1

INDEX

- Main Menu
- Annex Level1
- Annex Level2
- Annex Level3
- NW Level1
- SW Level1
- SE Level1
- NE Level1
- NW Level2
- SW Level2
- SE Level2
- NE Level2
- NW Level3
- SW Level3
- SE Level3
- NE Level3

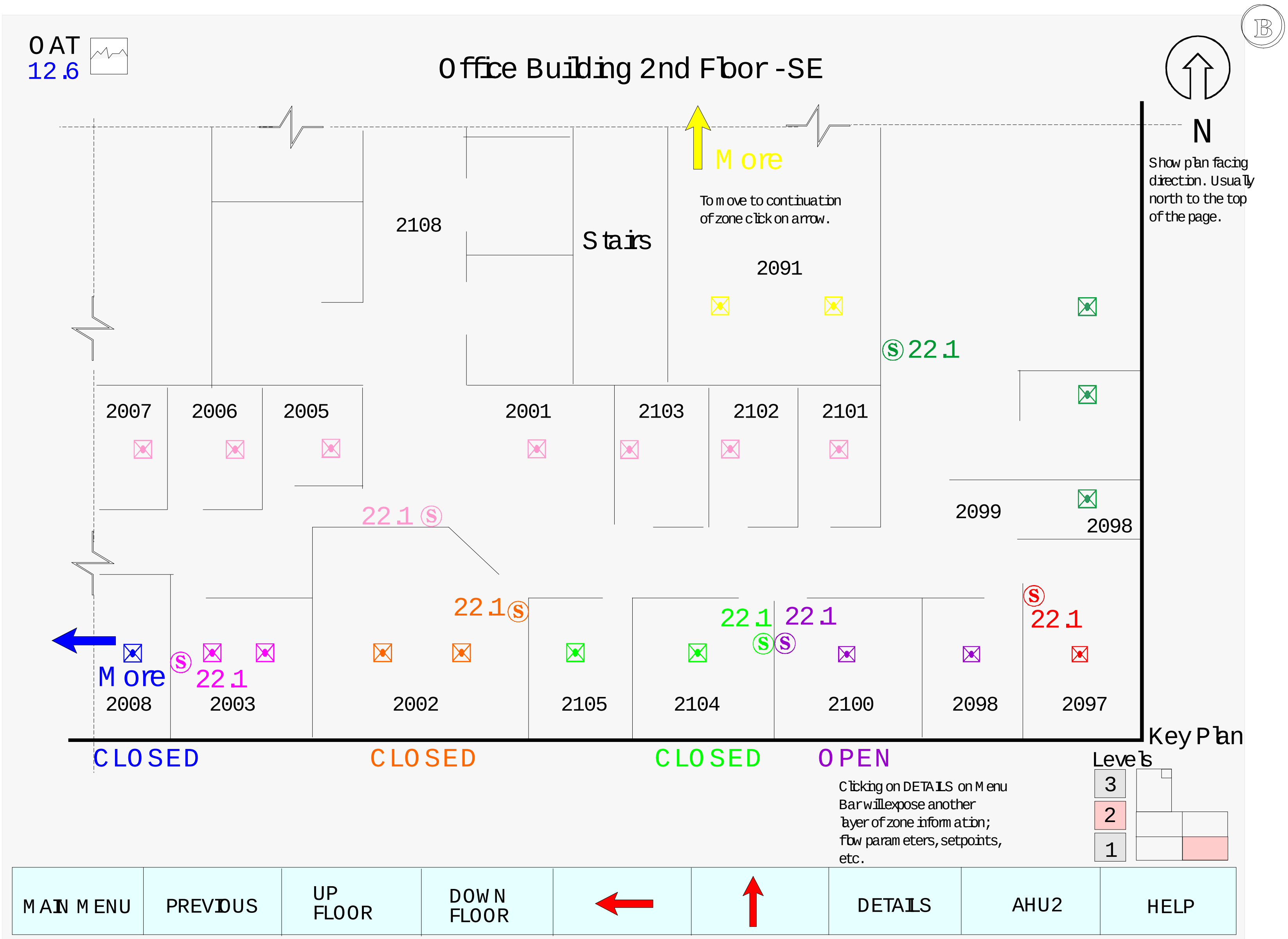
- Mechanical Equipment Overview
- AHU 1 Schematic
- AHU 2 Schematic
- AHU 3 Schematic
- Boilers Schematic
- Heating Pumps Flow Diagram
- Chillers Schematic
- Chilled Water Flow Diagram
- Client Complaint Database (optional)
- Client Contact Information (optional)
- Contractor Contact List (optional)
- CCS Support Personnel (optional)
- Message Bin (optional)

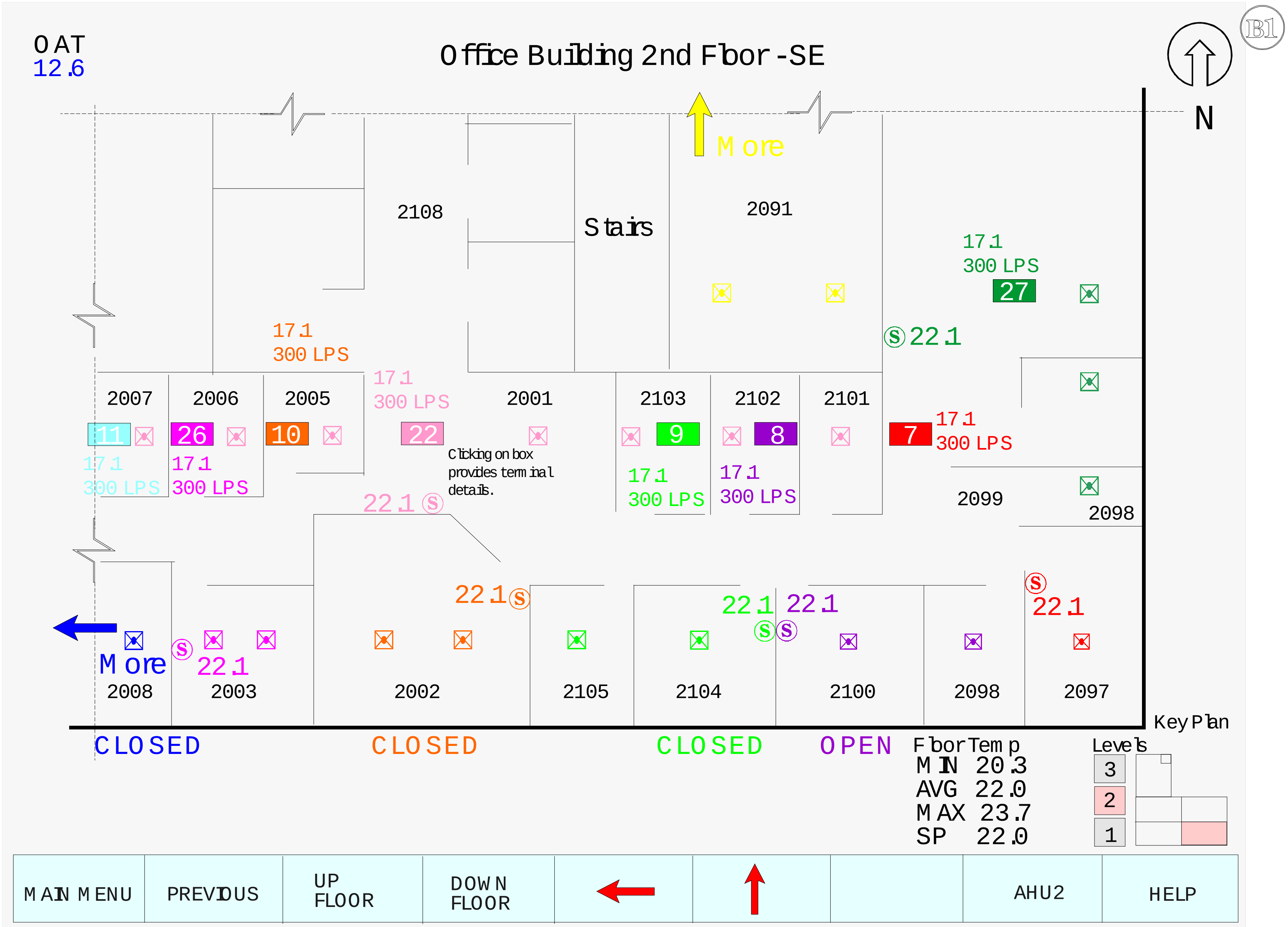
- CCS Overview
- Software Strategy Overview
- Energy Consumption Summary (optional)
- Runtime Summary
- Time Schedules
- Fire/Life Safety Plan (optional)

NOTE: IF POSSIBLE PROVIDE ACCESS TO EVERY GRAPHIC DIRECTLY FROM THIS MENU BY CLICKING ON THE BULLET OR LABEL.

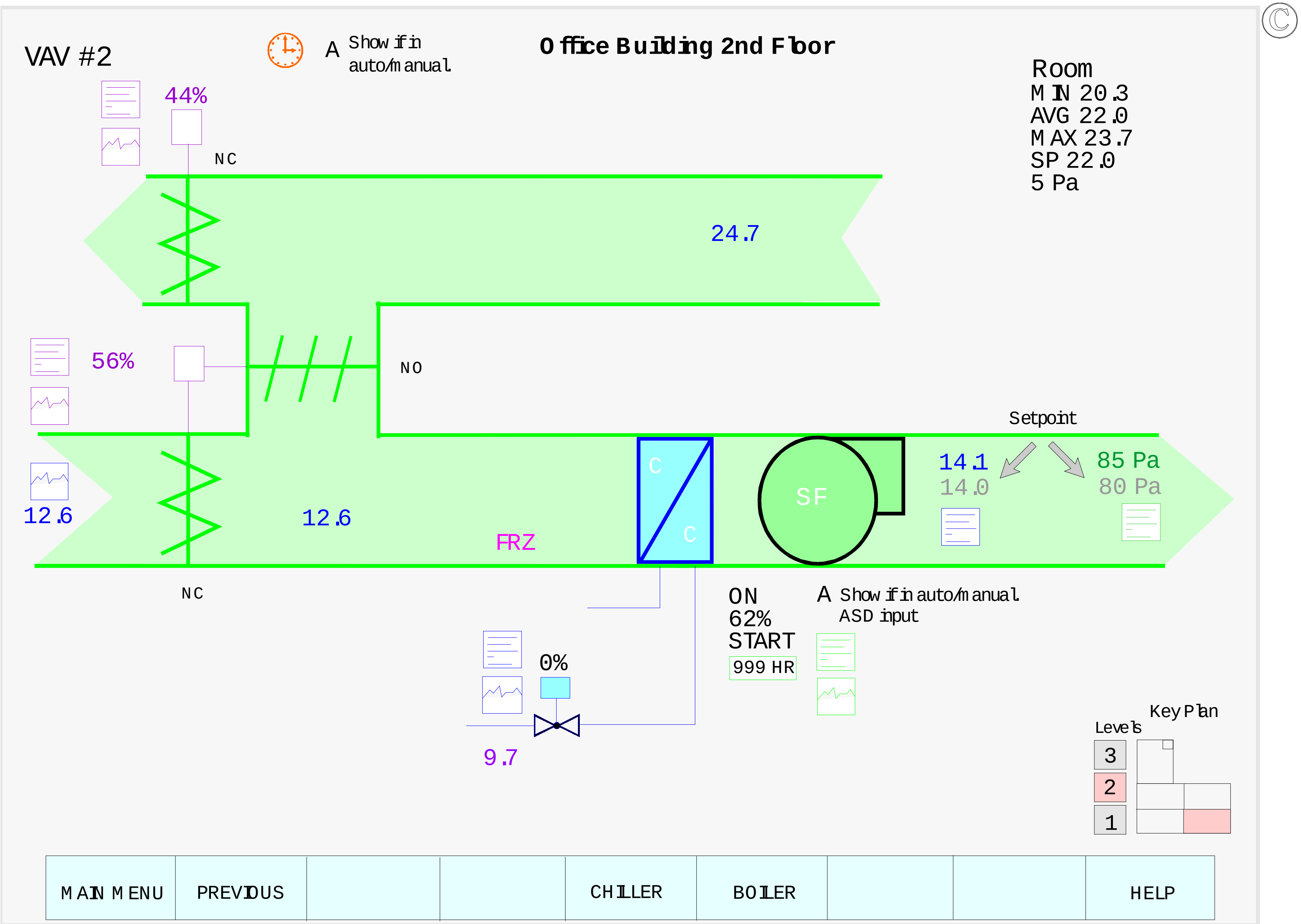
DEPENDS ON TOTAL NUMBER AND COMPLEXITY OF GRAPHICS.

MAIN MENU	PREVIOUS					COMMAND	BYE	HELP

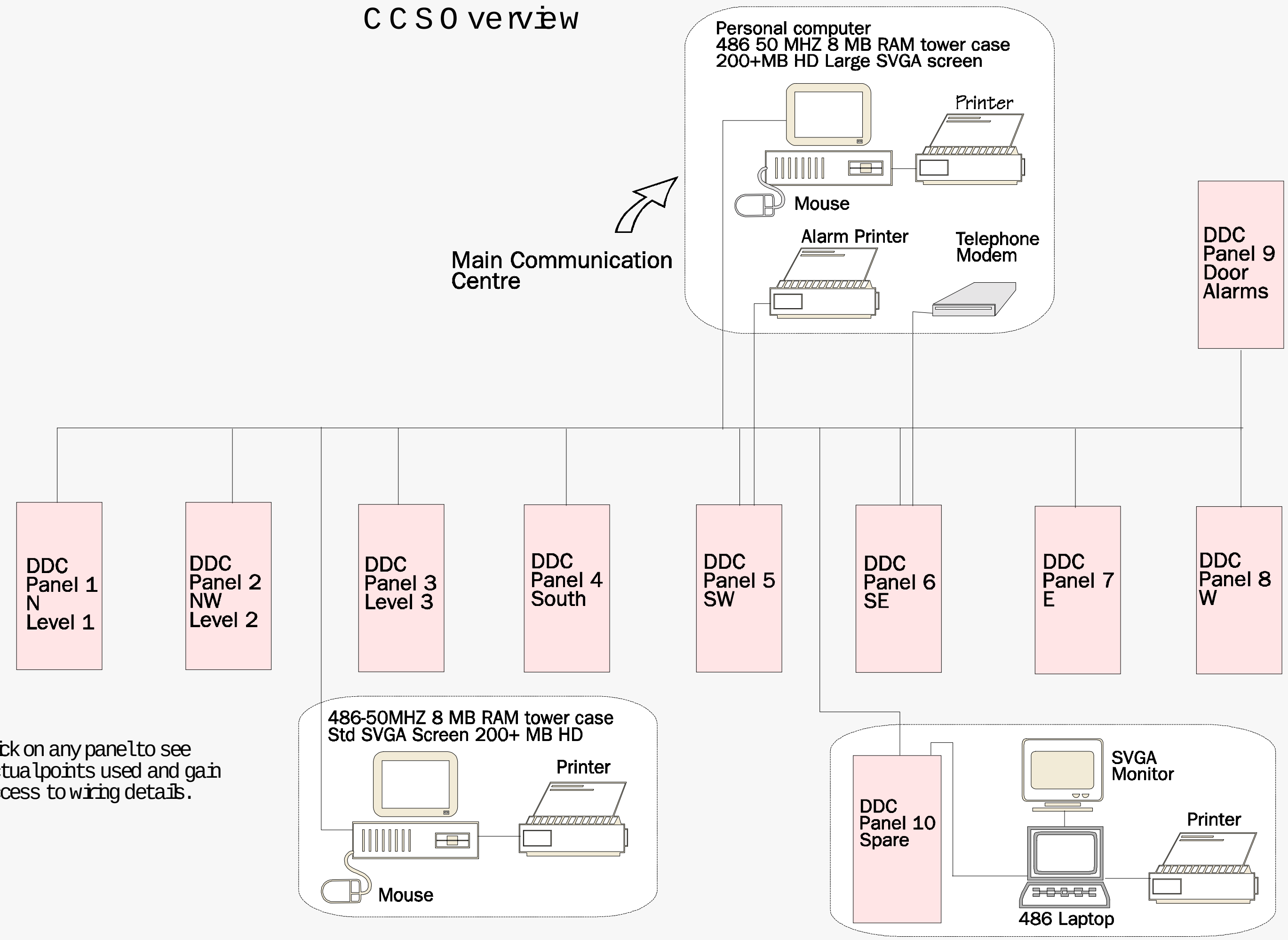

OAT
12.6
Office Building 2nd Floor - SE
N
Show plan facing direction. Usually north to the top of the page.
More
To move to continuation of zone click on arrow.
2108
Stairs
2091
22.1
2007
2006
2005
2001
2103
2102
2101
2099
2098
22.1
22.1
22.1
22.1
22.1
22.1
More
2008
2003
2002
2105
2104
2100
2098
2097
CLOSED
CLOSED
CLOSED
OPEN
Key Plan
Levels
3
2
1
Clicking on DETAILS on Menu Bar will expose another layer of zone information; flow parameters, setpoints, etc.
MAIN MENU
PREVIOUS
UP FLOOR
DOWN FLOOR
DETAILS
AHU2
HELP



OAT
12.6
Office Building 2nd Floor - SE
N
More
2108
Stairs
2091
17.1
300 LPS
27
22.1
2007
2006
2005
2001
2103
2102
2101
11
26
10
22
9
8
7
Clicking on box provides terminal details.
2099
2098
More
2008
2003
2002
2105
2104
2100
2098
2097
CLOSED
CLOSED
CLOSED
OPEN
Floor Temp
MIN 20.3
AVG 22.0
MAX 23.7
SP 22.0
Key Plan
Levels
3
2
1
MAIN MENU
PREVIOUS
UP FLOOR
DOWN FLOOR
AHU2
HELP

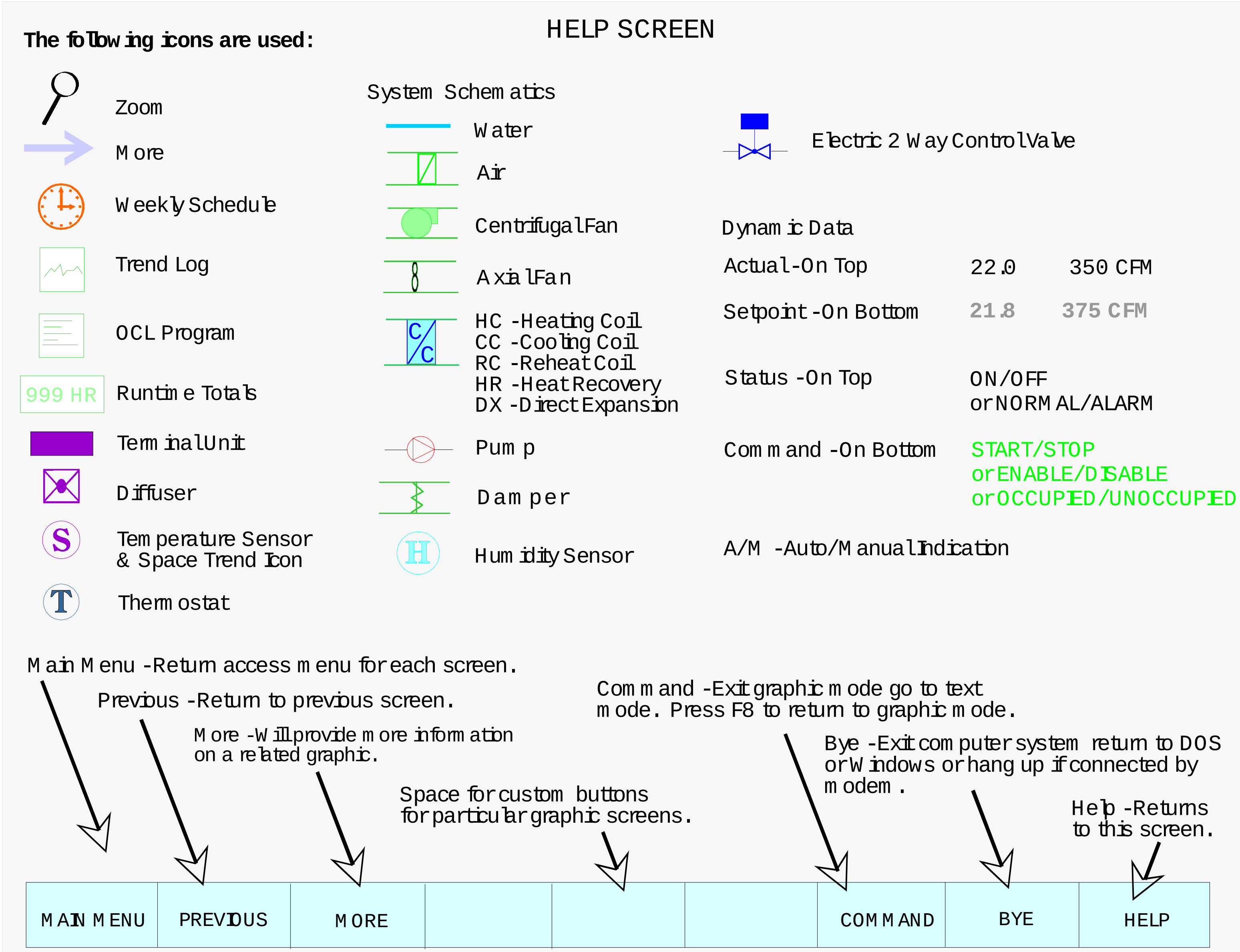

VAV #2
A Show if in auto/manual
Office Building 2nd Floor
Room
MIN 20.3
AVG 22.0
MAX 23.7
SP 22.0
5 Pa
44%
NC
24.7
56%
NO
Setpoint
12.6
12.6
FRZ
C
C
SF
14.1
14.0
85 Pa
80 Pa
NC
ON
62%
START
999 HR
A Show if in auto/manual
ASD input
0%
9.7
Key Plan
Levels
3
2
1
MAIN MENU
PREVIOUS
CHILLER
BOILER
HELP

CCS Overview



Click on any panel to see actual points used and gain access to wiring details.

MAIN MENU	PREVIOUS			PANELS		COMMAND	BYE	HELP


HELP SCREEN
The following icons are used:
Zoom
More
Weekly Schedule
Trend Log
OCL Program
999 HR
Runtime Totals
Terminal Unit
Diffuser
S
Temperature Sensor & Space Trend Icon
T
Thermostat
System Schematics
Water
Air
Centrifugal Fan
Axial Fan
C
C
HC - Heating Coil
CC - Cooling Coil
RC - Reheat Coil
HR - Heat Recovery
DX - Direct Expansion
Pump
Damper
H
Humidity Sensor
Electric 2 Way Control Valve
Dynamic Data
Actual - On Top
22.0
350 CFM
Setpoint - On Bottom
21.8
375 CFM
Status - On Top
ON/OFF
or NORMAL/ALARM
Command - On Bottom
START/STOP
or ENABLE/DISABLE
or OCCUPIED/UNOCCUPIED
A/M - Auto/Manual Indication
Main Menu - Return access menu for each screen.
Previous - Return to previous screen.
More - Will provide more information on a related graphic.
Space for custom buttons for particular graphic screens.
Command - Exit graphic mode go to text mode. Press F8 to return to graphic mode.
Bye - Exit computer system return to DOS or Windows or hang up if connected by modem.
Help - Returns to this screen.
MAIN MENU
PREVIOUS
MORE
COMMAND
BYE
HELP

3. *Concepts to Speed Graphic Generation*

.1 File Conversion
Several complexes have computerized the space management floor plates on an AutoCad system. Most AutoCad system information can be transferred electronically to most file formats. In most cases too much information is stored on AutoCad for good video screen presentation graphics. It is normally necessary to sit with a CAD operator and get only the simplest floor plate information on the screen and remove all layers before output to .DXF files. Text information usually causes problems as the fonts are different in most manufacturers' graphic systems. It is often easier to add text later in the font you wish. Major clean up is usually required with most file conversions.

.2 Screen Capture
If file conversion is not an option, screen capture should be considered if system supports bit map type graphics. Resolution of graphics are limited by overall screen resolution. Problems are often caused later if graphics need to be edited. Original graphics programs must be used requiring two sets of graphic records. Screen capture does not allow re-sizing once screen is captured. Usually not applicable to vector type graphics except if third party conversion programs are used. This is a workable but painful method.

.3 Scanning
If the information required to be turned into graphics is not available in electronic media, paper media can be scanned and digitized into computer files. Most scanners support many file types. These files can then be converted using file conversion routines into the required format. Low cost hand scanners can be used for low volumes of work but bed type scanners are preferred for large volumes plus the need to auto stitch scanned strips is eliminated.

.4 Transparency Tracing
When a scanner is not available or drawings have more data than required, transparency tracing offers a manual method of quickly tracing only the information you require off a drawing. First photocopy the drawing to be traced on to a clear transparency like the ones used for overheads. Then tape the transparency to your screen and trace under the transparency using the preferred drawing package. This method works amazingly well allowing for quick transfer of the pertinent data. If you have access to a reducing/expanding copier you can usually size drawing before copying to a transparency.

.5 Tricks and Traps

.1 Screen presentation graphics are quite different than graphics on paper media. The screen resolution and speed at which data is presented requires that print be larger, drawings simpler, colors softer and dynamic information as large as possible.

.2 Your colour choices should be reviewed on a black and white screen as most laptops do not support color.

.3 Most manufacturers keep drawings in a library or directory. Be sure you understand the inter-relationship of how the system calls the graphics. It is often not just as easy as moving or renaming graphics because of the interlinking created on each graphic.

.4 Store icons that you will use over and over as objects so that they may be sized and added to typical drawings.

.5 Use typical drawings and add or delete custom information for minimum effort and maximum graphic generation speed. Think about how you might use portions of a graphic again and save it in several pieces, each under a separate file name.

.6 Standardize as much as possible. It is often easier to modify a complete operating library file from another building than to begin again.

It is hoped that these guidelines will do much to aid standardization, reduce required effort and increase speed to build comprehensive graphics.

4. *Glossary of Computer Industry Existing Graphic Standards*

File formats are standardized methods of organizing images based on image class and compression type. Common file types include the following:

- TIFF (extension .TIF) - Tagged Information File Format; usable by most Window applications, common printing standards.
- GIF (extension .GIF) - Graphics Interchange Format, developed by CompuServe Incorporated.
- PCX (extension .PCX) - developed by ZSoft Corporation.
- BMP (extension .BMP) - an internal format used by Windows and OS/2.
- CUT (extension .CUT) - a file format developed by Media Cybernetics; it is the main file format of the popular Dr HALO IV paint package.
- IMG (extension .IMG) - developed by Digital Research, and used extensively by Ventura Publisher.
- MSP (extension .MSP) - developed by Microsoft for Microsoft Paint.
- TGA (extension .TGA) - TARGA - developed by True Vision.
- DXF (extension .DXF) - output file of AUTOCAD, importable in most high end graphic packages.

Some CCS vendors use custom file formats, but most provide a method of conversion from these standard file formats or offer screen capture methods. Vendors who are completely Window compatible are able to deal with the above formats and those that are not are presently implementing the necessary changes.

8.5 Sequence of Operation (Description of Start-Up Code)

CCS SEQUENCES OF OPERATION

Description

This example illustrates how the GENERIC START UP LOGIC is compared to a traditional SEQUENCE OF OPERATION. The overall logic for the system is split into sections. In each, the GENERIC START UP LOGIC is listed first, followed immediately by the corresponding SEQUENCE OF OPERATION wording in “normal” English.

The system selected is the PMA standard system VAV:J. It is a variable air volume system with an outdoor air economizer, hot water heating coil, 2-stage direct expansion cooling coil, and supply and return fans each with a variable speed drive.

1.3 Supply Fan

(A) Supply Fan (SF_PG)

GENERIC START UP LOGIC

```
IF RF ON-FOR 30 SEC THEN
        START SF
ELSE STOP SF

IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
```

SEQUENCE OF OPERATION

If the return fan has been commanded on for 30 seconds, the supply fan is enabled by the DDC panel by sending an “on” signal to the ASD; otherwise, disable the supply fan. If the supply fan is already “ON”, then a command to energize will maintain the status quo; and vice-versa when the fan is already “OFF”.

If the static pressure in the supply duct (SAP) is greater than 30 Pa as measured by the duct pressure sensor, the supply fan status point will be “ON”, otherwise the supply fan status is “OFF”,.

The supply fan program includes software to measure and display run hours and trend logs.

8.5 Sequence of Operation (Description of Start-Up Code)

(B) Supply Fan ASD (Adjustable Speed Drive)

GENERIC START UP LOGIC

```
IF SF ON THEN
        SF_ASD = SAP_CO
ELSE SF_ASD = 0
```

SEQUENCE OF OPERATION

If the supply fan (SF) control point is energized, then the output to the speed control portion of the ASD will equal the output of the SAP controller (SAP_CO). Input to SAP_CO is SAP and setpoint is SAP_SP. The rate of speed change is controlled internally by the ASD.

If the supply fan is not energized the signal to the supply fan ASD is zero.

2.2 Return Fan

(A) Return Fan (RF_PG)

GENERIC START UP LOGIC

```
IF WS ON OR RT_AVG < 14 THEN
        START RF
IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
```

SEQUENCE OF OPERATION

The operation of the return fan is controlled by a weekly schedule (WS) in the software in the panel. When the WS is “ON” (building is occupied or if the average room temperature is below 14°C, then energize the return fan (RF).

If the WS is “OFF” and the average room temperature is higher than 16°C, then de-energize the RF.

8.5 Sequence of Operation (Description of Start-Up Code)

(B) Return Fan ASD

GENERIC START UP LOGIC

```
BSP_SP = ____ DEFAULT = 20 Pa
IF RF ON THEN
        RF_ASD = SF_ASD - (BSP_SP - BSP)
ELSE RF_ASD = 0
```

SEQUENCE OF OPERATION

The return fan speed is controlled to maintain the building static pressure (BSP) at a positive value (relative to outside); a default value of 20 Pascals (Pa) has been selected as the BSP setpoint (BSP_SP).

If the return fan has been commanded "ON" (there is no return fan status point, so this indication cannot come directly from status), then theDDC output (0 - 100%) to the RF speed controller (RF_ASD) is equal to the percentage output value to the supply fan ASD minus a numerical value equal to the building static pressure setpoint minus the building static pressure. The rate of speed change is controlled internally by the ASD. If the return fan has been commanded "OFF", then the return fan ASD output is set to zero.

3.2 Mixed Air Damper

(A) Part 1 of the logic.

GENERIC START UP LOGIC

```
MAD_MIN = ____ DEFAULT = 30%
DO EVERY 3 S RAMP = RAMP + 1%
IF SF OFF THEN
        RAMP = 0%
IF RAMP > 100% THEN
        RAMP = 100% END DO
```

SEQUENCE OF OPERATION

The mixed air damper minimum (MAD_MIN) is a variable for selecting outside air damper minimum position; the default value is 30%. The variable "RAMP" controls the speed at which the damper can open; set at a 1% increase every 3 seconds.

8.5 Sequence of Operation (Description of Start-Up Code)

If the supply fan is “OFF”, then the “RAMP” is reset to 0%. If the RAMP calculation results in an outside air damper position greater than 100%, then set “RAMP” equal to 100%.

(B) Part 2 of the Logic

GENERIC START UP LOGIC

```
IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG _MODE ON THEN
                IF RAT < OAT OR HTG_MODE ON THEN
                        MAD = MAD_MIN
                ELSE MAD = 100%
        ELSE
        MAD = MAX (MAD_MIN, MAD_CO)
        MAD = MIN (MAD, RAMP)
ELSE MAD = 0
```

SEQUENCE OF OPERATION

If the supply fan status is “ON”, the weekly schedule is “ON”, and the freeze control is “OFF” (ie. there is no freeze condition detected), then:

1. If there is a call for heating (“HTG_MODE” is “ON”), then set MAD to the minimum outside air position;
2. If there is a call for cooling (“CLG_MODE” is “ON”) and the return air temperature is lower than the outside air temperature, then set MAD to the minimum outside air position;
3. If there is a call for cooling and the return air temperature is equal to or higher than the outside air temperature, then set MAD to 100% outside air.
4. If there is no call for either heating or cooling (both “HTG_MODE” and “CLG_MODE” are “OFF”), then control the mixed air damper from the maximum value of either the MAD_MIN variable or the output of the software controller “MAD_CO” (which uses SAT as the input and SAT_SP as the setpoint). Also limit the rate of damper opening on start up, in order to prevent the freeze protect from tripping, by controlling the mixed air damper from the minimum value of either the mixed air damper position (from previous line) or the value of the RAMP variable.

Under all other conditions, the MAD is set to 0% outside air.

The mixed air damper program includes software to measure, display and store trend logs of damper position, mixed air temperature, freeze, and supply fan status.

8.5 Sequence of Operation (Description of Start-Up Code)

4.3 Cooling

The supply fan must be running (status in “ON”) or mechanical cooling cannot be energized.

(A) First Stage Cooling

GENERIC START UP LOGIC

```
IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2.0 THEN
                CLG_MODE = ON, START DX1
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
                CLG_MODE = OFF, STOP DX1
```

SEQUENCE OF OPERATION

If the average room temperature is higher than the room temperature setpoint plus 1.3°C or if the maximum room temperature is higher than the room temperature setpoint plus 2.0°C, the cooling mode is set to “ON” and the first stage of mechanical cooling (“DX1”) is energized.

When the average room temperature is less than the room temperature set point plus 0.8°C and the maximum room temperature is less than the room temperature set point plus 1.5°C, the cooling mode is “OFF” and the first stage of mechanical cooling is de-energized.

(B) Second Stage Cooling

GENERIC START UP LOGIC

```
IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.5 OR
        RT_MAX > RT_SP + 2.3 OR
        DX1 ON-FOR 15 MIN THEN
                START DX2
        IF RT_AVG < RT_SP +1.0 AND
        RT_MAX < RT_SP + 1.7 THEN
                STOP DX2
ELSE STOP DX2
```

8.5 Sequence of Operation (Description of Start-Up Code)

SEQUENCE OF OPERATION

If the average room temperature is higher than the room temperature setpoint plus 1.5°C or if the maximum room temperature is higher than the room temperature setpoint plus 2.3°C or if the first stage of cooling has been on for 15 minutes or more, then the second stage of mechanical cooling ("DX2") is energized.

If the average room temperature is less than the room temperature setpoint plus 1.0°C and the maximum room temperature is less than the room temperature setpoint plus 1.7°C, then de-energize the second stage of cooling.

5.2 Heating

(A) Heating (HTG_PG)

GENERIC START UP LOGIC

IF SAT < 10 THEN
    HTG_MODE = ON, HCV = HCV_CO
IF SAT > 14 THEN
    HTG_MODE = OFF, HCV = 0

SEQUENCE OF OPERATION

If the supply air temperature (SAT) is less than 10°C, the heating mode is energized and the heating coil valve is controlled by a software controller in the DDC panel ("HCV_CO") to meet the ~~SAT~~ setpoint of 12°C (see points list). If the supply air temperature rises above 14°C, the heating mode is de-energized and the heating coil valve closes.

(B) Heating Coil Pump

GENERIC START UP LOGIC

IF HCV > 15% OR MAT < 3 THEN
    START HCP
IF HCV < 2% AND MAT > 7 THEN
    STOP HCP

8.5 Sequence of Operation (Description of Start-Up Code)

SEQUENCE OF OPERATION

If the heating coil valve is more than 15% open, or the mixed air temperature ("MAT") is less than 3°C, then start the heating coil pump. If the heating coil valve is less than 2% open, and the MAT is higher than 7°C, then stop the heating coil pump.

The heating program includes software to measure, display and store trend logs of heating coil valve position, supply air temperature setpoint, supply air temperature, and heating coil pump operation.

11.3 Supply Air Temperature

GENERIC START UP LOGIC

RT_SP = _____ *DEFAULT = 22*
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

SEQUENCE OF OPERATION

A room temperature setpoint ("RT_SP") is selected (default value is 22°C). The supply air temperature set point is set equal to 18°C minus (4 times (the average room temperature minus the room temperature setpoint)).

The supply air temperature program includes software to measure, display and trend the supply air temperature and setpoint, and the room temperature and setpoint.

12.3 Supply Air Pressure

GENERIC START UP LOGIC

SAP_SP = _____ DEFAULT = 100 Pa

SEQUENCE OF OPERATION

A supply duct static pressure setpoint ("SAP_SP") is selected (default value is 100 Pascals). The supply air pressure program ustilizes a software controller ("SAP_CO") to control the supply fan ASD to maintain the supply duct static pressure setpoint. Refer back to 1.3 (B) Supply Fan ASD for the controlling logic.

The supply air pressure program includes software to measure, display and trend the supply air pressure and setpoint.

9.0 OPTIMIZATION GUIDELINES

9.1 GENERAL OPTIMIZATION GUIDELINES

This section has been published as a draft. We feel that it will generate discussion and feedback that will allow it to be improved and become more useful.

Introduction

The sections following are arranged in rough chronological order for your convenience. The System Protection items should be considered during the seven day test procedure, while the Client Comfort section could be implemented after the building has been occupied or during move-in. The Energy/Operational items could be considered after the building has been occupied for some time and some operating experience has been gained. These lists of ideas are not meant to be exhaustive nor all-inclusive. If there are items missing that you feel should be included, please send the information back to us so that a more comprehensive list can be assembled in the future.

9.1.1 Pre-Occupancy Optimization SYSTEM PROTECTION

.1 Check ramp for MAD to ensure it opens slowly enough to prevent freeze protection from tripping during morning
start-up in cold weather.

.2 Install Night Setback routines to allow equipment shut-down and still provide for building protection

.3 Set-up amperage points so that a broken belt or coupling will show OFF status.

.4 Check for good outside and return air mixing in economizer section of air handlers.

.5 Install routines to keep units off after freeze thermostat triggered, until reset by operator.

.6 Program alarms as required for building safety and operator preference.

.7 Ensure heating coil pumps are on when outside air temperature is below freezing or valve open.

.8 Ensure ramps on ASDs are set up to be slow enough to prevent overloading, and that all the parameters are set up.

9.1.2 Post-Occupancy Optimization CLIENT COMFORT

.1 Ensure that there is an adequate deadband between heating and cooling setpoints to prevent cycling.

.2 Set room temperature setpoint to match occupants' expectations.

.3 Enhance SAT setpoint calculations with additional feedback.

.4 Check to see if VAV boxes should have increased airflow to solve stratification when reheat on.

.5 Ensure that overrides are set up for appropriate duration.

.6 Check for noisy or drafty diffusers in occupied areas.

9.1.3 Post-Occupancy Optimization ENERGY/OPERATIONAL

.1 Shut off any energy using devices for as long as possible. Consider optimal start.

.2 Install Dynamic Control Strategies in medium and large mass buildings.

.3 Optimize lighting off times through off-sweeps or other methods.

.4 Upgrade graphics to operators requirements.

.5 Optimize all heating and cooling to prevent/reduce chances of reheating/recooling.

.6 Ensure that when devices are off that setpoints concur with that action.

.7 Ensure that all software controllers are set up to reduce hunting and cycling.

.8 Input holidays into an annual schedule and incorporate year into point name. Eg. "SCH96_AS".

.9 Consider getting low use rooms up to temperature in morning and shutting off for rest of day,

or widening deadbands,
but only if occupants can restart when required. Note must be put in area.
.10 If information metering is installed, set up daily energy accounting routines.
.11 Ensure that heating coil pumps are only on when below freezing outside or here is a heating demand and off at other
times.
.12 Set up building so that it operates on outside air for cooling if possible and bring on mechanical cooling only when
required.
.13 Ensure that there is an adequate deadband between heating and cooling setpoints.
.14 Ensure that overrides are set up for appropriate durations.
.15 Find the areas of the building that are driving the setpoints and make changes to minimize their impact.

9.2 SYSTEM OPTIMIZATION GUIDELINES

Introduction

The generic startup logic used in the Client Comfort System Design Manual has been purposely simplified to allow commissioning and start up to be straight forward. The format and linking of the output orientated code with graphic icons, has put in place a system that will allow this code to be easily optimized and documented. The following guidelines provide a check list of optimization concepts that should be considered for each system. Chapter 38, Building Operating Dynamics and Strategies, of the 1995 ASHRAE Handbook HVAC Applications should be reviewed to provide background and rationale for optimization.
Optimization is a process of providing the optimum fit of the new CCS with the actual installed mechanical system's limitations and the building characteristics. This process can only be completed when the building is occupied and used for its intended purpose. Trend data gathered by the CCS strongly suggests the areas in which optimization will be most effective. Analyzing the trend data will quickly identify system problems and opportunities for optimization. Trend graphics will also allow us to judge the success of our optimization strategies.

General Concepts

The optimization concepts are organized to match the output orientated code for all systems as outlined in Section 5 of the manual. The basic optimization concept is presented with supporting information. Exact generic code has not been provided as the actual implementation of the concepts are building and CCS vendor dependent. The lists of optimization concepts should be treated as the minimum optimization concepts to be applied to each system. Each project will present its own optimization opportunities and no attempt has been made to document these.

9C OPTIMIZATION COOLING SYSTEMS

PMA Single Centrifugal Chiller Type D (C:D)

Chiller Optimization Concepts

PG 3 Chiller

Reduce chiller runtime to the lowest possible number of hours in the most effective operating range.

.1 Control from actual space temperature demand not only outdoor air temperature.
.2 Use dynamic calculation as a lock out to prevent unnecessary chiller operation.
.3 Use room temperature average or return air temperature for stability.
.4 Avoid starting chiller for only one area of building. Solve hot spot problems so that they require cooling at approximately
the same time as the rest of the building.

PG 3 Chiller Vane Program

Ramp chiller slowly on start up.

.1 When the chiller starts the complete loop is usually warm. If the chiller is not ramped over a period longer than the loop
pull down, the chiller will go to full capacity to cool. This may exceed the condensing capacity of

the system, causing the
unit to trip on high head pressure or potentially establish a new electrical demand penalty. The highest value of the ramp
should be limited during shoulder months to reduce electrical demand. Tune start up coding to match application.

PG 3 Chiller Vane Program

Reset chilled water to highest possible temperature.

.1 Actual space demand should be fed back to the chilled water reset to insure that the warmest possible chilled water is
being used to meet the load. A safety low minimum should be set as well as a high limit, which when reached should stop
the chiller.

PG 22 Cooling Tower

Reset condenser water to lowest possible temperature.

.1 Actual chiller machine design will determine the lowest possible water temperature that can be operated. Achieve
condenser water control by cycling the condenser or cooling tower fans, or control output capacity not bypass condenser
water.

9V OPTIMIZATION VARIABLE VOLUME AIR SYSTEMS

PG 2.2 Return Fan or Exhaust Air Pressurization Control

Maintain optimum positive building pressure.

.1 Building pressure should be maintained positive to reduce infiltration. If setpoint is too high air movement at doors could
be a problem and exhaust air volume may be restricted. Too low a setpoint will allow building to go negative. Outside air
reset may be required to offset pressurization changes caused by the stack effect as building thermocline reverses from
winter to summer. In some systems return fan will be able to be shut off when system is on a high percentage of
recirculation.

PG 4.3 Cooling

Reduce cooling run hours as low as possible.

.1 Prohibit mechanical cooling if Cold Day = YES. Cold Day is calculated in Temperature Predictor program.

.2 If the supply air is too cold with one stage of DX, hold off cooling start decision or increase air flow to warm area. In
severe conditions you may have to increase minimum flow to solve low temperature or provide a false load with mixed air.

.3 For direct expansion systems if discharge air temperature drops too low with two stages of cooling hold off second stage
until supply air increases above setpoint.

PG 5.2 Heating

Review original design intent for heating.

.1 Insure that heating is meeting the original design intent. If early morning warm up is included provide programming. Use
optimum start to start fan and heating. Insure mix is set to 0% for warm up.

.2 Optimization of heating will require a clear understanding of actual heating performance. Most systems have heating coils
to heat minimum ventilation air at extreme cold ambient temperatures.

PG 6.2 Evaporative Cooling

Maximize evaporative cooling to reduce mechanical cooling.

.1 Trend a start cycle of evaporative cooling. Note response time effect of cold water as it fills. An interlock will be required
to prevent outside air on mix from closing down. If outside air on mix is reduced, humidity in space will rise rapidly.
Discharge control may have to be implemented to prevent over cooling. Rapid cycling of pump or valve can usually
achieve some control. Each system will be unique.

PG 11.3 Supply Air Temperature

.1 *Add high and low temperature adjust to supply air temperature calculation.*
Generic Start Up Code
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4) ADD B + C
Add:
IF MAX_RT > 23.5 THEN B = (23.5 - MAX_RT) * 3 ELSE B = 0
IF MIN_RT < 21 THEN C = (21 - MIN_RT * 3 ELSE C = 0
Tune algorithm to match actual conditions.

.2 *Add minimum ventilation calculation*.
Calculate the maximum supply air temperature (ventilation air temperature setpoint VAT_SP) that will still insure minimum
ventilation is being met.
SAT_SP = LSEL(SAT_SP, VAT_ST)
When cooling is started:
VAT_SP = SAT_SP
If heating is used consider using mixed air temperature rather than supply air. If mixed air is not stable hold fixed minimum
position with damper analog out.
Ventilation air temperature setpoint = ((Minimum CFM * Outside Air Temp) + ((Total Air Flow - Minimum CFM) *
Return Air Temp)/Total Air Flow)
If no flow measurement exists estimate flow from ASD position speed calculation and fan curves.
Review PMA Adequate Ventilation Document.

.3 *Optimize supply air temperature and ventilation fan volume.*
Example: If ASD > 80 reset supply air temperature setpoint down. *I*f ASD < 60 reset supply air temperature setpoint up.
Limit will be required. Keep air flow high enough to meet minimum air flow and ventilation requirements. Reset must be
timed to prevent cycling.

PG 12.3 Supply Air Pressure

Implement terminal regulated air volume control (TRAV).

.1 Insure that at least one terminal VAV box is completely open and temperature parameters cannot be met before
increasing fan static pressure.

.2 Identify boxes that can never achieve temperature or air volume setpoint and take corrective action.
Eg: - increasing air flow,
- removing duct restrictions,
- improve diffusion,
- increase static and lower supply air only as a last resort because total energy will be increased.

EXAMPLE OF
CLIENT COMFORT SYSTEM
OPTIMIZATION MATRIX

Project:__________________________ Date:_______________ Prepared by:_______________

Building	**A**		**B**			**C**				**D**	
System	**SZ**	**VAV**	**VAV1**	**VAV2**	**GYM SZ**	**SZ1**	**SZ2**	**SZ3**	**SZ4**	**SZ1**	**SZ2**
Implementation of Temperature Predictor Program	X	X	X	X	X	X	X	X	X	X	X
Feedback to boiler reset program		X					X			X	
Night setback of space temperature	X									X	X
Fan shut off at night			X		X	X	X	X	X		
Fan slow down at night		X		X							
VAV box control - night mode		X		X							
Reheat valve control - night mode	X		X		X	X	X	X	X	X	X
Room temperature control of SAT_SP	X	X	X	X	X	X	X	X	X	X	X
Reheat flush at 6:00 when cold day		X	X	X	X	X	X	X	X	X	X
Return fan off when not required		X	X	X							
Exhaust fan control	X		X		X	X	X	X	X		
Loss of box volume alarm		X	X	X							
Overrides push buttons			X	X	X	X	X	X	X	X	X
2nd pump operation	X				X	X	X	X	X	X	X
Set up alarms	X	X	X	X	X	X	X	X	X	X	X
Energy Accounting implemented by building											

PROJECT NO: **123**

PROJECT DESCRIPTION: **EXAMPLE BUILDING**

EXAMPLE

TABLE OF CONTENTS

PROPERTY
MANAGEMENT AGENCY

NOTE: The Section to be assembled from the Pre-Approved Systems in TAB 5 of the manual. Use following Example for clarification

15900 Controls General

All controls are referred to as the Client Comfort System (CCS). All controls shall be computerized direct digital except where noted in the following specification.

15910 Scope of Work

Provide a Client Comfort System, as specified in this document, for the Example Building. CCS shall be accessed remotely via modem. The operating system of the CCS shall operate in Windows 3.1 or higher, and shall coexist with other vendor's systems, presently operating in Windows, to provide a multi-vendor work station at the Property Management Agency Office.

15920 Job Specific Alterations to Property Management Agency Performance Specifications

No communication computers will be provided for this project. Communication will be via modem with existing computer at the Property Management Unit. Contractor shall make the CCS operating system operational on this computer and demonstrate remote communication to system. Computer will meet Agency's hardware and set up standards and will have at least 10 MB of disk space.

15925 Smoke/Fire Sequence

The following smoke sequences shall be incorporated in the Client Comfort System.

When fire alarm system is activated both VAV1 and VAV2 shall shut down via a hardware connection to the fire panel. If the fire department activates a particular fan system for smoke removal, a smoke override switch on the fire panel shall restore power to the fan control circuits and a smoke override VAV1 SMOKE1_OVR or smoke override VAV2 SMOKE2_OVR relay shall be turned on . These are two separate digital inputs to the CCS connected to the smoke relays on the fire panel. These points are shown as part of the CCS on the Miscellaneous Point Sheet.

The following smoke sequence shall be added to the Generic Start Up Code for VAV1 (Property Management Agency Variable Volume Type L) and VAV2 (Property Management Agency Variable Volume Type A).

VAV1 modify 2.2 to read:

```
IF WS ON OR RT_AVG < 14 OR SMOKE1_OVR THEN
        START RF
IF SMOKE1_OVR OFF AND WS OFF AND RT_AVG > 16 THEN
        STOP RF
```


VAV2 modify 1.2 to read:

```
IF WS ON OR RT_AVG < 14 OR SMOKE2_OVR THEN
        START SF
IF SMOKE2_OVR OFF AND WS OFF AND RT_AVG > 16 THEN
        STOP SF
```

Add as last line of 3.2 VAV1 and VAV2:

```
IF SAT > 5 AND SMOKEx_OVR THEN
        MAD = 100
ELSE
        MAD = MAD_CO
```

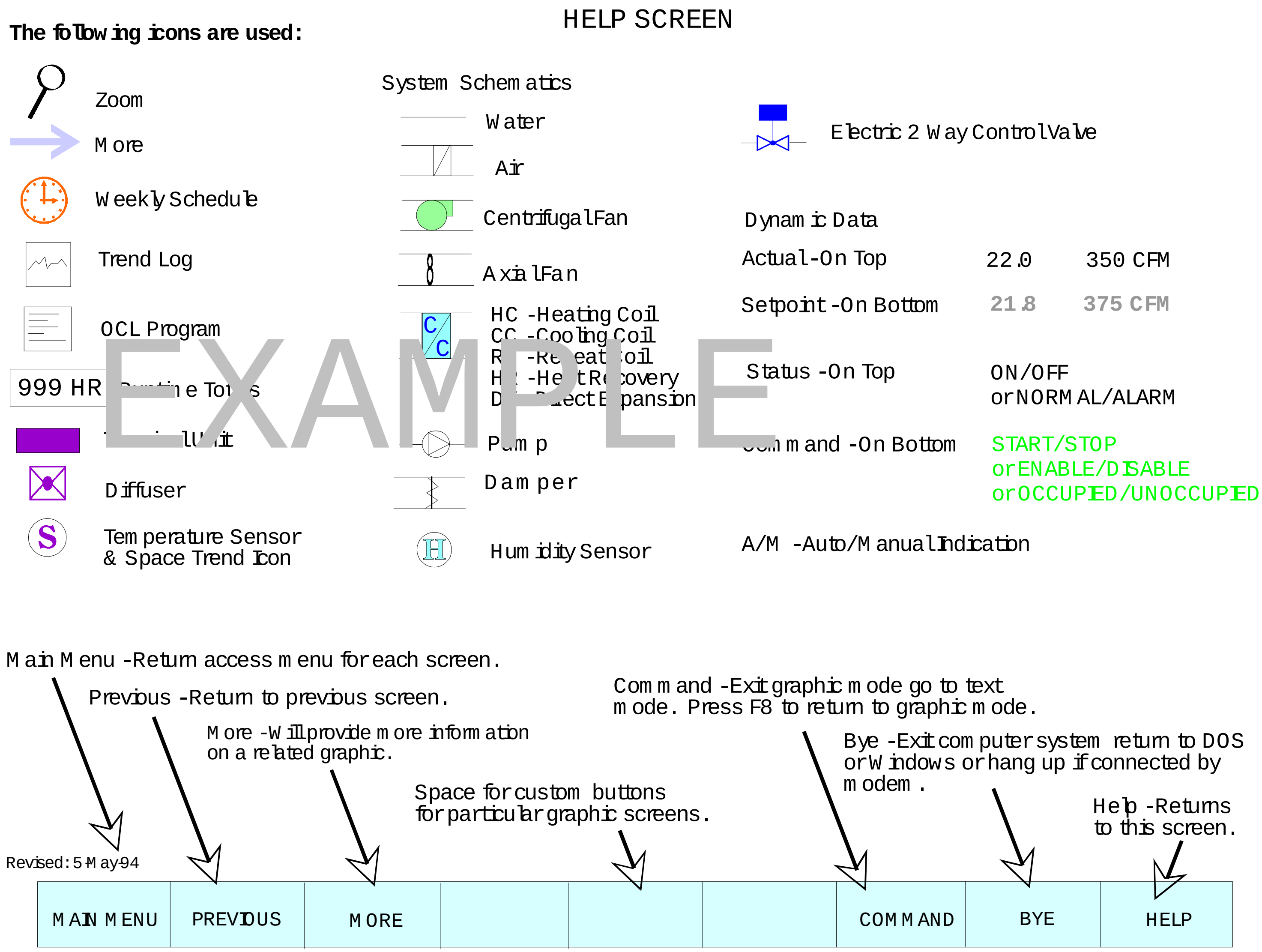
The following smoke sequence shall be added to the Generic Start Up Code for Property Management Agency Variable Air Volume TUC (Type V-A) and (Type V-N).

Add as last line of 9 Box Program:

```
IF SMOKEx_OVR THEN BxyzF_SP = BxyzFMAX
(Apply to all boxes.)
```

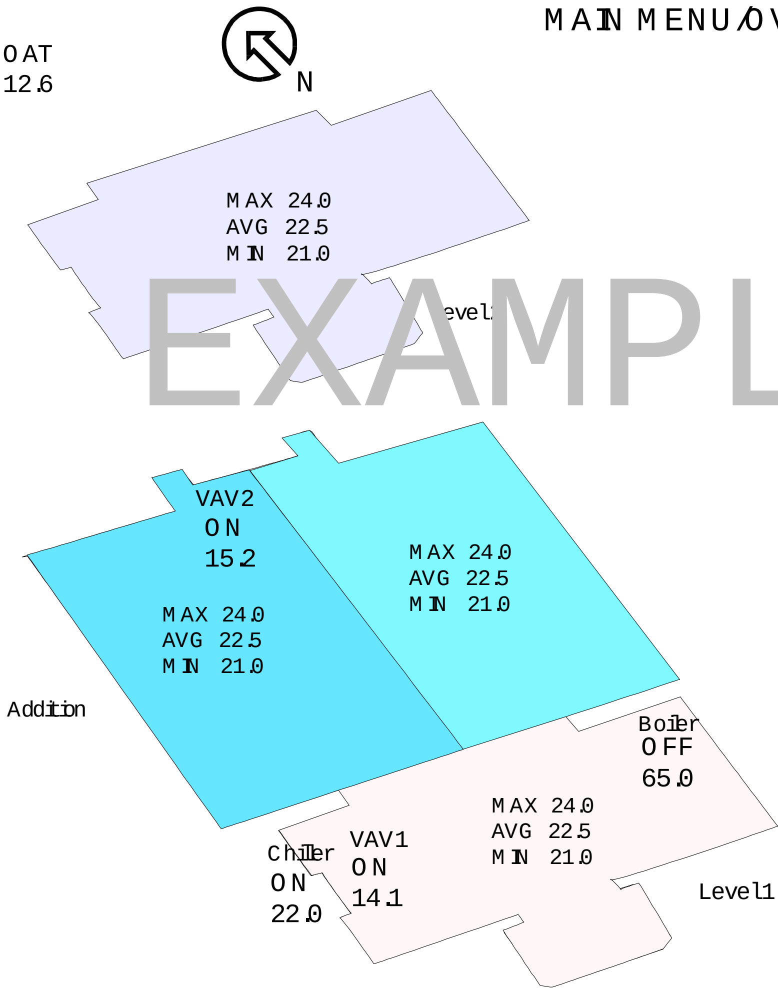
SECTION 15930 - CCS PROJECT SUMMARY TABLE OF CONTENTS

Project Number: 123		Project Name: EXAMPLE BUILDING												
	Page	DDC Hardware Pt				Virtual	Non	Emer/	Terminal Unit Controllers				# of Graphic Screens	
System Description	No	DO	DI	AI	AO	Point	DDC	Safety	V-A	V-N		Total		Notes
Help Screen	6												1	
Main Menu/Overview	7												1	
Graphics Index	8												1	
Floor Graphics	9												4	NW,NE,S-1,S-2
Detail Floor Graphics	10												4	NW,NE,S-1,S-2
VAV1	11-12	4	1	5	5	34							1	
VAV1 TUC	13-16								15	10		25	2	
VAV2	17-18	3	1	3	5	27							1	
VAV2 TUC	13-16								18	12		30	2	
Cooling	19-20	2	2	1	3	5							1	
Heating	21-22	2			3	8							1	
Miscellaneous	23-24	2	1		2	7							1	
Non DDC	25						2							
Emergency/Safety	26							2						
CCS Overview	27												1	
Panel Layout	28												*	*One per panel
Wire Detail	29												*	*Show as builts
Total Summary		13	5	9	18	81	2	2	33	22		55	21	
			33	33	66	297								
			44	44	66	264								
Grand Total Summary		13	82	86	150	642	2	2	33	22		55	21	

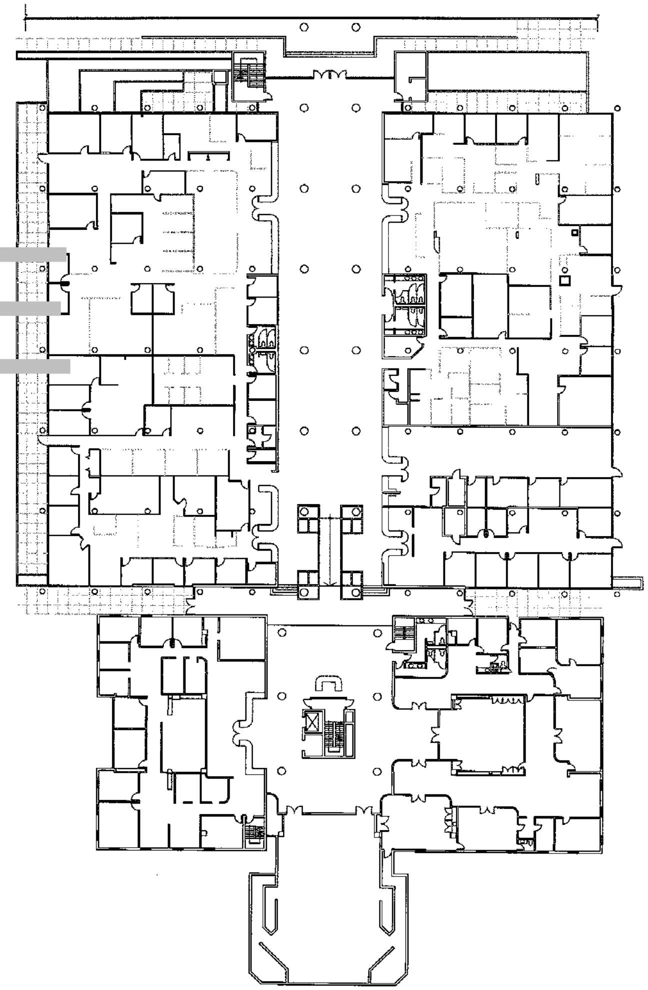

HELP SCREEN
The following icons are used:
Zoom
More
Weekly Schedule
Trend Log
OCL Program
999 HR
Diffuser
Temperature Sensor
& Space Trend Icon
System Schematics
Water
Air
Centrifugal Fan
Axial Fan
HC -Heating Coil
CC -Cooling Coil
C
C
Pump
Damper
Humidity Sensor
H
Electric 2 Way Control Valve
Dynamic Data
Actual -On Top
22.0
350 CFM
Setpoint -On Bottom
21.8
375 CFM
Status -On Top
ON/OFF
or NORMAL/ALARM
START/STOP
or ENABLE/DISABLE
or OCCUPIED/UNOCCUPIED
A/M -Auto/Manual Indication
Main Menu -Return access menu for each screen.
Previous -Return to previous screen.
More -Will provide more information
on a related graphic.
Space for custom buttons
for particular graphic screens.
Command -Exit graphic mode go to text
mode. Press F8 to return to graphic mode.
Bye -Exit computer system return to DOS
or Windows or hang up if connected by
modem.
Help -Returns
to this screen.
Revised: 5-May-94
MAIN MENU
PREVIOUS
MORE
COMMAND
BYE
HELP

MAIN MENU/OVERVIEW

OAT
12.6



EXAMPLE



Revised: 26-July-94

MAIN MENU	PREVIOUS	INDEX	BOILER	CHILLER		COMMAND	BYE	HELP

GRAPHIC INDEX

- Main Menu/Overview
- Addition NW Level 1
- Addition NE Level 1
- South Level 1
- South Level 2

- VAV 1 Schematic
- VAV 2 Schematic
- Heating Schematic
- Cooling Schematic
- Miscellaneous Systems Schematic
- Message Bin

- CCS Overview
- Panel Layout
- Wire Detail

EXAMPLE

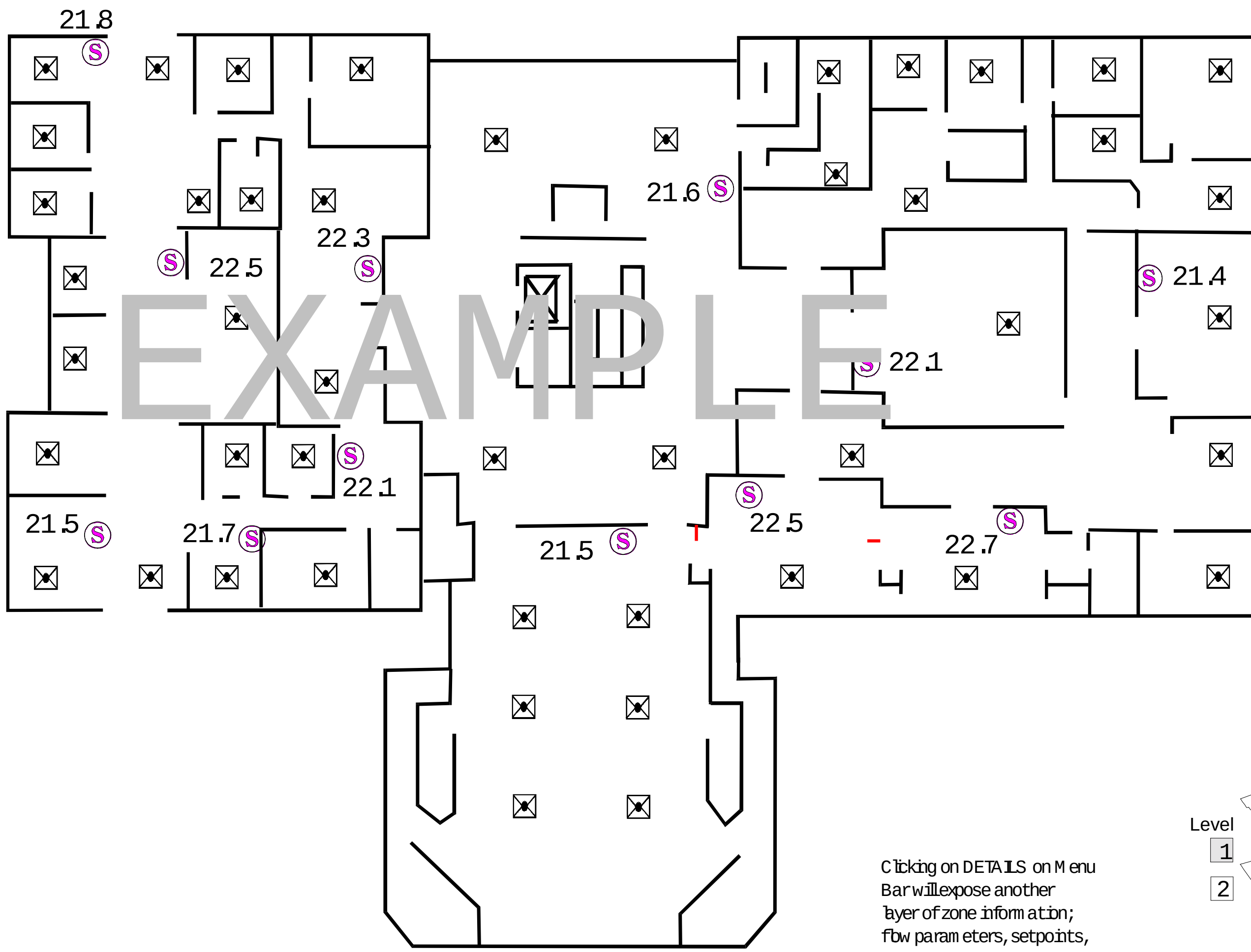
Revised 27-September-94

MAIN MENU	PREVIOUS					COMMAND	BYE	HELP

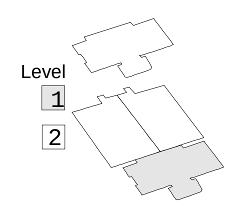
OAT
12.6

EXAMPLE OFFICE BUILDING 1st LEVEL - SOUTH

N



Key Plan

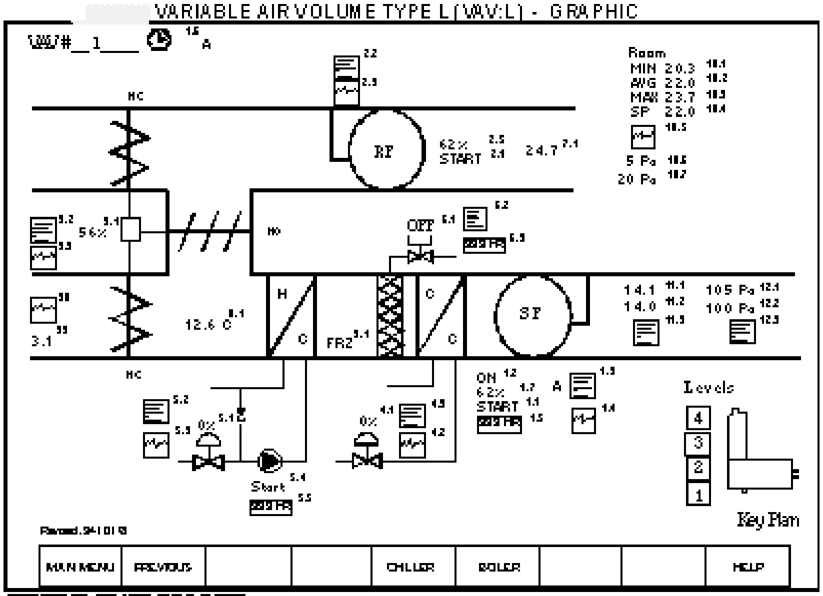


Clicking on DETAILS on Menu Bar will expose another layer of zone information; flow parameters, setpoints, etc.

Revised: 95/06/02

MAIN MENU	PREVIOUS				UP FLOOR	DETAILS	AHU1	HELP

VARIABLE AIR VOLUME TYPE L (VAV:L) - GRAPHIC



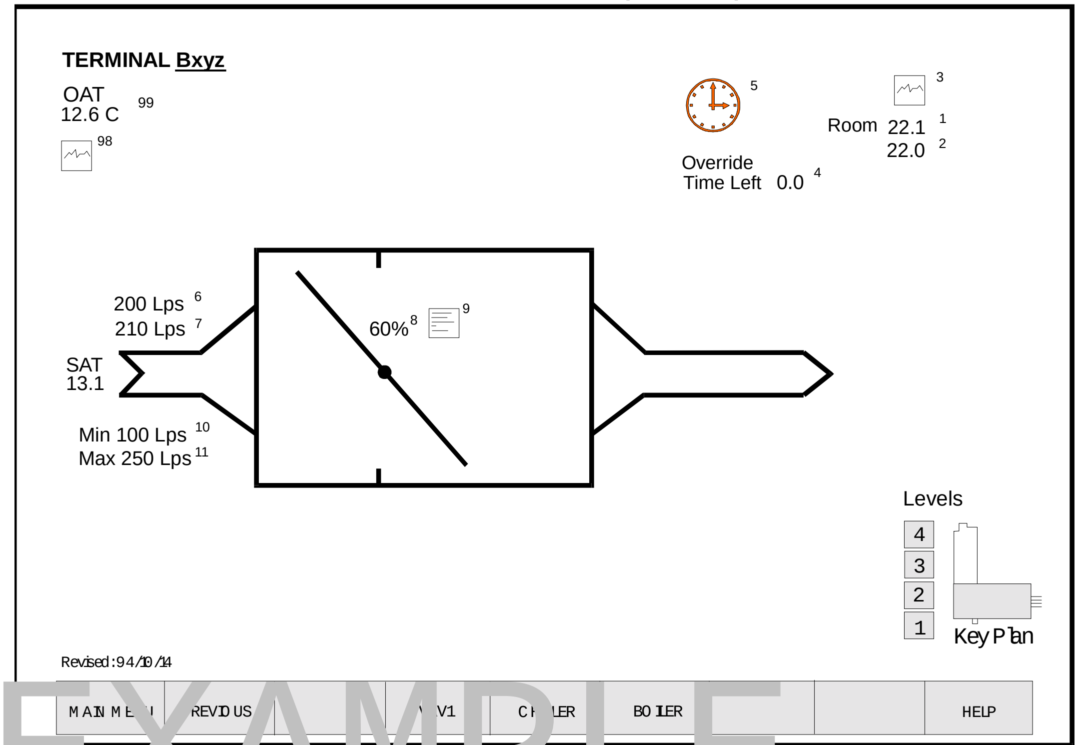
GENERIC START UP LOGIC

```
1.2 Supply Fan (SF_PG)
    IF RF ON-FOR 30 SEC THEN
        START SF
    ELSE STOP SF
    IF SAP > 30 THEN SF_S = ON
        ELSE SF_S = OFF
    [Supply Fan ASD]
    IF SF ON THEN
        SF_ASD = SAP_CO
    ELSE SF_ASD = 0
2.2 Return Fan (RF_PG)
    IF WS ON OR RT_AVG < 14 THEN
        START RF
    IF WS OFF AND RT_AVG > 16 THEN
        STOP RF
    [Return Fan ASD]
    BSP_SP = _____ DEFAULT = 30 Pa
    IF RF ON THEN
        RF_ASD = SF_ASD - (BSP_SP - BSP)
    ELSE RF_ASD = 0
9.2 Mixed Air Damper (MAD_PG)
    MAD_MIN = _____ DEFAULT = 30%
    DO EVERY 3 S RAMP = RAMP + 1%
    IF SF OFF THEN
        RAMP = 0%
    IF RAMP > 100% THEN
        RAMP = 100% END DO
    IF SF_S ON AND WS ON AND FRZ OFF THEN
        IF CLG_MODE ON OR HTG_MODE ON THEN
            IF RAT < OAT OR HTG_MODE ON THEN
                MAD = MAD_MIN
            ELSE MAD = 100%
        ELSE
            MAD = MAX(MAD_MIN, MAD_CO)
            MAD = MIN(MAD, RAMP)
    ELSE MAD = 0

4.2 Cooling (CLG_PG)
    IF SF_S ON THEN
        IF RT_AVG > RT_SP + 1.3 OR
        RT_MAX > RT_SP + 2 THEN
            CLG_MODE = ON, CCV = CCV_CO
        IF RT_AVG < RT_SP + 0.8 AND
        RT_MAX < RT_SP + 1.5 THEN
            CLG_MODE = OFF, CCV = 0
    ELSE
        CLG_MODE = OFF, CCV = 0
5.2 Heating (HTG_PG)
    IF SAT < 10 THEN
        HTG_MODE = ON, HCV = HCV_CO
    IF SAT > 14 THEN
        HTG_MODE = OFF, HCV = 0
    [Heating Coil Pump]
    IF HCV > 15 OR MAT < 3 THEN
        START HCP
    IF HCV < 2 AND MAT > 7 THEN
        STOP HCP
8.2 Evaporative Cooling (EC_PG)
    IF SF_S ON AND CLG_MODE OFF THEN
        IF RT_AVG > RT_SP + 0.5 OR
        RT_HIGH > RT_SP + 1 THEN
            START EC
        IF RT_AVG < RT_SP + 0.1 THEN
            STOP EC
    ELSE STOP EC
11.2 Supply Air Temp (SAT_PG)
    RT_SP = _____ DEFAULT = 22
    SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)
12.2 Supply Air Pressure (SAP_PG)
    SAP_SP = _____ DEFAULT = 100 Pa
```

PMA VARIABLE AIR VOLUME TYPE L (VAV:L) - POINTS LIST

Project Number: 123		Project Name: EXAMPLE BUILDING									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop	VAV1	SF	CR1	1						
1.2	Supply Fan Status	VAV1	SF_S	V					1		
1.3	Supply Fan Program	VAV1	SF_PG	PG					1		
1.4	Supply Fan Trendlog	VAV1	SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours	VAV1	SF_TZ	TZ					1		
1.6	Weekly Schedule	VAV1	WS	WS					1		
1.7	Supply Fan ASD	VAV1	SF_ASD	DDC			1				
2.1	Return Fan Start/Stop	VAV1	RF	CR1	1						
2.2	Return Fan Program	VAV1	RF_PG	PG					1		
2.3	Return Fan Trendlog	VAV1	RF_TL	TL					1	RF,RAT,BSP,ASD	
2.5	Return Fan ASD	VAV1	RF_ASD	DDC			1				
3.1	Mixed Air Damper	VAV1	MAD	DA2			1				
	Mixed Air Damper Controller	VAV1	MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum	VAV1	MAD_MIN	V					1		
	Mixed Air Damper Ramp	VAV1	RAMP	V					1		
3.2	Mixed Air Program	VAV1	MAD_PG	PG					1		
3.3	Mixed Air Trendlog	VAV1	MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode	VAV1	CLG_MODE	V					1		
4.1	Cooling Coil Valve	VAV1	CCV	CV3			1				
	Cooling Coil Controller	VAV1	CCV_CO	CO					1	use SAT:SAT_SP	
4.2	Cooling Coil Trendlog	VAV1	CLG_TL	TL					1	CCV,SAT_SP,SAT,EC	
4.3	Cooling Coil Program	VAV1	CCV_PG	PG					1		
	Heating Mode	VAV1	HTG_MODE	V					1		
5.1	Heating Coil Valve	VAV1	HCV	CV3			1				
	Heating Coil Controller	VAV1	HCV_CO	CO					1	use SAT:SP = 12	
5.2	Heating Program	VAV1	HTG_PG	PG					1		
5.3	Heating Coil Valve Trendlog	VAV1	HCV_TL	TL					1	HCV,SAT_SP,SAT,HCP	
5.4	Heating Coil Pump	VAV1	HCP	CR1	1						
5.5	Heating Coil Pump Run Hours	VAV1	HCP_TZ	TZ					1		
6.1	Evaporative Cooling	VAV1	EC	CR1	1						
6.2	Evaporative Cooling Program	VAV1	EC_PG	PG					1		
6.3	Evaporative Cooling Run Hours	VAV1	EC_TZ	TZ					1		
7.1	Return Air Temperature	VAV1	RAT	DTS2				1			
8.1	Mixed Air Temperature	VAV1	MAT	DTS1				1			
9.1	Freeze Control	VAV1	FRZ	FRZ		1					
10.1	Room Temperature Minimum	VAV1	RT_MIN	V					1		
10.2	Room Temperature Average	VAV1	RT_AVG	V					1		
10.3	Room Temperature Maximum	VAV1	RT_MAX	V					1		
10.4	Room Temperature Setpoint	VAV1	RT_SP	V					1		
10.5	Room Temperature Trendlog	VAV1	RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure	VAV1	BSP	DPS				1			
10.7	Building Pressure Setpoint	VAV1	BSP_SP	V					1		
11.1	Supply Air Temperature	VAV1	SAT	DTS2				1			
11.2	Supply Air Temp Setpoint	VAV1	SAT_SP	V					1		
11.3	Supply Air Temp Program	VAV1	SAT_PG	PG					1		
12.1	Supply Air Pressure	VAV1	SAP	DPS				1			
12.2	Supply Air Pressure Setpoint	VAV1	SAP_SP	V					1		
12.3	Supply Air Pressure Program	VAV1	SAP_PG	PG					1		
	Supply Air Pressure Controller	VAV1	SAP_CO	CO					1	use SAP:SAP_SP	
	Total				4	1	5	5	34		

BCBC VARIABLE AIR VOLUME TUC (TYPE V-A) - GRAPHIC



GENERIC START UP LOGIC

9 **Box Program BxyzPG**

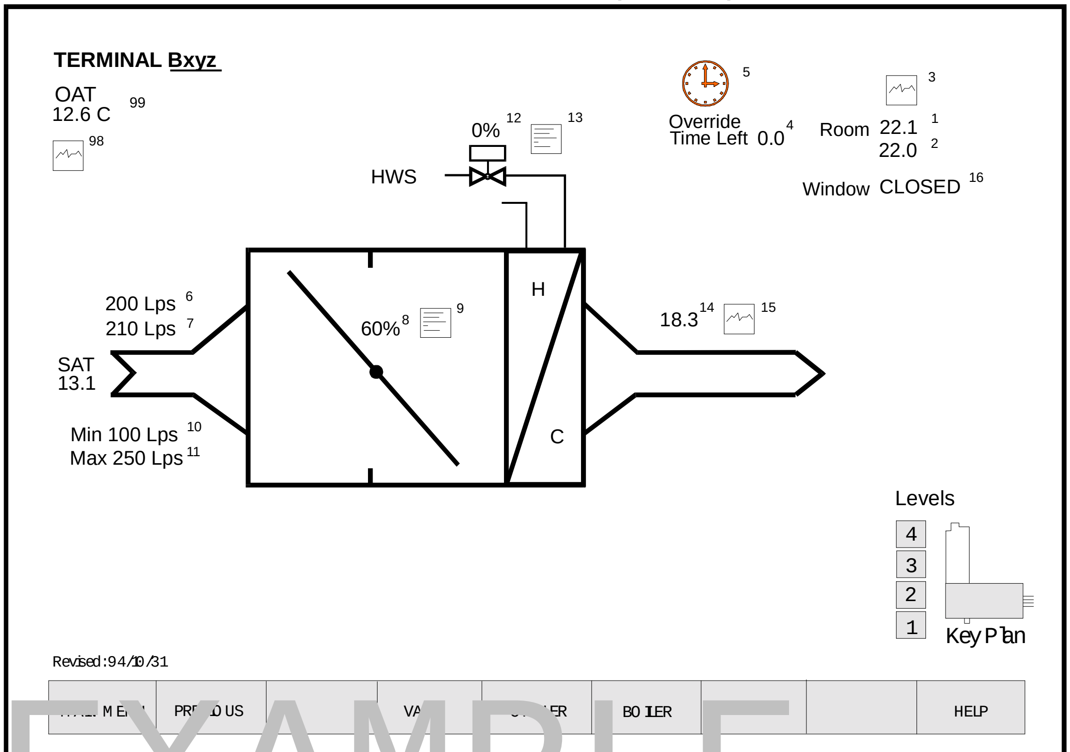
```
BxyzRT_SP = 22.0
BxyzD = BxyzF_CO
IF BxyzWS or BxyzOR_T > 1 THEN
     BxyzF_SP = BxyzFMIN_SP + ((BxyzFMAX_SP - BxyzFMIN_SP) * (BxyzRT_CO/100))
ELSE
     BxyzF_SP = 0
IF BxyzOR THEN BxyzOR_T = 60.0
DO EVERY 1 M
BxyzOR_T = BxyzOR_T - 1.0
END_DO
```

PMA VARIABLE AIR VOLUME TUC (TYPE V-A) - POINTS LIST

Project Number: 123		Project Name: EXAMPLE BUILDING									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Room Temperature	VAV#	BxyzRT	RTS1				1			
2	Room Temperature Setpoint	VAV#	BxyzRT_SP	V					1		
3	Room Trendlog	VAV#	BxyzRT_TL	TL					1	RT,RT_SP,F,F_SP	
	Room Override	VAV#	BxyzOR	CRS		1					
4	Room Override Time Left	VAV#	BxyzOR_T	V					1	Set 60 min	
5	Room Weekly Schedule	VAV#	BxyzWS	WS						See Spec 15925	
6	Flow	VAV#	BxyzF	FS				1			
7	Flow Setpoint	VAV#	BxyzF_SP	V					1		
8	Damper	VAV#	BxyzD	DA1			1				
	Temperature Controller	VAV#	BxyzRT_CO	CO					1	use RT:RT_SP	
	Flow Controller	VAV#	BxyzF_CO	CO					1	use F:F_SP	
9	Program	VAV#	BxyzPG	PG					1		
10	Minimum Flow Setpoint	VAV#	BxyzFMIN_SP	V					1		
11	Maximum Flow Setpoint	VAV#	BxyzFMAX_SP	V					1		
	Total				0	1	1	2	9		

NOTE: x = Floor #
yz = Box # of Floor #
For VAV# and Box # see mechanical schedule

BCBC VARIABLE AIR VOLUME TUC (TYPE V-N) - GRAPHIC



GENERIC START UP LOGIC

9 **Box Program Bxyz_PG**

```
BxyzRT_SP = 22.0
BxyzD = BxyzF_CO
IF BxyzWS or BxyzOR_T > 1 THEN
     BxyzF_SP = BxyzFMIN_SP + ((BxyzFMAX_SP - BxyzFMIN_SP) * (BxyzRT_CO/100))
ELSE
     BxyzF_SP = 0
IF BxyzOR THEN BxyzOR_T = 60.0
DO EVERY 1 M
BxyzOR_T = BxyzOR_T - 1.0
END_DO
IF BxyzWIN AND BxyzWS THEN
     BxyzF_SP = BxyzFMIN_SP
```

13 **Reheat Coil Program BxyzRCV_PG**

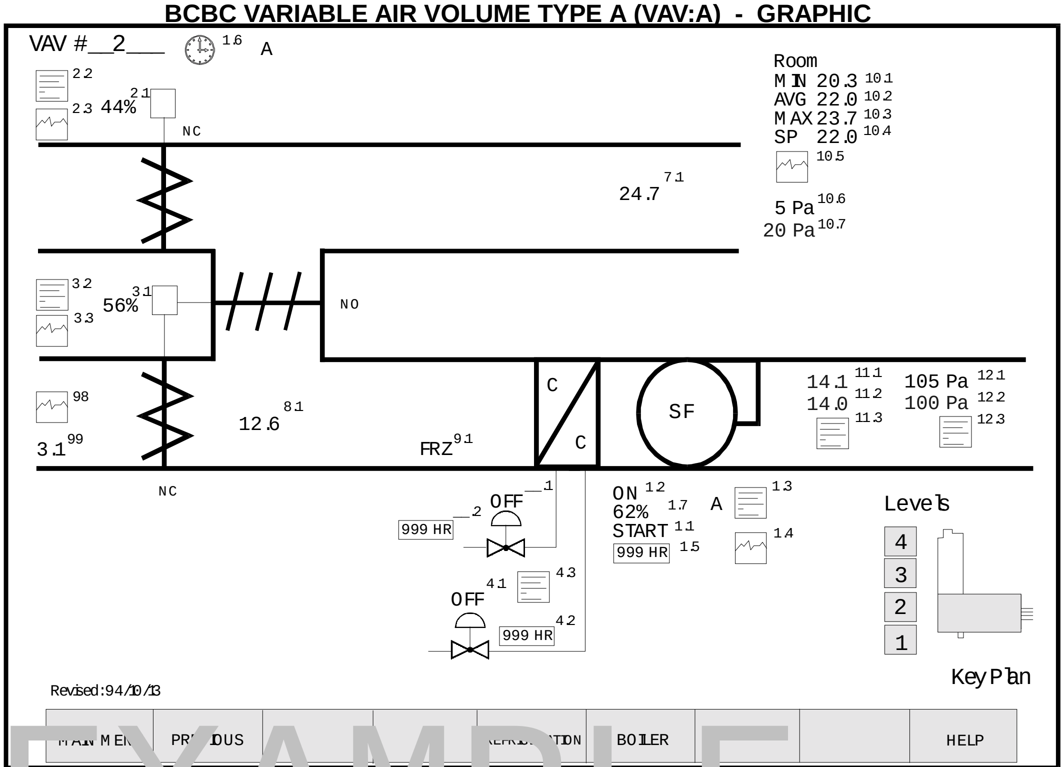
```
IF BxyzWIN THEN
     BxyzRT_SP = BxyzRT_SP - 1
IF BxyzF_SP = BxyzFMIN_SP AND
BxyzRT < BxyzRT_SP - 0.8 THEN
     BxyzRCV = BxyzRCV_CO
IF BxyzF > BxyzFMIN_SP OR
BxyzRT > BxyzRT_SP - 0.3 OR
BxyzF < (BxyzFMIN_SP/2) THEN
     BxyzRCV = 0
```

PMA VARIABLE AIR VOLUME TUC (TYPE V-N) - POINTS LIST

Project Number: 123		Project Name: EXAMPLE BUILDING									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Room Temperature	VAV#	BxyzRT	RTS1				1			
2	Room Temperature Setpoint	VAV#	BxyzRT_SP	V					1		
3	Room Trendlog	VAV#	BxyzRT_TL	TL					1	RT,RT_SP,F,F_SP	
	Room Override	VAV#	BxyzOR	CRS		1					
4	Room Override Time Left	VAV#	BxyzOR_T	V					1	Set 60 min	
5	Room Weekly Schedule	VAV#	BxyzWS	WS						See Spec 15925	
6	Flow	VAV#	BxyzF	FS				1			
7	Flow Setpoint	VAV#	BxyzF_SP	V					1		
8	Damper	VAV#	BxyzD	DA1			1				
	Temperature Controller	VAV#	BxyzRT_CO	CO					1	use RT:RT_SP	
	Flow Controller	VAV#	BxyzF_CO	CO					1	use F:F_SP	
9	Program	VAV#	BxyzPG	PG					1		
10	Minimum Flow Setpoint	VAV#	BxyzF_MIN_SP	V					1		
11	Maximum Flow Setpoint	VAV#	BxyzF_MAX_SP	V					1		
12	Reheat Coil Valve	VAV#	BxyzRCV	CV3			1				
	Reheat Coil Valve Controller	VAV#	BxyzRCV_CO	CO					1	use RT:RT_SP	
13	Reheat Coil Valve Program	VAV#	BxyzRCV_PG	PG					1		
14	TUC Supply Air Temperature	VAV#	BxyzSAT	DTS1				1			
15	TUC Supply Air Trendlog	VAV#	BxyzSAT_TL	TL					1	VAV#_SAT,BxyzSAT	
16	Window Status	VAV#	BxyzWIN	CRS		1					
	Total				0	2	2	3	12		

NOTE: x = Floor #
yz = Box # of Floor #
For VAV# and Box # see mechanical schedule

BCBC VARIABLE AIR VOLUME TYPE A (VAV:A) - GRAPHIC



GENERIC START UP LOGIC

1 **Supply Fan (SF_PG)**
IF WS ON OR RT_AVG < 14 THEN
    START SF
IF WS OFF AND RT_AVG > 16 THEN
    STOP SF
IF SAP > 30 THEN SF_S = ON
    ELSE SF_S = OFF

[Supply Fan ASD]
IF SF ON THEN
    SF_ASD = SAP_CO
ELSE
    SF_ASD = 0

2.2 **Exhaust Air Damper (EAD_PG)**
BSP_SP = _____ *DEFAULT = 20 Pa*
EAD = MAD - (BSP_SP - BSP)

3.2 **Mixed Air Damper (MAD_PG)**
MAD_MIN = _____ *DEFAULT = 30%*
DO EVERY 3 S RAMP = RAMP + 1%
IF SF OFF THEN
    RAMP = 0%
IF RAMP > 100% THEN
    RAMP = 100% END DO
IF SF_S ON AND WS ON AND FRZ OFF THEN
    IF CLG_MODE ON THEN
        IF RAT < OAT THEN
            MAD = MAD_MIN
        ELSE
            MAD = 100%
    ELSE
        MAD = MAX(MAD_MIN, MAD_CO)
        MAD = MIN(MAD,RAMP)
ELSE MAD = 0

4.3 **Cooling (CLG_PG)**
IF SF_S ON THEN
    IF RT_AVG > RT_SP + 1.3 OR
    RT_MAX > RT_SP + 2 THEN
        CLG_MODE = ON, START DX1
    IF RT_AVG < RT_SP + 0.8 AND
    RT_MAX < RT_SP + 1.5 THEN
        CLG_MODE = OFF, STOP DX1
ELSE
    CLG_MODE = OFF, STOP DX1
[Cooling Stage 2]
IF SF_S ON THEN
    IF RT_AVG > RT_SP + 1.5 OR
    RT_MAX > RT_SP + 2.3 OR
    DX1 ON-FOR 15 MIN THEN
        START DX2
    IF RT_AVG < RT_SP + 1.0 AND
    RT_MAX < RT_SP + 1.7 THEN
        STOP DX2
ELSE
    STOP DX2

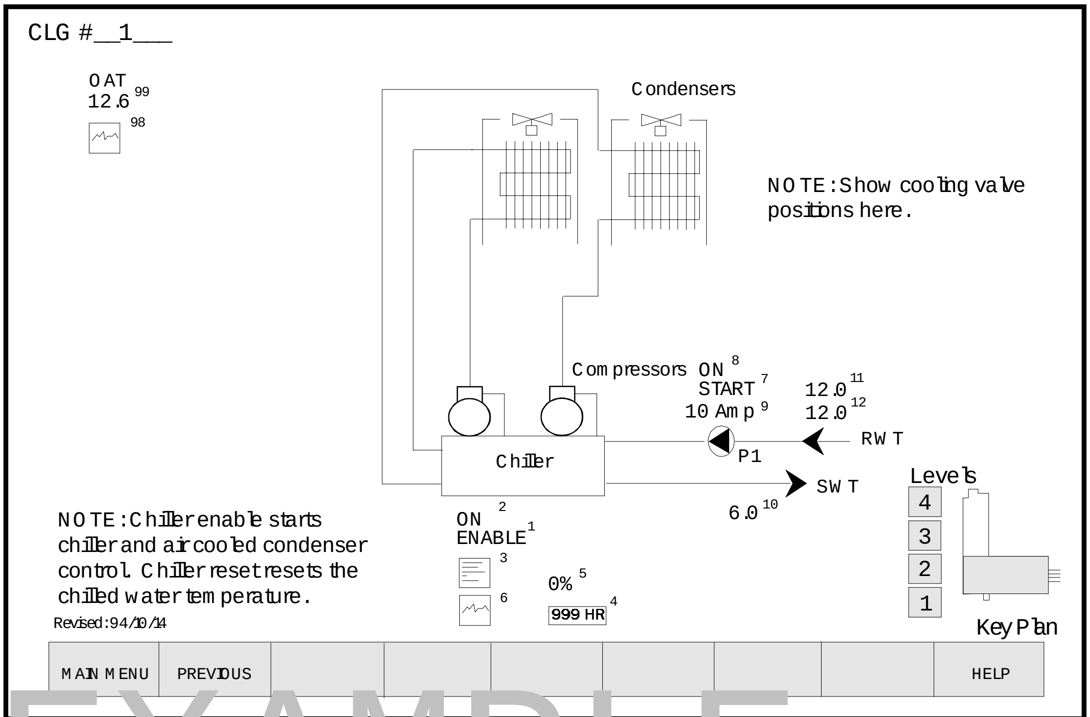
11.3 **Supply Air Temp (SAT_PG)**
RT_SP = ____ *DEFAULT = 22*
SAT_SP = 18 - ((RT_AVG - RT_SP) * 4)

12.3 **Supply Air Pressure (SAP_PG)**
SAP_SP = ____ *DEFAULT = 100 Pa*

PMA VARIABLE AIR VOLUME TYPE A (VAV:A) - POINTS LIST

Project Number: 123		Project Name: EXAMPLE BUILDING									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1.1	Supply Fan Start/Stop	VAV2	SF	CR1	1						
1.2	Supply Fan Status	VAV2	SF_S	V					1		
1.3	Supply Fan Program	VAV2	SF_PG	PG					1		
1.4	Supply Fan Trendlog	VAV2	SF_TL	TL					1	SF,SF_ASD,SAT,SAP	
1.5	Supply Fan Run Hours	VAV2	SF_TZ	TZ					1		
1.6	Weekly Schedule	VAV2	WS	WS					1		
1.7	Supply Fan ASD	VAV2	SF_ASD	DDC			1				
2.1	Exhaust Air Damper	VAV2	EAD	DA2			1				
2.2	Exhaust Air Damper Program	VAV2	EAD_PG	PG					1		
2.3	Exhaust Air Damper Trendlog	VAV2	EAD_TL	TL					1	EAD,BSP,MAD,BSP_SP	
3.1	Mixed Air Damper	VAV2	MAD	DA2			1				
	Mixed Air Damper Controller	VAV2	MAD_CO	CO					1	use SAT:SAT_SP	
	Mixed Air Damper Minimum	VAV2	MAD_MIN	V					1		
	Mixed Air Damper Ramp	VAV2	RAMP	V					1		
3.2	Mixed Air Program	VAV2	MAD_PG	PG					1		
3.3	Mixed Air Trendlog	VAV2	MAD_TL	TL					1	SF_S,FRZ,MAD,MAT	
	Cooling Mode	VAV2	CLG_MODE	V					1		
4.1	Stage 1-DX	VAV2	DX1	CR1	1						
4.2	DX1 Run Hours	VAV2	DX1_TZ	TZ					1		
4.3	DX Program	VAV2	CLG_PG	PG					1		
__.1	Stage -DX	VAV2	DX__	CR1						As Required	
__.2	DX Run Hours	VAV2	DX _TZ	TZ						As Required	
7.1	Return Air Temperature		RAT	DTS2				1			
8.1	Mixed Air Temperature		MAT	DTS1				1			
9.1	Freeze Control		FRZ	FRZ		1					
10.1	Room Temperature Minimum		RT_MIN	V					1		
10.2	Room Temperature Average		RT_AVG	V					1		
10.3	Room Temperature Maximum		RT_MAX	V					1		
10.4	Room Temperature Setpoint		RT_SP	V					1		
10.5	Room Temperature Trendlog		RT_TL	TL					1	SAT,MIN,AVG,MAX	
10.6	Building Pressure		BSP	DPS				1			
10.7	Building Pressure Setpoint		BSP_SP	V					1		
11.1	Supply Air Temperature		SAT	DTS2				1			
11.2	Supply Air Temp Setpoint		SAT_SP	V					1		
11.3	Supply Air Temp Program		SAT_PG	PG					1		
12.1	Supply Air Pressure		SAP	DPS				1			
12.2	Supply Air Pressure Setpoint		SAP_SP	V					1		
12.3	Supply Air Pressure Program		SAP_PG	PG					1		
	Supply Air Pressure Controller		SAP_CO	CO					1	use SAP:SAP_SP	
	Total				2	1	3	5	26		

SINGLE RECIPROCATING CHILLER, AIR COOLED CONDENSERS (BCBC TYPE C:A) - GRAPHIC



GENERIC START UP LOGIC

3 **Chiller (CL_G)**

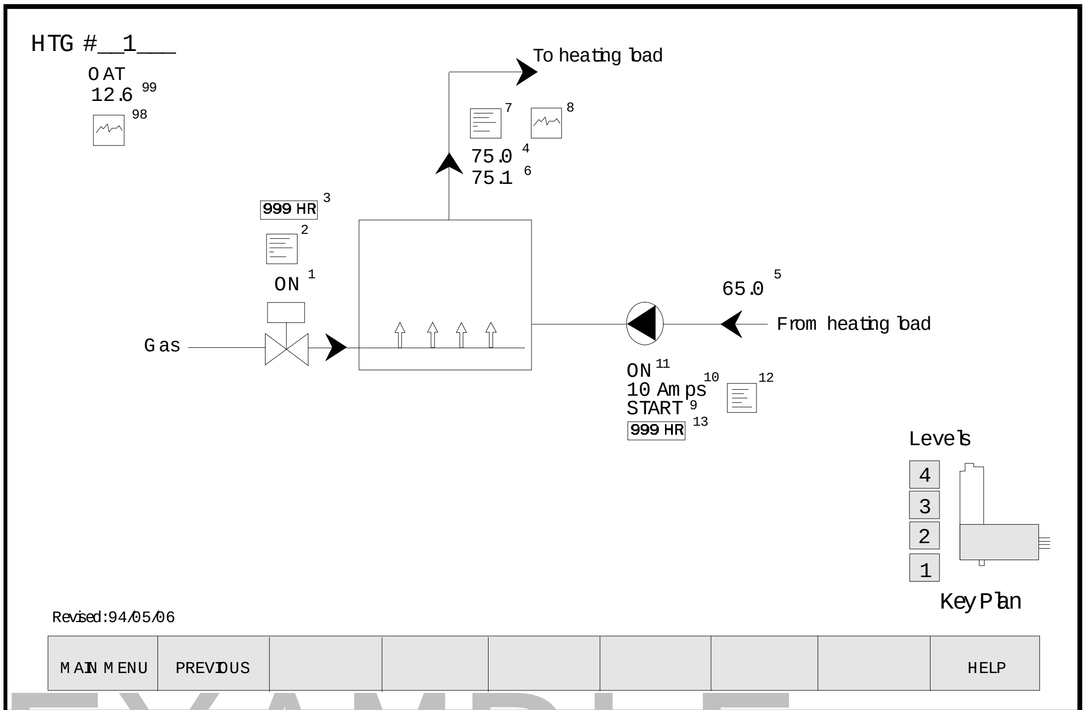
IF OAT > 1 AND ENBL OFF-FOR 30 M AND
MAX (CCV1, CCV2, etc) > 90 THEN
ENBL = ON, START P1
IF OAT < 11 OR
MAX (CCV1, CCV2, etc) < 10 THEN
ENBL = OFF
IF ENBL OFF-FOR 15 M THEN STOP P1
IF P1_AMP > 6 THEN
P1_S = ON
ELSE P1_S = OFF

[Chiller Reset]
RWT_SP = 12
IF ENBL ON THEN CR = CO
ELSE CR = 0

SINGLE RECIPROCATING CHILLER, AIR COOLED CONDENSERS (PMA TYPE C:A) - POINTS LIST

Project Number: 123		Project Name: EXAMPLE BUILDING									
Graphic Logic Location		Point Name Mnemonic		Point	Hardware Point				Virtual	Notes See Page #	Note
	Point Description	System	Point	Type	DO	DI	AO	AI	Point	Comments	#
1	Chiller Control	CLG1	ENBL	CR1	1						
2	Chiller Status	CLG1	S	CRS		1					
3	Chiller Program	CLG1	PG	PG					1		
4	Chiller Run Hours	CLG1	TZ	TZ					1		
5	Chiller Reset	CLG1	CR	DDC			1				
	Chiller Controller	CLG1	CO	CO					1	use RWT:RWT_SP	
6	Chiller Trendlog	CLG1	TL	TL					1	CR,SWT,RWT,ENBL	
7	Chilled Water Pump	CLG1	P1	CR1	1						
8	Chilled Water Pump Status	CLG1	P1_S	CRS		1					
9	Chilled Water Pump Amps	CLG1	P1_AMP	CS1				1			
10	Supply Water Temperature	CLG1	SWT	PTS1				1			
11	Return Water Temperature	CLG1	RWT	PTS1				1			
12	Return Water Setpoint	CLG1	RWT_SP	V					1		
					2	2	1	3	5		

SINGLE ON OFF BOILER (BCBC TYPE H:A) - GRAPHIC



GENERIC START UP LOGIC

2 **Boiler (BLR_PG)**
IF SWT < SWT_SP AND P1_S ON THEN
START BLR_GV
IF SWT > SWT_SP + 5 OR P1_S OFF THEN
STOP BLR_GV

7 **Supply Water Temperature (SWT_PG)**
SWT_SP = 80 - OAT
IF SWT_SP > 94 THEN
SWT_SP = 94
IF SWT_SP < 60 THEN
SWT_SP = 60

12 **Heating Pump (P1_PG)**
IF OAT < 13 THEN
START P1
IF OAT > 16 THEN
STOP P1
IF P1_AMP > 3 THEN
P1_S = ON
ELSE
P1_S = OFF

Project Number:		Project Name:									
Graphic Logic Location		Point Name Mnemonic		Point Type	Hardware Point				Virtual Point	Notes See Page #	Note #
	Point Description	System	Point	D0	D1	A0	A1	Comments			
1	Boiler Gas Valve	HTG1	BLR_GV	CR1	1	.	.	.	.	.	.
2	Boiler Control Program	HTG1	BLR_PG	PG	.	.	.	.	1	.	.
3	Boiler Run Hours	HTG1	BLR_TZ	TZ	.	.	.	.	1	.	.
4	Supply Water Temperature	HTG1	SWT	PTS1	.	.	.	1	.	.	.
5	Return Water Temperature	HTG1	RWT	PTS1	.	.	.	1	.	.	.
6	Supply Water Setpoint	HTG1	SWT_SP	V	.	.	.	.	1	.	.
7	Supply Water Program	HTG1	SWT_PG	PG	.	.	.	.	1	.	.
8	Heating System Trendlog	HTG1	TL	TL	.	.	.	.	1	"SWT,SWT_SP ,RWT,OAT"	.
9	Heating Pump Control	HTG1	P1	CR1	1	.	.	.	.	.	.
10	Heating Pump Amps	HTG1	P1_AMP	CS1	.	.	.	1	.	.	.
11	Heating Pump Status	HTG1	P1_S	V	.	.	.	.	1	.	.
12	Heating Pump Program	HTG1	P1_PG	PG	.	.	.	.	1	.	.
13	Heating Pump Run Hours	HTG1	P1_TZ	TZ	.	.	.	.	1	.	.
.	.	.	.	.	2	0	0	3	8	.	.

E. ELECTRICAL DESIGN STANDARDS

INTRODUCTION
Electricity is now available in every community in the Yukon. Electric lighting, appliances and telecommunications equipment are now typical in buildings across the Yukon. As well, the construction of increasingly air-tight buildings, in the interest of reducing fuel costs, has resulted in an increased use of electricity to power mechanical systems and controls. Although the use of automatic controls may at times seem at odds with the desire to keep Yukon buildings simple to operate and maintain. Standards included here cover installations, which have been found acceptable by Property Management to date. We are attempting to balance the sometimes-conflicting requirements for comfort, energy conservation, simplicity and reliability.

Design consultants to ensure all equipment supplied and installed is completely operational regarding the Y2K time spans and that warranty(s) also cover the situation.

E1 CODES AND REGULATIONS

1.1 REFERENCED DOCUMENTS

Documents referenced in this section include:

National Building Code of Canada
Canadian Electrical Code
Underwriters Laboratories Canada (ULC)
Underwriters Laboratories Incorporated (ULI Canada)
Canadian Standards Association (CSA)
Illuminating Engineering Society (IES)
Institute of Electrical and Electronics Engineers (IEEE)

Related offices include:

Community & Transportation Public Safety Electrical Inspection Branch
Y.E.C.L. (Yukon Electric Company Ltd.)

1.2 MATERIAL STANDARDS

Requirements	Rationale
All electrical equipment is to be approved by Canadian Standards Association (CSA), Warnock Hersey, ULC, ULI Canada, ETL Laboratories Inc. or any other accredited agency approved in accordance with the Electrical Protection Regulations by the Chief Electrical Inspector.	*To ensure the electrical equipment, appliances and wiring products installed in Yukon buildings conform to specific national standards recognized by the Standards Council of Canada (SCC). Recent approval of ETL Laboratories Inc. prompted this heading as CSA and ULC were the only accredited electrical standards organizations for many years*

E2 OPERATION AND MAINTENANCE

2.1 GENERAL

See G1 “Local Resources” and G4 “Appropriate Technology”

2.2 ACCESS

Electrical systems generally require relatively little maintenance. However, easy access to equipment that must be serviced even occasionally, is important. Access hatches and space to be provided for all electrical equipment are required to ensure safe working areas to service or replace all electrical equipment.

2.3 SPARES

Facilities and Regional Managers should determine, in consultation with the Project Managers and design consultants what spares should be provided. The following is a recommended list of spare parts that should be stored in each facility for communities that are not on the road system:

- 1 set of each type of manual starter heater,
- 5 spare fuses of each type used (i.e.: control fuses)
- 1 spare coils for each starter size
- 1 spare control transformers of each type used
- 5 spare pilot lights of each type used (i.e.: fire alarm panels, MCC’s, transfer switch), 10 of each if they are incandescent
- spare incandescent lamps equal to 20% of the original number of lamps installed.
- spare H.I.D. lamps equal to 20% of the original number of lamps installed.
- spare 4’ fluorescent lamps equal to 20% of the original number of lamps installed (to the nearest case)
- 5 spare of each other type or size of lamp used (i.e.: 2’, 3’ compact fluorescents, incandescents)
- 5 spare 2-lamp fluorescent ballasts
- 2 spare single lamp fluorescent ballasts of each type used (i.e.: 2’, 3’, compact fluorescent)
- 2 spare H.I.D. ballast of each type used
- 1 spare breaker of each type used in distribution panelboards and motor control centres (except main breaker)

If a generator is required, provide:

- 1 spare oil filters
- 1 spare fuel filters
- 1 spare air filters
- 1 spare fan belts of each type used
- 1 spare hose of each type used

Rationale

Spare parts are often difficult, if not impossible to get within many communities and there is often a long time lapse required to send in spare parts. A minimum of spare parts as listed, if maintained, should cover most of the regular and emergency maintenance required on electrical systems during a facility’s lifetime.

2.4 STANDARDIZATION

In the interest of maintenance and economy all starters, switches and panels are to be of the same manufacturer. All wiring devices to be of one manufacture throughout project.

2.5 OPERATION AND MAINTENANCE MANUALS (O & M MANUALS)

At present, manuals are to be prepared in accordance with good engineering practice. "Guidelines for the Preparation of Operations and Maintenance Manuals for Electrical System" are currently in a draft form and will be distributed when completed.

E3 IDENTIFICATION

Clear identification of electrical equipment is particularly important for the electrical system. Local maintainers and tradespeople should be able to quickly understand and locate related system equipment. Consistent identification in all Yukon buildings is required to ensure that maintainers and operators can easily become familiar with any Yukon building in any community.

3.1 CONDUCTOR IDENTIFICATION

Requirements	Rationale
Colours of conductors shall be as specified in the Canadian Electrical Code.	
Adhesive conductor markers must be used to identify conductors at all panelboards, motor control centres, junction boxes, terminal cabinets and outlet boxes. The numbering system must include circuit numbers on power circuits. In low voltage and control system wiring, the numbering must match the control diagrams.	*Circuit numbers are useful to identify wiring (trouble-shooting and to avoid accidents by preventing contact with energized conductors.) Due to the increasing complexity of electrical systems, it becomes important to identify wiring with control diagrams on systems to be able to trace wiring during operation and maintenance problems. The minimal cost of identifying the conductors is paid back during trouble-shooting, during training of maintainers or when modifying the system.*

3.2 RACEWAYS/JUNCTION BOXES IDENTIFICATION

	Requirements	Rationale
3.2.1	**Provide identification of systems conduit wherever it is accessible.** See Electrical System Identification Tables E1 and E2.	*For tracing system problems and for making additions or deletions to the system.*

3.3 EQUIPMENT IDENTIFICATION

See Electrical System Identification Tables E-1 and E-2.

Requirements Rationale

3.3.1 Panel Directory

Typewritten panel directories are required. Any room numbers used must be those which will be used by occupants, not room numbers used on contract documents.

*Users need to be able to identify the circuit quickly, by the name or number they commonly use.*3.3.2

3.3.2 Terminal Cabinets

In terminal cabinets for control wiring and low voltage wiring, identify terminal strips with a written directory.

For operations and maintenance staff (maintainers to factory representatives) to quickly trouble-shoot problems and to add and delete parts of the system.

3.3.3 Labels and Lamacoids in Service Rooms

Mechanically fasten all lamacoids in service areas and mount adjacent to, not on controllers.

Mechanically fastened lamacoids are required so they will not fall off - especially noticeable in hot mechanical rooms when adhesive backed lamacoids are used. Mounting beside, rather than on controllers ensures identification when two or more identical control covers are removed during maintenance, or when a defective controller is replaced.

3.4 RECEPTACLE IDENTIFICATION

Receptacles are to be identified by circuit and panel only when it is important that a building user, unfamiliar with the electrical system, be able to quickly re-set breakers.

Requirements	.Rationale
3.4.1 See Electrical System Identification tables E-1 and E-2.	*Typically required in basic health care areas of Health Centres, patient care areas of hospitals, industrial arts rooms in schools.*
3.4.2 Mount labels adjacent to, not on, receptacles.	*Ensures identification when the cover plates are removed (i.e.: during painting)*

ELECTRICAL SYSTEM IDENTIFICATION TABLE E-1
LABELS AND LAMACOIDS

COMPONENT	TYPE	INFORMATION
Main distribution centre Main breaker Sub-distribution panel	A A A	Year installed and name of facility Names of Electrical Engineer and Electrical Contractor Voltage, phase, amps Name of panels it is feeding (i.e.: Panel A, Panel B)
Panelboards	B	Panel designation (i.e.: A,B,C or EA,EB,EC for panels fed from emergency power)
Terminal cabinets i.e.: Telephone, Low voltage	B	Indicate equipment controlled (i.e.: Telephone rooms 1-12, Intercom rooms 1-7)
Equipment > motors, fans, pumps etc.		SEE MECHANICAL IDENTIFICATIONS STANDARDS
Disconnect switches	B	Indicate equipment controlled and voltage
Starters/contractors	B	Indicate equipment controlled and voltage
Motor control centres	B	Indicate equipment controlled and voltage
Transformers	B	Circuit and panel designations
Junction boxes, pull boxes	D	Circuit and panel designation for power. Contents for low voltage (i.e. TV rooms 1-12 or Security rooms 1, 2 & 7)
-On/Off switches -Fire Alarm Devices (i.e.: pull stations, bells, end-of line)	C C	If it is not obvious, then indicate area being served (i.e. Service spaces or grouped switches) Zone number and device number in that zone (i.e.: zone 1-# 3, zone 10 - # 7)
Receptacles Standard duplex GFCI surge suppression special receptacles	 C C C C	If required, then indicate: circuit/panel designation circuit/panel designation circuit/panel designation circuit/panel designation and voltage, phase, amps

	LETTER HEIGHT	TYPE	COLORS
Label Type A	9.5 mm	lamacoid	white lettering/black background
Label Type B	6.0 mm	lamacoid	white lettering/black background
Label Type C	3.0 mm	lamacoid	white lettering/black background
Label Type D	3.0 mm	adhesive labels	no preference

ELECTRICAL SYSTEM IDENTIFICATION TABLE E-2

COLOURS

COMPONENTS	CONDUCTORS	RACEWAYS[1] AND JUNCTION BOXES[2]	RECEPTACLES	OTHER
Normal Power 120/208 , 240 volt 347 /600 volt	 code code	 Gray Sand	 as specified by the designer	
Emergency Power 120/208 , 240 volt 347 /600 volt	 code code	 Gray w/red bands Sand w/red bands	 Red n/a	
Low voltage: -switching/controls -emergency/exit lighting -security -mechanical alarms		 Black Black w/red bands Black w/blue bands Black w/yellow bands		 Strobe (blue) Strobe (amber)
Fire alarm		Red		Strobe (red)
Owner Equipment: -telephone -intercom and sound -computer networks -television and cable -airport instrumentation and controls		 White White w/yellow bands White w/black bands White w/blue bands White w/orange bands		

1 Exposed raceways are to be colour coded in mechanical and electrical rooms, above removable ceilings and where they enter and leave a room.
The main colour band must be a minimum of 130 mm x 30 mm with auxiliary colour bands at each end (if required) being a minimum of 20mm x 30 mm.
Raceways (i.e.: conduit) must be coloured within 200 mm from each enclosure and at 5 m on centre thereafter within an area.

2 All junction boxes, pull boxes and their covers must be painted according to the colour coding schedule.

E4 POWER SUPPLY

Electricity is supplied in most Yukon communities by diesel generators operated by the Yukon Electric Co. Ltd. Power costs are very high. Hydropower is currently available in 7 communities (Whitehorse, Mayo, Teslin, Haines Junction, Carmacks, Carcross and Faro). Voltage spikes are typical and power outages not infrequent.

4.1 PUBLIC UTILITIES

Power is supplied and generally distributed by Yukon Electric Co. Ltd.

Requirements	Rationale
4.1.1 Consumption targets See specific sections regarding energy consumption requirements (i.e. lighting, motors). See G6.1	
4.1.2 Underground service Underground services are becoming the norm in most larger buildings in Whitehorse. Overhead seems to be the norm in communities on most buildings.	*Local and site conditions govern.*

4.2 STANDBY POWER

Reliability of power supply for equipment is more important in cold climates than in moderate climates because of the dire consequences of failure. Systems depend on electricity for boilers, pumps, fire protection and heating controls. Power failures in northern communities are common due to various environmental and system factors. For this reason, individual standby generators are often required in Yukon buildings where essential services must be maintained.

The importance of reliability is mentioned, not so much for community functions, but because of the dependence on electricity for building systems.

(Note the term "standby" generator is specifically used as opposed to "emergency" generator, which has stringent code requirements)

Requirements	Rationale
4.2.1 Where Required Standby power is only to be provided in buildings where essential services must be maintained.	*Capital and maintenance costs are high - generators must be exercised and checked weekly. Typically provided in evacuation or reception centres designated under the Emergency Measures act, or buildings such as Health Centres or Group Homes*

4.2.2 CSA C282-M89

This standard is deemed suitable for the design of gensets for most Yukon facilities except that a manual bypass, as outlined in section 8 .5 of the standard, is not required in health centres**.**

The CSA standard was developed to cover installations where power is required on an emergency basis. In most Yukon facilities stand-by power is provided as a back-up for convenience, not safety, and shut-downs can be scheduled making a manual bypass unnecessary

4.2.3 Components Required

When generators are required, they should be:

- fuelled by same auxiliary tank provided for heating system
  Assures fuel supply.
- skid mounted and come complete with:
  Is easier to move if equipment needs to be repaired.
  - glow plug and timer
    Install where required.
  - steel springs and/or rubber pads as recommended by the manufacturer
    To combat light and heavy vibrations.
  - remote annunciator package for critical functions
    To identify generator problems.
  - thermostatically controlled electric circulating block heater
    To ensure the generator is warm for easy starting.
  - integral radiator
    See above regarding remote radiators.
  - hospital or critical grade muffler
    For noise reduction.
  - flexible exhaust section
    To dampen generator vibration to the exhaust.
  - battery, automatic battery charger, cable and rack
    Starting system failures typically cause 85% of failures on standby generators. Proper selection of battery and charges is particularly important.
  - 12 volt electric start
    Preferred over 24 volt systems for safety and maintenance.
  - Generator common trouble to be indicated on the fire alarm panel. The generator hand/off/auto switch to show common trouble when placed in the hand or off position. The Main circuit breaker located on the generator to show common trouble when in the off or tripped position
    To ensure emergency power is always available.

4.2.4 Capacity

Standby generators must be sized to carry the following as a minimum:

- complete heating system including fuel pumps, controls and boilers
- fire protection system (including fire pump and jockey pump)
- exit lighting
- domestic water pumps
- sanitary pumping
- lighting and power loads deemed necessary

To Allow buildings to continue operating with minimal disruption. In many instances the entire electrical system can function on standby power as there is no cost or operational advantage to diminishing lighting and receptacle capacities. Refer to the facility program to determine when lighting and power loads are essential.

4.2.5 Controls

All generator control panels are to be remote mounted.

To avoid vibration damage to controls when mounted on the generator

4.2.6 Automatic exercising

Time clocks for automatically exercising the generators are not required.

In the past there was concern that maintenance staff were either non-existent or untrained for testing the generator regularly. Consequently, time clocks were installed to ensure the generator was cycled regularly to ensure proper operation. With qualified maintainers in all communities and the requirement of CSA C282 & Preventative Maintenance Management System (PMMS) to record and log all instrument readings during a weekly test, the time clock is redundant

4.2.7 Timer

Provide timer (holdover timer or "time delay, emergency- to- normal") with a minimum lag time of 2 minutes before retransfer from generator power to normal power after normal power restarts.

To allow time for the normal power to stabilize.

4.2.8 Location

All standby generators are to be installed in a room separated from other oil fired equipment and with connecting door large enough to allow for changing the generator.

Ensures that generator operation doesn't consume boiler combustion air.

4.2.9 Portable Generators

Portable generators are acceptable in unique circumstances in Yukon buildings.

Where a generator is required, it should be permanently installed to ensure reliability and regular maintenance. Because it is portable, there is a good possibility it will not be readily available when it is required. Portable units can also be hazardous if improperly installed, grounded or exhausted.

4.2.10 CSA Z32.4

"Essential Electrical Systems for Hospitals" is generally not applicable to Yukon Health Centres

Health Centres are not deemed to be hospitals nor do they offer the level of service expected of a hospital

4.3 RENEWABLE ENERGY (SUN, WIND)

The seasonal availability of solar and wind energy in the north is often much higher than southern locations annually. However, renewable energy systems should only be considered where life cycles costs can be shown to be lower than for alternatives.

Requirements	Rationale
4.3.1 Unsuitable Applications 1) Where buildings can be connected to a grid, solar power generation technologies, which generate electricity, should be carefully considered.	*Renewable energy equipment which is grid connected tends to be accompanied by high capital cost of synchronous inverters to perform the grid link, and refusal of utilities to pay fairly for energy supplied. Code and enforcement also add to the cost and complexity.*
2) Systems that use solar energy primarily to provide lighting should not be used when day lighting can be used to provide adequate lighting.	*In the summer months natural daylight is available. Solar panels are not effective in the winter due to short daylight hours.*
4.3.2 Suitable Applications 1) Solar energy technologies which generate electricity are best suited for remote and/or summer-use facilities such as: parks buildings, field research stations and fire towers.	*The cost of operating and fuelling generators in remote locations in the north is usually very expensive. Alternative energy is expensive but has very low operational costs*
2) All electrical loads must be reduced to an absolute minimum by using the most efficient hardware and appliances available before renewable energy hardware is to be considered.	*The initial cost of buying a renewable energy system is normally the largest component of the life cycle costs. As the initial cost is proportional to the size of the loads imposed on the system, reducing the loads will help minimize the life-cycle costs of the system.*
3) Where wind turbines are installed, they will generally require a separate power source.	*Most wind turbines are induction generators and require excitation from a separate power source.*

4.4 CONSUMERS SERVICE AND DISTRIBUTION

Requirements	Rationale
4.4.1 Electrical Service Rooms (1) Separate Room A separate electrical room is preferred for all Yukon facilities.	*Consolidates electrical equipment and, by separating from mechanical equipment, generally ensures better access for maintenance operations*
Wherever standby power is provided, electrical panels and equipment may be located in generator room noted in E4.2.8 above, with the exception of motor control centres.	*As a separate room is already required for the generator; electrical equipment can be located there. Motor control centres are usually better placed in the mechanical room so the controls are within sight of more of the motors they control*

2) Working space

Provide adequate space around electrical equipment. Co-ordination with the other disciplines (especially mechanical) is essential. Entrance to and exit from the working space around electrical equipment must be kept clear of all obstructions.

Past experience with unacceptable clearances has resulted in need for on-site changes.
We intend to ensure that safe working space is provided around electrical equipment (i.e.: including space to stand beside panelboards while disconnecting breakers).
Careful consideration during the design phase can help to anticipate and avoid the working space being used for storage space

4.4.2 Components

Standard of acceptance for power systems is Square D, Westinghouse, Commander, FPE, Siemens Standard of acceptance for control equipment is Square D, Westinghouse, Commander, Siemens

To standardize so maintenance staff are familiar with the products. To reduce inventory.

4.4.3 Spare Capacity

The main distribution should be sized to handle the calculated load (connected load with demand factors as permitted by the CEC) plus a 15% to 35% additional capacity.

Electricity demand has been steadily increasing for many years due to the steady increase in electrical products available (i.e.: microwave ovens and computers). Additional capacity is required for additional loads expected over the lifetime of the building. Note: These are minimum requirements (i.e.: Facilities planned with a future expansion may require a larger capacity)

4.4.4 Panelboards - Spare Conduit

For flush mounted panels, stub 3 spare 19 mm conduit out to the ceiling space and/or crawl space (whichever is accessible afterwards). Ensure conduit are suitable capped off.

To provide ready access to the panelboards for future circuitry requirements.

See CEC 12-940

4.4.5 Breakers

Wherever possible, use breakers rather than fuses.

Tripped breakers can be reset; burnt-out fuses must be replaced. Replacement fuses are not readily available in most communities which can lead to the serious consequences associated with loss of power in cold climates. Fuses may be specified only where a large interrupting rating is required

4.4.6 Location of Receptacles

(1) Receptacles facing up

Receptacles should not be mounted facing up either inside or on shelving units, work surfaces our counter. The only exception permitted is a floor box with an independent cover.

Dirt accumulation or spilled substances could create problems (i.e.: Home Economic Rooms & Science Rooms).

(2) Receptacles in exterior walls

Where possible, avoid outlets in exterior walls if the air/vapour barrier must be broken to accommodate the devices.

It is not always possible in large rooms with exterior walls (i.e.: gyms, assembly halls) but the intent is to reduce the number of penetrations. (Note: this is not a concern where walls are built or strapped on the warm side of the air-vapour barrier)

4.4.7 Provision of Branch Circuits

(1) Counter receptacle
At least one 3-wire branch circuit (split receptacle) should be provided at counter work surfaces where coffee making is anticipated.

To prevent overloading of a circuit. These requirements border on adequacy provisions, but experience shows that if there isn't a degree of adequacy in the electrical installation, they quickly become unsafe. (Examples include adult education classrooms, school lounges, offices, office staff room, lunch and coffee rooms).

(2) Fridge, microwave, freezer
A separate branch circuit should supply each receptacle installed for a refrigerator, microwave oven or freezer

Same as above

4.4.8 Branch Circuits

Circ. pump, heat trace
A separate branch circuit should supply each water circulation pump, boiler and heat trace outlet.

To prevent freezing of the facility water supply due to a fault in other electrical equipment

4.4.9 Electrical Boxes

Sectional boxes are not to be ganged.

Floor boxes
Use floor mounted receptacles only if there is no alternative to providing power to equipment. If used, they must be flush mounting type complete with hinged covers

Ganged boxes can come apart during rough-in which eliminates the grounding between boxes. Boxes that are flush mounted are less obtrusive and less of a "tripping" hazard compared to surface mounted floor boxes. Flush mounted floor boxes with removable covers are often misplaced; leaving receptacle facing up which is an electrical hazard

E5 GROUNDING AND BONDING

Grounding by connecting to municipal water mains, as is typical in most of urban Canada, is seldom possible for Yukon buildings. Means of adequately grounding facilities are covered by the CEC; the preferences stated reflect Property Management experience with different situations encountered in Yukon buildings.

5.1 ORDER OF PREFERENCE:

Requirements	Rationale

5.1.1 Order of preference as follows:

1. Municipal piped water system
2. Exothermic (cad) weld to a minimum of 4 steel pipe piles
3. Minimum 9.5 mm ($^3/_8$) bolts (copper, bronze or brass) tapped and threaded to a minimum of 4 steel pipe piles
4. Uffer ground or rod electrodes
5. Plate electrodes.

The electrical resistance of the ground in the Yukon is extremely variable (1 to 1000 ohms for a standard 16 mm by 1.5 m grounding rod). The resistivities of frozen ground are inadequate to meet the electrical code requirements. The choices given indicate the options in order of preference for providing the best possible ground system.
Consideration must be given at the design stage to pick the best possible system avoiding dissimilar metals from galvanic action set up under certain soil conditions

5.2 CSA Z32.2 “Electrical Safety in Patient Care Areas”

Assume procedures as noted in 6.3.7 .

E6 WIRING

6.1 USE OF CONDUIT

Property Management previously required all wiring to be run in conduit. This was viewed as a worthwhile investment as it simplified any unforeseen expansion or changes. In practice not all facilities make use of this feature over a 20 year lifetime. The need for conduit has now been reviewed and modified as noted below.

Requirements	Rationale
6.1.1 Conduit installed in Wood Frame Construction Where conduit is not required by Code but is installed in wood frame construction for the convenience of future expansion, such conduit is to terminate in junction boxes convenient to each room (i.e.: above T-bar ceilings, corridor ceiling spaces, crawlspaces). Wiring to the power outlets from this junction box can be accomplished using NMD90 or armoured cable from the junction boxes.	*The intent is to allow some flexibility to reduce construction costs associated with conduit in wood frame construction, yet provide a “grid” system of conduit and junction boxes for future circuiting and trouble shooting requirements.*
Conduit is also not required for long runs where only a single circuit is used. (I.e.: exterior lights, exit lights, emergency battery pack remote heads).	*Conduit to allow for expansion of electrical power systems is typically <u>not</u> required for residential facilities such as student residences or group homes, arena support space areas, gymnasiums or community halls, garages, warehouses or firehalls.* *Allowances should be made for spare conduits to be located in buildings with no crawlspace or t-bar access.*
6.1.2 Telephones Conduit is to be provided as outlined in the booklet "Standards and Requirements for Telephone Services" dated June 1980, available from Northwestel through their Building Industry Consulting Service in Whitehorse.	*Northwestel supplies and installs all outside wiring and cable required for telephone system, but the owner must supply equipment space.*
6.1.3 Owner equipment Group wiring and cables for centrally controlled or networked equipment in a common conduit, raceway, or cable rings, sized to allow for some expansion.	*Examples of systems where this should be applied include computer LAN's, intercom systems (independent of telephone), sound systems, and television. Equipment and systems should be identified in facility programs*

6.2 WIRE AND CABLE

Requirements	Rationale

6.2.1 Type & Size

1) Copper wiring only, type R90 or RW90 (X link). All wiring to be minimum # 12 gauge with the exception of control wiring and low voltage wiring.

#12 is specified to prevent voltage drop problems associated with #14. Heat (I^2R) losses are reduced

2) Control wiring and low voltage wiring (i.e.: fire alarm) can be as per minimum code requirements.

Confirming that minimum code requirements are acceptable for control and low-voltage wiring

3) FAS cable is acceptable for fire alarm systems in wood frame construction.

Confirming that minimum code requirements are acceptable for control and low voltage wiring

4) The use of aluminium wiring is prohibited

Because connections require annual inspections as they have a tendency to loosen

5) Communication and data wiring

As per ISB, Department of Government Services, structured wiring systems standards April 1995. See appendix "M".

6.3 WIRING DEVICES

See E2.4 "Standardization."

Requirements	Rationale

6.3.1 Grade

Wiring devices should be "Specification Grade" or better for all applications.
The following set the Standard of acceptance:

- Standard Receptacle: Arrow Hart 5252 series, Bryant 5252 series, Hubbell 5252 series.
- Surge suppression Receptacle: Hubbell 5252-S c/w blue nylon face (5261-SP).
- Ground Fault Receptacle: Bryant GFR 5252 FT, Hubbell GF 5252.
- Standard switch: Arrow Hart 18 91 series, Bryant 48 01 series, Hubbell 1201 series, Leviton 53501/001 series.
- Exterior light control: Hubbell 138 1-T (spdt).

Residential quality is simply not durable enough for public buildings.

6.3.2 Colour

Wiring devices (receptacles and switches) are to be of the same colour throughout the building. (exceptions: surge protection outlets, emergency outlets, etc.)

To standardize the colour for replacement/stocking purposes yet allow some flexibility for the designers choice. (i.e.: ivory, white, brown)

6.3.3 GFCI Outlets

A GFCI breaker should protect exterior receptacles requiring ground fault circuit interrupter (GFCI) protection.
Interior ground fault receptacles are to be the receptacle type and have "test" and "reset" on face of receptacle.

GFCI breakers are stipulated over GFCI receptacles for exterior use as the "test" and "reset" buttons on the receptacles do not function in extreme cold conditions (i.e.: -40°C).
GFCI receptacles are much less expensive than GFCI breakers and also more likely to be tested regularly because the "test" is readily accessible.

6.3.4 Cover Plates

Stainless steel, enamel finish metal, or nylon receptacle plates preferred. Do not use Bakelite.

Stainless steel typically used in community use or detention facilities, as they are least susceptible to damage. Enamel finish metal or nylon acceptable for most other uses including student residences, offices, group homes or treatment centres.

6.3.5 Crawlspace

Receptacles must be provided in all enclosed crawlspaces adjacent to all equipment so that any point in the area is not more than 25 m horizontally from a receptacle.

The NBC does not clearly cover requirements for crawlspaces commonly used in Yukon buildings.

6.3.6 Outdoor Plug-ins

Provide where identified as a program requirement. Mount exterior electrical outlets on the building unless otherwise stipulated. Use underground cable to rails or posts only where necessary or unavoidable.

Minimize use of exterior electrical cables, keep outlets above snow level, and people tend to not run into buildings as often as car plug posts or rails.

Parking outlets must be split receptacles if they serve 2 parking stalls.

Vehicles in the north generally have a block heater and battery blanket and may also have an in-car warmer. The loads require a separate circuit for each parking stall. When more than 6 automobile stalls or spaces are required, provide a control system which provides power to the outlets in the following manner.

Above -20°C.	No power.
-20°C to -30°C.	Cycle power (I.e.: 20-30 min on, 20-30 min off)
Below -30°C.	Continuous power.

Energy conservation.

When 12 or more outlets are provided, at temperatures between -20°C and -30°C, the outlets should be cycled in such a manner that only one-half of the outlets are energized at any given time.

Energy conservation (to reduce demand charges).

6.3.7 CSA Z32.2 "Electrical Safety in Patient Care Areas" M1989

Receptacles to conform to requirements as follows:

- Assume casual contact only in basic care areas of community Health Care Centres.
- Assume casual contact, external connection and direct connection potential in basic care areas of Hospitals.

Clarification of application of Standard. Terms used here are as defined in standard.

6.3.8 Outlets for data and telephone to meet ISB standards.

E7 LIGHTING AND LIGHTING DESIGN

This section of the standards deals with lighting not only as it is related to building electrical systems, but also as it relates to architectural and interior design. Lighting Design is defined in the Illumination Engineers Society Handbook as

The purpose of this standard is to define lighting requirements that are both cost-efficient and optimum for the user.

There are large variations in light levels within buildings. The light level while walking from one point in a room to another may seem the same, even though it may vary. In fact, use of fluorescent fixtures can result in light levels that vary by 100 to 200 lux (10 - 20 foot-candles), depending on the spacing of fixtures, age of the fluorescent tubes, and type of louvers or lens on the fixture, for example. Yet many people are unaware of these light level differences.

Similarly, the light level at a ceiling light fixture can be 3,000 lux (300 foot-candles). The light level at the floor directly below can be 100 lux (10 foot-candles). Most people, however, perceive the light level as being uniform from floor to ceiling. Our eyes are accustomed to adjusting to varying light levels and do so automatically. This ability is believed to be an evolutionary adaptation to large changes in light levels in nature.

The lighting design task is not so much about light intensity as quality of the lighting design. Good design is critical to ensure appropriate light distribution that avoids excessively dark ceiling and wall areas, makes good use of available natural light, prevents excessive glare, and properly matches the light level to the task or activity in the room. A room with a higher average light level can seem darker than a room with a lower light level if such factors are not adequately considered in the design.

"Providing light for the visual tasks to be performed and creating a balanced, comfortable, and aesthetically appealing environment co-ordinated with the decorative and architectural theme."

7 .1 INTERIOR LIGHTING

Artificial lighting requirements are not much different in the Yukon than anywhere else in North America, although the potential for day-lighting is more limited during winter months. The use of "energy saving" lamps and fixtures and switching allowing close control is important as lighting accounts for a major portion of electrical costs. The use of new and innovative products, however, should be carefully considered in terms of cost, availability and maintenance. The role played by lighting in enhancing the architectural setting, orientation and atmosphere is to be recognised, but should be kept to a minimum.

Requirements	Rationale
7.1.1 Illumination levels	
(1) Lighting intensity is usually designed to the recommended minimum of the current edition of the Illuminating Engineering Society's (I.E.S.) Lighting Handbook or the minimum as required by the Yukon Government OH&S Act, whichever is the most stringent. Recommended IES illuminance are shown in Appendix H	*In many instances this has been considered as too high.* *Lighting levels are generally being lowered throughout government facilities.*
2) For schools, lighting for all areas shall be designed in accordance with the Illuminating Engineering Society Handbook, 8th edition or later, RP 20-198 5, Lighting for Parking Facilities, and, the Guide for Educational Facilities,	

ANSI/IES RP3-1988.

3) A 15% design allowance shall be made.

This design allowance compensates for light level deterioration over time due to fluorescent tube aging and normal dirt buildup on lenses and reflective surfaces between annual cleanings

4) The luminance or brightness ratio of significant surfaces in school classrooms and shops shall not be less than one third of the task luminance and not greater than five times the task luminance

This means that the highest light reading in the classroom should be no more than five times the light level on desks. The lowest light level should be no less than one third of the light level on desks.
As the eye shifts from one task, such as reading a book, to another task, such as looking at a chalkboard, it must adapt to a change in light level. If the difference in brightness is too great, eyestrain is experienced.

5) Wall surfaces, including window coverings, and ceiling surfaces shall have a design reflectance of 0.60 to 0.80 to allow for the actual reflectance of these surfaces in use. Similarly, floors shall have a design reflectance of 0.2 to 0.3. Walls and ceiling surfaces shall have a reflectance of 0.7 or higher on completion of installation. Floors shall have a reflectance of 0.20 or higher on completion of installation. Wall and ceiling paint shall be eggshell or semi-gloss.

Wall colour can have a negative impact on perceived light levels even when the light level on the work surface, such as a table or desk, is satisfactory. That is, some colours are generally considered drab and others are considered neutral. An office with gray walls, for example, can appear underlit, even at acceptable light levels on working surfaces. Darker colours do absorb a higher percentage of the light that shines on them. Dark wall and ceiling colours, for example, can absorb more than 50 per cent of the light from ceiling light fixtures.
Paint, ceiling tile and flooring suppliers provide the reflectance of their products. Eggshell and semigloss paint is specified to reduce deterioration of reflectance due to dirt build-up, helping to maintain the reflectivity in the specified range

7.1.2 Energy Efficiency

Designers are encouraged to stay within the energy budgets for lighting as set out in ASHRAE/IES 90.1. Energy consumption of the lighting should not exceed the ASHRAE/IES 90.1 standard for each space by more than 10%. and in all cases electricity use for lighting shall not exceed 15 watts per square meter(1.4 watts/square foot).

The goal is energy efficiency. While publications of the energy code is expected in 1996 it will not automatically be adopted within the Yukon as part of the NBCC.
The requirement for a specified energy use per unit area, measured in watts per square metre, provides a check on the lighting calculations. This requirement generally eliminates older style light fixtures that are costly because of their high electricity consumption, but does allow for both T-8 ceiling fixtures as well as some task lighting. It provides the designer with a simple check on his or her design. This approach is used in the new National Energy Code and is well accepted, largely for its simplicity.

7.1.3 Daylight

Where daylight can contribute to illumination for a significant portion of the annual occupied hours in any room, the artificial lighting levels should be adjustable to be able to take advantage of daylighting.

Minimum lighting levels have to be calculated based on northern winter conditions when daylighting is not possible in most Yukon communities. Where daylight can provide adequate illumination to a room or a portion of a room, there must be the capacity to turn off redundant electrical lighting if any energy savings are to be achieved. Large areas banks controlled by a single switch for example don't normally allow the flexibility required.

7.1.4 Indirect lighting

Indirect lighting should only be considered where the quality of the lighting is the most important factor in the lighting design.

For most Yukon buildings, the life cycle cost is the most important factor. Typical applications such as school gyms and entrance foyers should not be considered for indirect lighting unless the additional life-cycle cost is insignificant. (i.e. <5%)

Where indirect lighting is appropriate, reasonably uniform ceiling luminance is to be achieved.

If this is achieved, occupants may face in any direction without being subject to excessive veiling reflections on the tasks.

7.1.5 Valence Lighting or Spot Lighting

Use only for task lighting, display cases and walls which are intended to be features or where dramatic lighting is important.

Minimize use because of poor lumen/watt ratio and tendency to pick up irregularities of wall surfaces such as painted drywall.

7.1.6 Video Display Terminal (VDT) Lighting

(1)Where VDT's are used, lighting fixture lenses should be low-glare parabolic type.

Visual comfort means little or no glare. Glare from reflective and convex screens can be annoying and even painful for the operator. It is often difficult to position the VDT to prevent reflections on the screen.

(2) Where parabolic louvers are required, 3/4 inch x 3/4 inch (19 x 19 millimeters) openings are the minimum acceptable. Where this size is selected, 3/4 inch x 3/4 inch x 1/2 inch deep, 0.020 inch thick specular-silver-film-laminated plastic louvres with a minimum reflectance of 94 per cent shall be used. Deep cell parabolic louvres are an acceptable equivalent where approved by the owner.

From operating experience, 3/4 inch x 3/4 inch (19 x 19 millimetres) openings have been found to be the minimum acceptable opening size to provide a reasonable amount of light.

7.1.7 Night Lights

Provide night lighting only where minimum lighting for safety or security is required at night and where light switches cannot be conveniently located.

The high cost of electricity limits the use of night lighting. Appropriate uses are group home hallways (for safety) or arena lobbies (for security) where switches are normally located at a central panel or in a closed off room.

7.1.8 Fixtures

(1) <u>Polycarbonate fixtures</u> to be used in change rooms and ancillary washrooms.

High potential for vandalism in some washrooms and change-rooms (i.e. arenas, schools)

(2)<u>Over- Counter Lighting</u>
Provide task lighting over counters, separately switched (i.e.: fluorescent valance lighting under cupboards).

Work at counter tops often requires good lighting for tasks. (i.e.: Nursing stations - writing reports, kitchens - reading recipes) to overcome shadows cast by the body from general room lighting. Ensure a valence is installed to prevent glare at *eye level.*

(3)Task Lighting
Wherever possible, provide built-in task lighting to supplement the ambient lighting for critical seeing tasks rather than providing high ambient lighting.

Energy conservation. To accommodate the need for higher lighting levels due to task visual difficulty, glare, etc. Typical applications are offices & residential buildings.

(4) Imperial Fixtures
See "**Lamps"** "Imperial vs. metric" 7 .1.4

(5) Arena/Curling Fixtures
All luminaries in unventilated (less than 3 air changes/hour) arenas/curing rinks must be suitable for use in wet locations.

High humidity due to flooding of rinks and the lack of mechanical ventilation causes severe condensation and frost build-up.

7.1.9 Lamps

(1) Incandescent lamps
Incandescent lamps are only permitted in heated spaces for special light-critical applications, in cold temperature applications or in residential spaces where more efficient light sources would not be suitable.

Energy efficiency and to avoid relamping costs. Special applications may include hospital operating rooms, light sensitive display areas in museums.

(2) Fluorescent lamps

a) T-8 lamps must be used for most general lighting applications within heated spaces. Exceptions: residential buildings, unheated spaces.

Energy efficient, high colour rendering index (CRI) reduced inventory. Typical uses: general lighting in office areas, classrooms, lobbies, health centres, maintenance garages, firehalls, community halls, gyms, kitchens.
Single tube fixtures wherever possible*.*

b) Do not use U-shaped fluorescent lamps or tubes over 4 ft (1.2 m) in length.

Cost of U-shape is a major concern. (34 watt U shaped are currently 20 times as expensive as standard 4 ft. 34 watt lamp). Lamps over 4 ft (1.2 m) require larger storage area and are more susceptible to breakage during shipping.

c) Specify lamp length in Imperial measurement. (i.e.: 4 ft instead of 1.2 m)

Imperial lamps are still more readily available, inventory is reduced (avoids double stocking as metric lamps are shorter), and costs are about 2/3 of metric lamps.

d) T-8 fluorescent lamps shall have:

-a 4100ºK colour temperature,
-a Colour Rendering Index (CRI) greater than 8 0, and
-a rated life of 20,000 hours or more.

Fluorescent light fixtures in these standards use one inch diameter (T-8) fluorescent tubes (or better) rather than the older style one and a half inch diameter (T-12) fluorescent tubes. They use less electricity than older style T-12 fixtures producing the same amount of light, and even less when used with instant start electronic ballasts. Instant start ballasts use approximately two watts less than rapid start ballasts.
T-8 fixtures eliminate the hum associated with fluorescent lights, due to the higher operating frequency of the electronic ballast that they are used with. This higher operating frequency also means that the sometimes-irritating visible flicker

that used to be associated with fluorescent fixtures is eliminated.
T-8 tubes use special triphosphor coatings to achieve better control over the colour temperature and the colour rendering index. Colour temperature of a light source is a numerical measure of its colour appearance. A light source's colour temperature is expressed in degrees Kelvin (ºK). A light source with a low colour temperature of approximately 3000ºK in the red/orange/yellow side of the colour spectrum is described as warm. A light source with a high colour temperature of approximately 6000ºK in the blue side of the colour spectrum is described as cool. The colour temperature specified (4100ºK) is the one currently most popular, according to local suppliers

e) <u>Marking disconnected tubes</u>
Where fluorescent tubes have been twisted to disconnect them to reduce the light level, a 12.5 mm (1/2 inch) yellow dot shall be placed on the edge of the fixture to identify it for maintenance purposes.

Marking disconnected tubes and ballasts helps custodians and maintenance identify which fixtures have been disconnected and which require maintenance.

f) <u>Marking disconnected ballasts</u>
Where ballasts in fluorescent fixtures have been disconnected to reduce light level, a 12.5 mm (1/2 inch) red dot shall be placed on the edge of the fixture to identify it for maintenance purposes.

(3) <u>Compact fluorescent</u>
To be used wherever low level lighting is required to be on continuously or for extended periods of time.

Although lamps are more expensive than incandescent bulbs, very low energy consumption means life-cycle costs are much lower when lights are used continuously.
Typically used for lobby or corridor lighting in health centres, student residences and group homes and in exit lighting.

Compact fluorescent lamps to be limited to the 13 -watt size, twin and quad formats, or 26 watt size.

To standardize, especially important in remote communities, so as to standardize maintenance and lower inventory requirements.

(4)<u>High Intensity Discharge Lighting</u>

a) Metal Halide lamps are preferred in areas with high ceilings.

Typically used in community gyms, airports, and larger libraries or visitor centres.

b) High pressure sodium lamps are generally not acceptable for indoor use.

Poor colour rendition used outdoors.

c) Low pressure sodium lamps are not acceptable for interior use.

Very poor colour rendition

7.1.10 Ballasts

(1) Power factor

Ballasts are to be high power factor type (i.e.: minimum p.f. of 0.9)

To reduce operating costs

(2) Instant Start Ballasts shall be electronic with:

- a total harmonic distortion (THD) of less than 20% on current,
- a power factor of over 90 per cent,
- a crest factor of 1.7 or less, and
- instant start.

Where economic, high and low ballast factor ballasts shall be accepted.

IS ballasts are now more commonly available than rapid start ballasts. Previous problems with shortened lamp life are now resolved.

(3) Low Temperature Ballasts

Provide low temperature ballasts for all exterior lighting and for lighting in unheated buildings. (i.e.: arenas, cold storage garages).

Luminaries suitable for cold weather conditions are also required in unheated buildings.

(4) RFI Suppression Ballasts

Provide Radio Frequency Interference (RFI) suppressing ballasts in areas containing sensitive electronic equipment.

RFI suppressing ballasts are necessary to prevent interference where sensitive electronic equipment is present (i.e.: Typically required in Flight Service Stations and Community Air Radio Stations)

7.1.11 Plastic luminous panels

1) Acrylic prismatic lenses minimum thickness .125" (K12).

To identify the standard of acceptance.

2) All T-8 fluorescent light fixtures in school classrooms, libraries, offices, drafting areas, sewing rooms, shops, corridors, locker areas and washrooms shall have plastic luminous panels (acrylic lenses), or flat thin louvres, except where parabolic louvres are required (see section 7 .1.6 Video Display Terminal (VDT) Lighting). Direct/indirect suspended fixtures are acceptable.

Acrylic lenses provide more light laterally. That is, the light is directed less strongly downward than with parabolic louvres.

Either acrylic lenses or louvres are acceptable provided the achieved light level is appropriate for the task and all other requirements of the lighting design standards are met.

7.1.12 Lighting Controls

(1) Except as permitted in sentence (2), all interior lighting systems shall be provided with manual, automatic or programmable controls.

There is a pre-emptive adoption of a requirement proposed for the National Energy Code for Buildings to be published in 1996. The goal is energy efficiency.

2) Controls are not required where
(a) continuos lighting is required for safety or security purposes, or
(b) lighting is emergency or exit lighting

(3) Each space enclosed by walls or ceiling height partitions shall be provided with controls that, together or singly, are capable of turning off all the hard-wired lights within the space.

7.1.13 Controls for light fixtures

1) Except as provided in Sentences (2) and (3) lighting controls shall be
a) located next to the main entrance or entrances to the room or space whose lighting is controlled by those controls,
b) located such that there is a clear line of sight from the control to the area lighted, and
c) readily accessible to persons occupying or using the space.

This is a pre-emptive adoption of a requirement proposed for the National Energy Code for Buildings to be published in 1996. The goal is energy efficient.
Requiring controls to be located at the entrances to the spaces served will not only encourage the use of the controls but will reduce the likelihood that circuit breakers will be used for that purpose.

7.1.14 Type of controls

1) Low Voltage switching should be considered wherever there are multiple circuits and switching from multiple locations.

Not economical where there are few circuits. Typically used in schools, health centres correctional facilities.

2) HID Switches
Install HID switches so that they are protected against accidentally being shut off by:
1. location (i.e. in an area not readily accessible to the public) or
2. mounting height (i.e. install at 2.1m) or
3. protective covers

To prevent HID fixtures from being accidentally shut off. The restrike time creates a delay before light levels are back to normal and that delay is a safety concern. At best the delay is an inconvenience.

3) Ultasonic Motion sensors should be used to control lighting in all rooms that may be left unoccupied for extended period of time (i.e. classrooms, washrooms, offices, gyms, boardrooms, garages). They should be installed where:

1. The SIMPLE payback period is less than 5 years, or
2. automatic lights are required for security reasons.

To provide energy efficiency & security. Use passive infrared motion sensors when the reduced energy consumption makes the increased capital cost worthwhile. The cost of electricity, type of fixture and space function will determine when motion. sensors should be used. Wherever night lights are considered, use a motion. sensor instead.
Ultrasonic motion sensors sense motion quickly, react quickly, and because they are flat, are resistant to accidental misalignment and damage. They are also relatively inexpensive and save energy. The payback should be calculated to ensure that the application is appropriate.

3. The motion. sensors must have an override option.

In case of malfunction or inadequate coverage, the occupants must be able to override the lights.

Ceiling mounted sensors are preferred.

Because they provide full 360 coverage and are less likely to be tampered with.

4 do not use keyed lighting switches.

Keys are easily lost, and lights are left on unnecessarily because users without keys can't turn them off.

5 Service Space Lighting wherever lighting is provided in typically unoccupied spaces, (i.e. crawlspaces) a pilot light indicating service lights are on is to be provided at the entrance to the service space.

Lights can be left on inadvertently for extended periods of time and nobody is aware because that space is not normally used.

6 Applications
a) An ultrasonic motion sensor, rated for use

with fluorescent fixtures, shall control all the ceiling fixtures in selected office areas, classrooms, libraries, and computer areas, industrial shops, drafting rooms, sewing rooms, and hair care shops and every second light fixture in corridors. Where two-lamp fluorescent fixtures are used in corridors, an acceptable alternative is to control one fluorescent lamp in each fixture with the motion sensor. Ultrasonic motion sensor(s) shall control lights in gymnasiums.

b) In all rooms except gymnasiums, the motion sensor shall be installed approximately 15 to 30 centimetres (6 inches to 1 foot) below ceiling level, in the corner nearest the main entrance door to the room, or in accordance with the manufacturer's recommendations. In larger rooms**,** where required to ensure proper operation of the motion sensors, two or more motion sensors, wired in parallel, shall be installed.

Locating motion sensors by room entrances near the ceiling has been found to be effective.

c) In gymnasiums, motion sensors shall be located to ensure that lights remains on when the area under them is occupied. A minimum of one motion sensor for each bank of lights shall be used to ensure that lights remain on over the part of the gymnasium that is in use

d) The wiring shall be done so that the motion sensor will turn all lights controlled by the sensor on if the light switch is in the on position. The motion sensor sensitivity shall be adjusted so that ceiling lights come on within 2 seconds or less when motion is detected. The sensor sensitivity shall also be adjusted so that there is a delay of 20 to 25 minutes after motion is no longer detected before the ceiling lights go off

e) If the rated amperage of the sensor is not high enough for the switched load, then the sensor shall control a relay with an acceptable current rating

f) As a safety precaution, lights directly over shop equipment, such as lathes or table saws, shall not be controlled with a motion sensor

7.1.15 Guards for light fixtures

1) Luminaries in areas where they are subject to damage must have wire guards.

Protection of luminaries in these locations is necessary to prevent lamps from being damaged by moving objects such as storage materials, pucks, basketballs, and to prevent subsequent injury to persons. (Examples of where they may be required include gyms, service areas, storage areas, Industrial Arts classrooms, locker rooms, exterior lights)

2) <u>Safety Chains/Cables</u> suspended fixtures in

recreational/sports facilities must not rely on support directly from an outlet or box or fixture hanger; provide safety chains/cables.

To ensure that luminaries can not fall down when impacted by moving objects.

7.1.16 <u>Design Calculations & Pilots Requirements</u>

1) Typical design calculations shall be provided to the Project Manager at the 50% design stage to verify that lighting has been designed to meet the requirements in this standard. For lighting projects over $ 50,000 in value, computer-generated typical lighting contour plots shall also be provided at the 50% design stage to verify that lighting has been designed to meet the requirements in this standard.
2) Where more than four lighting retrofits are to be done in similar rooms, a pilot should be considered in one typical room. Any needed modifications identified shall be incorporated in the lighting retrofit for all similar rooms. The pilot may be waived by the client department.

Even with lighting design technology developments, care at the design stage is needed to ensure that a lighting design is suitable because each situation and room design is different. On all projects, good communication between the lighting designer, the architect and the project manager is important in order to ensure that wall, ceiling and floor reflectances, paint colours, types of fixtures, location of fixtures, and fixture lens and louvre choices are appropriate and consistent.

7.1.17 Windows and Window Coverings

1) Blinds, curtains, venetian blinds, or other moveable window coverings shall be semi-opaque or opaque.
2) Daylight factors should be considered in the lighting design.
3) In each classroom, including drafting areas, sewing areas and hair care shops, exterior wall windows shall cover 15 to 30% of the classroom's exterior wall area and shall be located to maximize the use of natural lighting.
4) In each gymnasium and industrial shop, exterior wall window size should generally equal 3 to 5% of the gymnasium's interior wall area. Windows shall be located to maximize the use of natural light.
5) The interior pane of gymnasium windows shall be made of wire glass or protected with guards and located so as to minimize potential damage from use of gym equipment**.**

Blinds and curtains are needed so that sunlight can be controlled and so that rooms can be darkened sufficiently to use overhead projectors with display panels, slide projectors and other audio-visual equipment.

Good use of natural lighting is an effective way to reduce the operating cost for artificial lighting.

7 .2 EXTERIOR LIGHTING

Exterior lighting should be provided for safety and security reasons only. The cost of electricity in the Yukon makes the use of any decorative lighting undesirable.

<u>Requirements</u> | <u>Rationale</u>

7.2.1 Fixtures

Polycarbonate fixtures to be used for all exterior lights.

To reduce breakage due to high potential of vandalism

7.2.2 Lamps

All exterior lighting to be high pressure sodium and must have an efficacy of not less than 50 lm/W.

Energy conservation. is necessary for lighting during long winter hours. has poor colour rendition, but it is better than LPS and is acceptable for outdoor use. Other disadvantages of LPS include slow delivery, higher initial cost, longer warm-up time, lamp wattage decreasing over time and high levels of sodium metal which is a hazardous substance.

7.2.3 Ballasts

See 7 .1.5.5 "Low temperature ballasts"

7.2.4 Controls

1) exterior lighting shall be controlled by:
   a) lighting schedule controllers,
   b) photocells (located so that the PEC is not covered in snow during the winter or adversely affected by the lights it controls (on/off cycling), or
   c) a combination of lighting schedule controllers and photocells.

This is a pre-emptive adoption of a requirement proposed for the National Energy Code for Buildings to be published in 1996. The goal is energy efficiency.

2) lighting schedule controllers shall be of automatic type or otherwise capable of being programmed for 7 days and for seasonal daylight schedule variations.

To simplify the manual requirements for operating the controllers.

3) All lighting schedule controllers shall be equipped with backup provisions to keep time during a power outage of a least 4 hours.

7 .3 EMERGENCY LIGHTING

Requirements	Rationale
7.3.1 Battery Packs Emergency battery-powered lamps should be installed in service spaces (i.e.: generator rooms, mechanical rooms, usable crawlspaces) and washrooms. **Units must have "brown-out" protection relays.**	*To allow servicing in service areas when power supply fails; lighting for egress from service areas, crawlspaces and washrooms should be maintained. Brown-out relays required as pacs do not come on in brown-out conditions without them.*
7.3.2 Timers Spaces which are illuminated only by HID lighting (i.e.: arenas); emergency lighting is to be timer controlled so that it stays on for 15 minutes after resumption of power. (HID lighting with quick restrike lamps as accessories such as quartz lights are an acceptable alternative).	*To provide emergency lighting while HID lights "restrike".*

7.3.3 Auto-test

Automated self-diagnostic circuitry card (auto-test) should be provided for emergency lighting in facilities with one central battery pack unit. The auto-test to be Lumacell Model/AT or equivalent.

The auto-test system automatically tests the central battery pack unit monthly. Burnt out lamps are automatically sensed to indicate replacement required. The auto-test system is economical on central battery pack systems

7 .4 EXIT SIGNS

Requirement | Rationale

7.4.1 Illumination

The exit sign should be illuminated with LED's with no external transformer required, with a 25 year life expectancy, a 5 year warranty, DC voltage option with brown-out relay and power consumption of 2 watts per face, maximum acceptable product: Lumacell model RG 36LER LMCE/2MT-CB201.

Low energy consumption.

7.4.2 Exit Light Fixtures

New and retrofitted exit light fixtures shall draw less than four watts of electricity. An LED light source (e.g., LED "bulb" or LED panel) shall be used, complete with the correct base to fit the fixture (e.g., candelabra, inter-mediate, medium or bayonet base). For proper operation, any existing diodes shall be removed, or alternatively, LED bulbs, or complete new fixtures suitable for use in circuits with diodes shall be installed**.**

Energy cost saving and longer bulb life.

7 .5 LIGHTING LEVELS

Requirements | Rationale

7.5.1 Offices, Libraries and Classrooms in Schools

1) With all ceiling light fixtures switched on over classroom, library or office working surfaces--such as desk tops, table tops, and lab benches-- the average light level shall be in the range of 350 to 450 lux (35 to 45 footcandles).

The goal of school lighting is to aid the learning process by providing properly lit classrooms. Good lighting ensures that students and teachers can complete tasks accurately, quickly and comfortably. The variety of visual tasks in a school means different light levels are required.

Fixtures shall be spaced so that individual light readings on working surfaces shall not be greater than 550 lux (55 footcandles) nor less than 200 lux (20 footcandles).

Teachers working in Yukon schools have also expressed a consistent preference for control over light levels in classrooms. This control is needed to match the lighting level to the nature of the tasks being performed by the students, and to better meet the varying needs of individual students, teachers and others. Meeting these varying requirements can best be achieved by making provision for controlling natural lighting from windows with blinds or curtains and by using *two-level switching..*

2) With half the ceiling lights switched on over classroom, library or office working surfaces, such that every second fixture (or every second fluorescent lamp) is on, the average light level shall be greater than 150 lux (15 footcandles).

Two-level switching means that every second fixture can be turned off over student working areas simply by using a switch. Light levels within the range specified (e.g., 350 to 450 lux (35 to 45 footcandles)) can be achieved with all of the light fixtures turned on.

3) Two switches shall be provided for each row of lights such that half the ceiling light fixtures in each row over classroom working surfaces are controlled by each switch. Each switch shall control alternate fixtures, in order to make the light level as uniform as possible. Where two-lamp fluorescent fixtures are used in corridors, an acceptable alternative is to wire the two switches so that one fluorescent lamp in each fixture can be switched off by each switch. For classrooms with a chalkboard, a third switch shall be provided to control the light fixtures over the chalkboard. A separate switch for lights over the chalkboard is not required for rooms where chalkboard use is minimal, such as kindergarten classrooms

Light levels above the minimum light level specified (e.g., 150 lux (15 footcandles) can be achieved with half of the ceiling light fixtures turned off. Two-level switching has been found to be cost-effective in helping to reduce electricity cost. All light level requirements are based on using artificial light, with no natural light coming from window.

A separate chalkboard switch makes it possible to have lights on over the chalkboard when other lights in the classroom are off. This light is sometimes needed to counteract glare from windows on the chalkboard.

4) T-8 fluorescent lamps or better shall be used in all office, library and general classroom ceiling fixtures. For example, T-5 fluorescent lamp applications will be considered.

Improvements in light fixtures and in computer analysis methods now allow relatively quick and accurate light level rendering and light level contour plotting at reasonable cost. These changes have improved the accuracy and eliminated most of the guesswork and much of the labour for lighting design. Nonetheless, in some cases, people may still want to make lighting adjustments by adding a task light or by rearranging furniture to suit their individual lighting preferences for the task being done.

7.5.2 Shops, Drafting and Sewing Areas in Schools

1) With all light fixtures on over drafting tables, in sewing rooms, in hair care shops and in industrial shops, where required for detailed work, the average light level shall be in the range of 450 to 550 lux (45 to 55 footcandles). Task lighting shall be used to supplement general classroom lighting to achieve this light range. Task lighting shall use T-8 fluorescent lamps or better, compact fluorescent or halogen bulbs. Halogen bulbs shall have a protective glass shield.

When higher lighting levels are needed, task lights can be used. Drafting tables, for example, frequently have a task lamp for the purpose of raising light level when needed. In most cases, this is a more cost-effective solution than using ceiling fixtures, largely because the light level from any fixture drops rapidly with the distance from the fixture

2) With half the light fixtures on over drafting room, sewing room and shop working surfaces, such that every second fixture (or every second fluorescent lamp) is on, and with the light fixtures on over the chalkboard, the average light level shall be greater than 150 lux (15 footcandles).

3) T-8 fluorescent lamps or better shall be used in all drafting, sewing room and shop ceiling fixtures except where metal halide

fixtures are approved by the owner. New technologies will be considered for pilots (e.g., compact fluorescent high bay light fixtures and T-5 fluorescent lamp applications).

7.5.3 Computer Areas in Schools

1) Where computers are in use for more than four hours per day:
a) With all ceiling light fixtures on over working surfaces the average light level shall be in the range of 250 to 350 lux (25 to 35 footcandles).
b) With half the ceiling light fixtures over working surfaces (or every second fluorescent lamp) switched on, the average light level shall be greater than 100 lux (10 footcandles).
c) Parabolic louvres or other methods of directing light from fixtures shall be used on all T-8 fixtures over or behind computers to reduce the glare from fixtures on the computer screens. (See also section 7 .1.6 Video Display Terminal (VDT) Lighting.)
d) T-8 fluorescent lamps or better shall be used in all ceiling fixtures in computer areas. For example, T-5 fluorescent lamp applications will be considered.

Lower lighting levels in areas where computers are used helps to reduce glare on computer monitors and to reduce the change in light level between the computer screen and the desk surface, reducing eyestrain. The main problem encountered with lighting spaces containing visual display terminals (VDTs) or computer monitor screens is that of reflections on the VDT screen. Reflections in near vertical screens are produced by luminaires above and behind the user; problems therefore generally occur in large open-plan offices rather than small cellular offices. Reflections on computer monitors can be avoided by using luminaires above and behind the user that direct the light strongly downwards. In general, the lower the cut-off angle (i.e. the maximum angle at which light comes out of a fixture), the greater the protection from screen reflections but the less efficient the luminaire, and the greater the energy consumption to provide a given illuminance. It is preferable therefore not to provide a higher degree of protection than is necessary. The degree of protection required will depend on the extent to which VDTs are used in the space: continuously, throughout the day, or only occasionally. It is also recommended that VDT users not face a window with a direct view of unobstructed sky; the difference in luminance between the VDT screen and the sky may cause eyestrain.

7.5.4 Gymnasiums in Schools

1) With all ceiling light fixtures switched on, the average light level shall be in the range of 450 to 550 lux (45-55 footcandles).
2) With half the ceiling light fixtures (or every second fluorescent lamp) switched on, the average light level shall be greater than 200 lux (20 footcandles).
3) Two master switches shall be provided such that half the fixtures are controlled by each switch. Each switch shall control alternate rows of fixtures in order to make the light level as uniform as possible when one master switch is turned off. Switches shall be provided such that each row of lights can also be controlled with its own switch.
4) T-8 fluorescent lamps or better shall be used in all gymnasium ceiling fixtures, except where metal halide fixtures are approved by the owner. Fixtures shall be

used with a guard or cover installed to protect each fixture. New technologies will be considered for pilots (e.g., compact fluorescent high bay light fixtures and T-5 fluorescent lamp applications will be considered).

7.5.5 Corridors, Washrooms and Locker Areas in Schools

1) With all ceiling light fixtures switched on, the average light level in corridors, locker areas and washrooms shall be in the range of 100 to 250 lux (10 to 25 footcandles).
2) With half the light fixtures switched on, such that every second light fixture (or every second fluorescent lamp) is switched on, for example, after hours, the average light level shall be greater than 50 lux (5 footcandles).
3) T-8 fluorescent lamps or better shall be used in all ceiling fixtures in corridors and locker areas. For example, T-5 fluorescent lamp applications will be considered.

For hallways, walkways and locker areas adjoining classrooms lower light levels are recommended (100 to 250 lux (10 to 25 footcandles)). Research and experience show people's eyes adjust more easily to difficult visual tasks in the brighter classroom areas if this is done. Researchers have also noted a significant beneficial reduction in hallway noise when light levels there are lowered

7.5.6 School Parking

1) In outdoor general parking and pedestrian areas the average light level on the area surface, and on any vertical surfaces, measured 1.8 metres (6 feet) above the area surface shall be in the range of 2 to 6 lux (0.2 to 0.6 footcandles).
2) In vehicle use areas, including access roads, exits, entrances, loading zones and pedestrian crossings, the average light level on the area surface, and on any vertical surfaces measured 1.8 metres (6 feet) above the area surface shall be 5 to 11 lux (0.5 to 1.1 footcandles).
3) Photocells shall be installed to control all parking lot light fixtures.
4) Timers shall be installed so that each light fixtures serving each section of a parking lot can be automatically shut off when not required.
5) For parking areas High Pressure Sodium fixtures shall be used.
6) Parking area lighting shall be designed in accordance with IES standard RP-20 *Lighting for Parking Facilities*.

E8 OWNER / COMMUNICATION EQUIPMENT

Although standard equipment such as telephones are anticipated during building design, computers are now common in many building types. Current and future equipment use requiring cable or special wiring must be routinely considered during design.

8.1 TELEPHONES AND INTERCOMS

Northwestel now provides telephone services across the Yukon. Communication systems vary from simple two or three line telephone distribution systems to multiple phone use with teleconferencing and video capability.

Requirements	Rationale
8.1.1 Northwestel Requirements A booklet "Standards and Requirements for Telephone Services" dated June 1980 is available from Northwestel through their Building Industry Consulting Service in Whitehorse.	*Northwestel supplies and installs all outside wiring and cable required for telephone system.*
8.1.2 Raceways Provide service raceways (conduits) c/w pull strings for the building telephone lines to the main telephone service. To terminate at a backboard in a service room with a dedicated duplex outlet.	*To ensure that a telephone service and raceway system is installed within every building and that a consistent location is chosen for terminations.* *Duplex outlet is for the NWTel power filter. (A quad receptacle shared with the cable TV is not acceptable as the size of plugs c/w transformers prohibits plugging both power supplies into a quad outlet.* *Interior building wiring to be to ISB horizontal wiring standards.*
8.1.3 Telephone Rooms/LAN Rooms Separate communications rooms should be provided only when the complexity of the communications systems warrants it.	*Health centres may require space for video conferencing and associated equipment for medical & educational support.*
The following are guidelines for space requirements: 1) Buildings with less than 10 phone lines min. 600mm x 600 mm wood backboard. It can be installed in a mechanical or electrical room.	*Modern telephone equipment can withstand a wide range of environmental conditions. Small and medium -sized key systems can operate in about any environment.*
2) Buildings with more than 10 phone lines min. 1200 x 2400 mm wood backboard installed. It can be installed in a mechanical or electrical room.	*Large systems, especially Private Branch Exchange (PBX) with many tie lines needs a more controlled operating environment.*

8.2 COMPUTERS

Computers require power, routes for networking cables and telephone line connections to allow communication by modem. Electrical design should ensure the system can accommodate future expansion without significantly increasing construction costs.

Requirements	Rationale
8.2.1 Networking	
As per Government Services structured wiring systems standards April 1995 - see Appendix "N"	*To provide consistent standards throughout government facilities.*

8 .3 TELEVISION AND CABLE

Requirements	Rationale
8.3.1 Conduit	
Where televisions or television monitors are identified as a current or potential requirement in a facility program, assume cable connection may be required and allow for capacity in common conduit as outlined in 6.1.	*Typically be used in classrooms, visitor centres and museums, group homes or detention facilities.*
Install a power outlet on distribution board.	*To ensure that a television service, where required, is installed at a consistent location.*
Wherever cable television is identified as a current or future requirement, run individual cables to each TV outlet from a main television service backboard located in a service room c/w a separate duplex receptacle.	*To identify that a conduit system is not required but that cables are not to be looped to outlets (to prevent a cable malfunction affecting more than one outlet). The duplex receptacle is required for a plug-in transformer.*

8 .4 CLOCKS

Requirements	Rationale
Battery powered clocks are preferred in facilities without master/slave clock systems.	*Power outages and the frequency of fluctuations in cycles/second (Hertz) of diesel generated power adversely affect the accuracy of 120V clocks.*
Master slave clocks are preferred in schools and institutions.	*For consistency of clocks for class schedules.*
In communities with diesel generated power, master clock must have a frequency correction module.	*To keep clock system accurate.*

8 .5 INTERCOM SYSTEMS

Requirements	Rationale
8.5.1 Call Back Buttons	*Hand pieces tend to go missing*
3-position call back buttons mounted on walls are preferred to wall mounted telephones with cord and hand piece.	

E9 ALARM SYSTEMS

9.1 FIRE ALARM SYSTEMS

Where clarification is required on Fire Alarm Systems, consult with Property Management Technical Support section early in design. Systems should be as simple as possible (i.e.: factory service technician should not be needed to program the fire alarm system and perform annual certification, testing and repair).

Requirements	Rationale
9.1.1 Supplier Qualifications Suppliers using third party in subcontracted installation or maintenance services are not acceptable.	*To clarify qualifications required supplying a fire alarm system.*
9.1.2 Product Manufacturers Fire alarm systems must be reviewed and approved by the owner.	
9.1.3 Types of Fire Alarm Systems Do not exceed the requirements of the NBC.	*Keep the systems as simple as possible, meeting minimum Code requirements*
If programming is required, must be site programmable with non-volatile memory (i.e.: lithium battery back-up for programming).	*To maintain programming memory in the event of loss of normal and battery power.*
9.1.4 Fire Alarm Installation Fire alarm symbols: The following symbols to be used on all drawings and floor plans.	*The use of standard symbols will reduce confusion and misunderstandings when reading drawings*
9.1.5 Strobes/Sirens As per NBC barrier free design	
9.1.6 Signals to Fire Department Reverse polarity in all communities except Dawson City/Old Crow.	*To ensure that fire departments automatically have earliest warning of a fire*
9.1.7 Manual Pull Station To be installed in every floor area near every required exit including crawlspace exits.	*Clarify the code requirements*
Manual pull stations in gymnasiums must be fully recessed.	*To prevent damage to pull stations in gyms.*
9.1.8 Fire Alarm Bells/Strobes Bells to be 250mm.9.1.9	*For audibility and keeping stock requirements to a minimum*

9.1.9 Fire Alarm Verification Specifications

1. Subcontractors: Neither the whole nor any part of the work may be subcontracted by the Contractor, without written permission of the Owners.

2. Verification agent must be an independent third party (independent of the installing contractor or installers forces, manufacturer, designer, supplier and commissioning agent).

3. Examination of Site: A bidder shall be deemed to have inspected the site and all conditions thereon and to have reviewed all contracts documents and to have made all investigation necessary to obtain full understanding as to the form and nature of the site, ground, the quantities, location and nature of the work, the means to access to the site, the accommodations and facilities required, and the condition under which the labor force will be employed. In general, have obtained all necessary information, local or otherwise, as to risks, contingencies and other circumstances, which may influence or effect the bid. No allowances will subsequently be made for failure to make sure inspection and reviews are made.

Requirement of Contract Work

1. Contractor shall be a U.L.C. listed Fire Alarm Service Company, qualified in Fire detection/alarm system installation and testing.
2. Contractor shall provide and pay for all transportation, accommodation, labor, materials, tools and equipment to perform fire alarm verifications.
3. Maintain in force for each and every contract and for the duration of such contract(s), insurance policies as described in this document.
4. All work in the contract shall be done in the presence of the owner's representative at his/her discretion.
5. Conduct one (1) complete 100% verification service of fire alarm system and components, as per CAN/ULC – S537 -97 (or latest issue) Standard for the verification of Fire Alarm Systems and other applicable codes (e.g.: Electrical Code, Building Code and Fire Code, etc.).
6. The contractor shall assume responsibility for ensuring that he/she has up-to-date wiring diagrams, manufacturer's manuals, leaflets and information relevant to the work. Update these where required (e.g.: red line changes on drawings). Project Manager to supply specifications and drawings for bid purposes. Project Manger to supply in writing any changes to specification and/or drawings (7) days prior to verification inspection.
7. The contractor shall inform the owner promptly (and confirm such information in writing) of any recognizable hazards malfunctions or repairs that are necessary, either for the protection of the equipment or for general safety.
8. Equipment with field adjustment capability shall be inspected to ensure that, where necessary, it has been adjusted so as to function as intended under expected ambient conditions (i.e. tamper switches flow switches etc.) all pertinent pressures, time delays etc. shall be recorded on report form.
9. Price to include a second verification of items that had deficiencies during the initial verification and have been rectified by the installing contractor.

Work under this contract Comprises

1. Verify installation is in accordance with design and CAN/ULC-S524 (or latest edition) Standard for installation of Fire Alarm Systems.
2. Verify all zones, signal, alarm and annunciation that have been installed or modified in any fashion. Verification to CAN/ULC-S537 (or latest edition).
3. Test each device and alarm circuit to ensure manual stations, thermal, smoke and duct detectors transmit alarm to control panels and activate first stage alarm, general alarm and ancillary devices. (Duct detector test to include air flow test).
4. Test each signal device and each signal circuit.
5. Check all annunciator panels to ensure zones are shown, labeled and actuated correctly. Ensure that each smoke detector is properly annunciated.
6. Simulate grounds and breaks on alarm and signaling devices and circuits to ensure proper operation of trouble signals.
7. Verification to include the operation of the municipal connection if installed. This to include: Trouble signal received, alarm signal received when panel is in a trouble free state, alarm signal received when panel is in trouble, an alarm signal when an alarm has been silenced and a different zone goes into alarm.
8. Verify that the fire alarm communicator operates as per specifications (if applicable).
9. Verification to include a witness of the ventilation system shutdown on fire alarm. (if applicable).
10. Verification to include a witness of the operation of magnetic door holders including witness of doors closure.

11. Verification to include a witness of the elevator(s) or handicap lift(s) to ensure they react correctly to a fire alarm signal. (if applicable).
12. Verification Report: Submit to the Project Manager four (4) copies of the verification reports on **Latest Edition of U.L.C.** forms for all test results.

9.1.10 Fire Alarm Annunciation

9.1.11 Monitoring of Sprinkler Water

9.1.12 Fire Alarm Symbols

To avoid confusion as to what device is indicated

Consultants and contractors to use YTG symbols on all drawings, prints and floor plans.

See Appendix “O”

9.1.13 Device List

For Property Management Agency records.

The installing contractor to supply an electronic list of fire alarm devices installed showing: building, type of device, make (manufacturer), model number, and location of the device in the building in a format compatible with Microsoft Windows 95.

9.2 COMMUNITY FIRE SIRENS

Requirements	Rationale
9.2.1 Standard of Acceptance Standard of acceptance is Federal Signal Corporation for items listed below: **Sirens** Model No. STH 10A (3ø) or STH10B (1ø) equivalent. **Controls** PGA (Predetermined General Alarm) timer or equivalent. **Motor Starter** RC5 Motor Starter (Heavy duty relay capable of handling the starting and operating current) or equivalent.	*Most of the community Fire Alarm Sirens in the Yukon are now of this type and this manufacture.*
9.2.2 Fire Alarm Symbols Consultants and contractors to use YTG symbols on all drawings, prints and floor plans. See Appendices:	*To avoid confusion as to what device is indicated*.

9.3 MECHANICAL SYSTEM ALARMS

Failures of mechanical and especially heating systems can have serious consequences during long, cold, winter months. The sooner maintainers can be alerted to a problem, the sooner they can switch the building over to standby systems or effect repairs.

9.3.1 Mech Alarm Annunciators

Mechanical alarm equipment and sensors should be tied into security system. (Unless otherwise requested i.e.: propane alarms)

- most security systems have telephone communication capability.
- route alarms to Facilities Management or answering service.

9.4 SECURITY SYSTEMS

Requirements	Rationale
9.4.1 Regulation Qualifications The security consultant, installation contractor and their employees must comply with the regulations set down in the “Private Investigators and Security Guard Act”, Yukon Electrical Protection Act, Canadian Electrical Code plus any other applicable codes, regulations and standards.	
9.4.2 Intrusion Alarm Systems Minimum requirement for all new buildings to have an empty conduit system in place.	*All buildings are subject to break ins and vandalism*
9.4.3 Control Panel - 24 hour battery backup - Digital communicator capable of reporting in a format monitored locally. - Minimum of 8 zones - In schools, must be capable of true partitioning - Installed on a separate cct and preferable on standby power panel. - Requires minimum of 1 dedicated phone line	
9.4.4 Devices - All interior devices to be dual type devices - Magnetic door switch on perimeter door to be wide gap, rated for type of door and recessed.	*Reduce false alarms*
Sirens and Horns When suitable for building occupants.	
Auxiliary Devices - Capable of monitoring various building devices in low building temperature. Carbon monoxide levels etc.	
9.4.5 Panic Alarm Systems Where panic alarm systems are a program requirement they may be audible or inaudible depending on the situation. They must have a regular test/maintenance procedure set up to ensure good working order and communications with monitoring agency	

9.5 COMMUNICATORS

Requirement	Rationale
Where off premise monitoring is not required by code but is a program requirement, it must be digital communicator type as noted below:	*Communicators are the best method available to notify of potential problems where there is potential for property loss. (i.e. schools, health centres).* *Should not be used on fire alarm or sprinkler system. To be monitored by a central station.*

9.6 ALARM LIGHTS AND AUDIBLE ALARMS

	Requirements	Rationale
9.6.1	**Exterior Alarm Lights** (1) Lights or strobes to be located on high point of buildings, clearly visible from roadway.	*Lights can be used either to indicate a building condition, or to act as an alarm indicating a critical condition requiring immediate attention. Intended as a supplement to the autodialer.* *To avoid confusion with landing lights, vehicle lights, etc.*
	(2) Colour of lights Fire alarm: red Mechanical alarm: amber Security/panic: blue See I.D. Table E-2.	*Colour coding is standardized on Yukon buildings. Blue strobes are typically used for security systems and panic systems in Health Centres and correctional facilities where staff may be alone with clients and could require immediate assistance.*
9.6.2	**Sirens/Horns**	

E10 MOTORS

	Requirements	Rationale
10.1	Type Motors must meet the specified minimum efficiencies in Appendix I unless it can be shown that a lower efficiency motor will yield lower life cycle costs.	*Energy conservation*
	Use 200V motors for 208 V services.	*Although 240 V motors may function on 208 V, experience has shown they burn out faster.*
10.2	**Sprinkler Pumps** The standby generator must feed sprinkler jockey pump.	*Past experience has shown that when the jockey pump is not on standby power, the fire pump cannot always operate properly.*

10. 3 Disconnects

A lockable disconnecting means to isolate a motor should be located within sight of and within 9 m of the motor and the machinery driven thereby.

For safe operation and maintenance.

10.4 Motor Terminations

Stranded wire should be used where wiring to motors ends in a terminal strip.

Solid wiring to terminal strips in motors (i.e.: Grundfos) tend to become loose due to motor vibrations.

10.5 Phase Protection

Provide single phase protection for all motors 5 hp or larger. (i.e.: magnetic starters with solid state adjustable overload sections offering phase loss protection).

To prevent costly motor replacement of large motors due to single phasing.

E11 MISCELLANEOUS

11.1 AUTOMATIC DOOR OPENERS

See A4.3.2 and 4.3.3

11.2 HEAT TRACE

Requirements — Rationale

11.2.1 Heat Trace

Where heat trace is required for water, sewer, or rain water leaders, it must be the self-limiting type with metal braid approved for the application.

For equipment and building safety.

11.2.2 Power Circuit

The power circuit must be controlled by a thermostat c/w pilot light, in the case of rain water leaders it must be a dual set point thermostat.

For energy efficiency and ease of maintenance

11.2.3 GFIC

The power must come from a GFIC protected circuit dedicated and identified for "Heat Trace" identifying location of all heat trace on circuit.

For personnel and building safety and ease of maintenance

11.2.4 External Switches

The external switch(es) that allow the person filling the propane tank(s) to switch off the power to the propane blankets to be lockable and have an indicating light showing the status of the switch.

To prevent unauthorized persons opening the switch, also to ensure power is supplied to blanket(s).

11.2.5 Latest Bulletins

Designer and installer must be aware of latest bulletins from authority having jurisdiction regarding heat trace installations, see appendix “M” electrical bulletins.

APPENDIX A (1)

RESOURCE MATERIALS

Available in the Technical Support Section
133 Industrial Road, Whitehorse, Yukon

Glossary of Permafrost and Related Ground-Ice Terms, Permafrost subcommittee, Associate Committee on Geotechnical research, National Research Council of Canada, 1988

Introduction to Foundation Engineering in Northern Canada, course notes prepared for the Yukon Housing Corporation, November 5 and 6, 1985, by Bruce Smith, P. Eng., Thurber Consultants Ltd.

Handbook of Snow, Principles, Processes, Management and Use, Edited by D.M. Gray and D.H. Male (University of Saskatchewan), Pergamon Press, Toronto, 1981.

Building Practice Note, Energy Consideration in the Design of Northern Housing, N.K. Larsson, National Research Council of Canada, July 1985.

Building Science for a Cold Climate, Neil B. Hutcheon, Gustave O.P. Handegord, National Research Council of Canada, 1983.

NRC Building Digests, Building Research Notes

Handbook of Noise Control, Second Edition, Edited by Cyril M. Harris, McGraw-Hill Book Company, USA, 1979.

Healthy Building Manual, prepared by Engineering Interface Ltd. By authority of the Minister of EMR, Government of Canada, for the Coordinating Council of Commercial, Institutional and Agricultural Energy Management Task Force, May 1988.

Lighting Handbook, Reference and Application, Illuminating Engineering Society of North America, 8th edition

CAN/CSA - Z 317.5-M89 “Illumination Systems in Health Care Facilities:

CAN/CSA - Z 412-M89 Office Standards

APPENDIX A (2)

BUILDING ENVELOPE DESIGN - INFORMATION SOURCES

Canadian Building Digests
Digest #23 "Air Leakage in Buildings"
Digest #175 "Vapour Barriers: What Are They? Are They Effective"
Digest #155 "Joint Movement and Sealant Selection"

An Air Barrier for the Building Envelope R.L. Quirouette, U. Ganguli, M.E. Lux

Building Practice Note 54 - The Difference between a Vapour Barrier and an Air Barrier R.L. Quirouette

Building Science Forum '82 - Exterior Walls: Understanding the Problems
Building Science Forum '83 - Humidity, Condensation and Ventilation in Houses
Building Science Forum '86 - An Air Barrier for the Building Envelope NRC 29943
Registry of Product Evaluations

All of the above are available through:
Client Services, Institute for Research in Construction
National Research Council of Canada, Ottawa, Ontario, K1A 0R6
Phone (613)993-2463 Fax (613)952-7673

Building Science for a Cold Climate,
N.B. Hutcheon and G.O.P. Handegord
Construction Technology Centre Atlantic Inc., P.O. Box 4400, Fredericton, N.B., E3B 5A3
Phone (506)453-5000 Fax (506)453-3568

Tek Aid on Air Barriers
Construction Specification Canada
100 Lombard St, Suite 200, Toronto, Ontario, M5C 1M3
Phone (416)777-2198 Fax (416)777-2197

Testing of Air Barrier Systems for Wood Frame Walls, CMHC Report No. CR5505.1
Testing of Air Barriers - Construction Details, CMHC Report No. 3012.or/2 August 1991
Criteria for the Air Leakage Characteristics of Building Envelopes, TROW Inc, December 1991
A Study of the Rainscreen Concept Applied to Cladding Systems on Wood Frames Walls, CMHC Report No. 39108.OR1, August, 1990

Structural Requirements for Air Barriers, CMHC Report No. 30133.OR1, August 1991

CMHC Publications are Available From:
Canadian Housing Information Centre
700 Montreal Rd, Ottawa, Ontario, K1A OP7
Phone (613)748-2567 Fax(613)748-4069

NBEC Digest: Materials for Air Barriers
National Building Envelope Council
18 Crispen Private, Vanier, Ontario K1K 2T8
Phone (613)739-2910 Fax(613)739-4926

APPENDIX B (1)

BUILDING STANDARDS - POTABLE WATER HOLDING TANKS

1. Water holding tanks shall be water tight and constructed of material that is not subject to decay or corrosion and has been approved for use for drinking water storage by an authority acceptable to the Health Officer.

2. Water holding tanks shall be designed to resist deformation or rupture due to induced hydrostatic pressure.

3. Water holding tanks must be provided with a drainer tap, situated in such a manner that the entire contents of the tank can be drained by gravity.

4. Water holding tanks shall be provided with a means of access for inspection and cleaning. Access holes shall have a minimum inside diameter of 450mm, be provided with water tight, child proof cover and be easily accessible. On large tanks, the number of access holes shall be required under the Yukon Safety Act and Regulations.

5. To exclude dust, birds, insects and animals, water hold tank vents and overflows must either be screened, or must terminate with an elbow fitting located a minimum distance of three times the diameter of the pipe away from the opening of the pipe. Ground level vents/overflows must terminate in an inverted U position, the opening of which is a minimum of 600mm above the ground surface.

6. Water holding tanks shall be provided with a fill pipe, which is accessible to the water delivery truck from the outside of the building, and is equipped with a self closing cover or enclosed in a box with a self closing cover. The water tank filling point shall be separated from the sewage suction pipe by a minimum distance of 1.5m measured horizontally, and shall be located one meter above the sewage tank suction pipe.

7. All piping associated with water holding tanks must conform with the requirements of the Canadian Plumbing Code.

8. The building's water distribution system shall be equipped with an automatic device so that it shuts down when the sewage tank is filled to a level as described in the Sewage Holding Tank Standards. This device should be designed and situated to discourage tampering.

9. Water holding tanks installed and buried below ground surface must be located not less than 15m from the sewage holding tank.

10. When the capacity of a water holding tank is greater than 15 times the estimated normal daily water flow for the building, the building shall be provided with either:

    a) a separate holding tank for potable water storage,
    b) an automatic device for disinfecting the water downstream of the storage tank, or
    c) some other suitable method, acceptable to the Health Officer, which will ensure the water at the taps meets the requirements of the Guidelines for Canadian Drinking Water Quality.

APPENDIX B (2)

BUILDING STANDARDS - SEWAGE HOLDING TANKS

1. Sewage holding tanks shall be designed and constructed in accordance with the standards set by the Canadian Standards Association (CSA). The design and construction of tanks greater than 4500L must be certified by a professional engineer.

2. Poured in place concrete holding tanks shall be designed, reinforced, and constructed in accordance with CSA standards and the concrete design provisions of the National Building Code.

3. Prefabricated sewage holding tanks shall be designed and constructed in accordance with the standards set by the Canadian Standards Association, and bear the CSA seal of compliance.

4. Sewage holding tanks shall be equipped with a suction pipe ending with a quick connect fitting to allow the sanitary removal of the tanks contents. The size and type of the fitting shall be consistent with local conditions.

5. Sewage holding tanks shall be designed and constructed to allow the complete removal of solid matter that can be expected to settle in any part of the holding tank.

6. Sewage holding tanks must be provided with a means of access for inspection and repairs. Access holes shall have a minimum inside diameter of 450mm and be provided with a water tight, secure cover.

7. All piping associated with the sewage holding tank must conform with the requirements of the Canadian Plumbing Code.

8. The building drainage system shall be adequately vented to prevent siphoning traps during removal of the tanks contents.

9. Sewage holding tanks shall be equipped with an apparatus or device which causes the buildings water distribution system to shut down when the sewage tank is nearing capacity. This device shall be set to activate at a level where there is free remaining storage capacity for a volume of waste water equalling the combined volume of all fixtures in the building.

10. Sewage holding tanks installed and buried below ground surface must be located not less than 15m from any subsurface portion of the potable water system.

11. The working capacity of a sewage holding tank shall not be less than one and one half the total volume of the water holding tank or tanks.

APPENDIX C

VENTILATION SYSTEMS

CALCULATIONS OF OPTIMUM QUANTITIES OF OUTDOOR AIR

The optimum amount of outdoor air to bring into a building is the amount (above the minimum set by ASHRAE) that can be allowed in without increasing associated heating costs. That amount is variable and depends on the outdoor air temperature: when it is very cold out, as little outdoor air as possible is brought into the building; when it is warm out, as much outdoor air as possible brought into the building. With the extreme cold temperature of the Yukon, some heating of outdoor air is unavoidable. Bringing in more than the minimum air when it is very cold out should be avoided, as this results in higher energy costs. Unfortunately, building maintainers who operate the ventilation system do not monitor building energy costs and there is currently no way to see the effect of operational practices on energy costs. To determine the % of outdoor air that should be brought into the ventilation system:

Where:

RA = return air
MA = mixed air
OA = outdoor air

and

%OA = [(RA temp. - MA temp) / (RA temp - OA temp)] * 100%

Examples:

1. Typical winter conditions

RA = 20°
MA = 13°
OA = -30°

then, [(20-13) / (20+30)] * 100% = 7 / 50 * 100% = 14%

2. Typical spring or early summer conditions

RA = 25°
MA = 13°
OA - 10°

then, [(25-13) / (25-10)] * 100% = 12 / 15 * 100% = 80%

3. Hot summer conditions

RA = 28°
MA = 15°
OA = 26°

Then [(28-15) / (28-26)] * 100% = 13 / 2 * 100% = 650%
Obviously, this is indicating you just can’t bring in enough outdoor air to cool the mixed air down to 15°, the best you can do is bring in 100% outdoor air, which would result in a MA temperature of about 26°.

APPENDIX D

AIR PERMEABILITY OF COMMON MATERIALS AND ASSEMBLIES

The following pages are extracts from documents published by the National Research Council as included in DPW "Building Envelope Systems" seminar notes.

Materials of air barrier systems must exhibit low permeability to air. Design practitioners need to know how building materials and assemblies compare in air permeability along with how to evaluate the differences.

Accurate and reproducible testing procedures, developed a few years ago by IRC, and private laboratories, are available to evaluate the air permeability of building material and assemblies. Typically, the sample occupies one large face of an airtight box. The rate at which air flows through the sample is measured for various pressure differentials. The airflow rate at other pressure differentials can be calculated using a characteristic equation derived from the test results. For comparison, air permeability measured in litres per second square metre of sample are reported at an air pressure differential of 75 Pascals (Pa).

CMHC sponsored the testing of building components by at least three agencies. IRC tested a dozen wood frame wall assemblies, Air-Ins Inc. tested 36 assorted building materials, and Ortech International evaluated elastomeric membranes applied to masonry walls.

The table presents the air permeability at 75 Pa of most materials and assemblies tested. Keep in mind that the data in the table represent the best performance possible. Tests were conducted in the protected environment of the laboratory with no outside weathering. The harsher conditions of actual installations would like cause an increase in air permeability.

Selecting materials with low air permeability, however, is only one step in the process of designing an air barrier assembly. Here are several other important criteria for obtaining and maintaining assemblies that work:

Rigidity and strength - to transfer sustained gust wind loads (1000 Pa and greater), mechanical ventilation and stack effect tot he structure with limited deflection. (IRC and Ortech International also examined this aspect of performance in their testing procedure.)

Continuity - of airtightness, rigidity and support. To obtain and maintain continuity of airtightness at interfaces, consider compatibility between materials, build ability of construction details, necessary level of execution, ease of inspection and need for temporary protection of substrates against weathering to ensure good adhesion of sealants and tapes.

Durability - as a function of the quality of the materials used and of the conditions to which the materials are exposed. Durability of the air barrier depends on the overall design of the wall or roof (e.g., location of insulation, presence of a wind barrier, application of the rain screen principle), on the ease of inspection and maintenance, and on the chance of damage during service life.

Another important issue for the design of air barrier systems is the relationship between airflow and moisture damage. This relationship takes into account the amount of air flow per square metre and the indoor and outdoor temperature, humidity and pressure. A few models predicting moisture damage to the building envelope as a function of materials used, and indoor and outdoor environments have been developed, but their accuracy and limitations are not yet know n since they have yet to be thoroughly validated in site conditions.

In 1986, IRC suggested that maximum airflow rates per unit area of air barrier assembly be established according to indoor humidity levels. Starting with the American industry guideline for the maximum allowable leakage for curtain walls (0.3 L/s per m² at 75 Pa) and estimating a further 50% reduction achievable in Canadian Construction, the levels were suggested as:

- ☐ 0.15 L/s per m² 75 Pa for buildings operated at indoor humidity levels up to 27%.
- ☐ 0.1 L/s per m² at 75 Pa for indoor humidity levels between 27 and 55%.
- ☐ 0.05 L/s per m² at 75 Pa for indoor humidity levels over 55%.

These values were proposed for discussion with building envelope specialists, designers and builders. Indeed, the figures are still open for discussion and feedback on their adequacy.

Most recently, Construction Specifications Canada in their document Tek-Aid on Air Barriers suggests using material and assemblies that do not leak more than 0.1 L/s per m² at 75 Pa. Remember though obtaining this airflow rate via the air barrier assembly will not necessarily prevent all moisture damage in all types of buildings in the Canadian climate. Nevertheless, this target specification, published in March 1990, definitely demands improved design and construction practices.

Technical Enquiries: Air Barrier Systems

For more information, refer to Building Science Insight ‘86, “An Air Barrier for the Building Envelope, “NRCC 29943. This publication can be purchased for $20 from IRC Publications Sales, Building M-19, Montreal Road, Ottawa, Ontario, K1A 0R6, telephone (613) 993-2463. To obtain the three research reports by IRC, Air Ins Inc. And Ortech International, contact Jacques Rousseau, Canada Mortgage and Housing Corporation, 682 Montreal Road, Ottawa, Ontario, K1A 0P7 fax (613) 748-6192. Tek-Aid on Barriers is available from Construction Specifications Canada, telephone (416) 922-3159.

Information: M.Z. Rousseau

Air permeability of building materials and assemblies

NOTE: Assumes Material or composite wall assembly L/s per m² at 75 PA in the following table.

9.5 mm plywood sheathing	<0.005
38 mm extruded polystyrene insulation	<0.005
*38 mm extruded polystyrene insulation + compatible tape at joints (with or without tape and nail heads)	<0.005
25 mm foilback urethane insulation board	<0.005
24 and 42 mm phenolic foam insulation	<0.005
*28 mm phenolic foam insulation + compatible tape at joints and nail heads	<0.005
13 mm cement board	<0.005
13 mm foil-backed gypsum board	<0.005
aluminium foil on paper backing	<0.005
1.3 mm modified bituminous self-adhesive membrane	<0.005
2.7 mm modified bituminous torched-on membrane	<0.005
*synthetic stucco finish on 51 mm expanded polystyrene insulation on 13 mm exterior gypsum board	<0.005
*13 mm interior gypsum board painted with 2 coats of latex paint with joint of paper tape and joint compound	<0.005
*0.9 mm sheathing grade plywood on both sides of studs + subfloor adhesive at studs + 64 mm glass fibre batt insulation in cavity	<0.005
*9.5 mm sheathing grade plywood on both sides of studs (1 sheathing with two 51 mm holes) + subfloor adhesive at the studs + 64 mm glass fibre batt insulation in cavity	0.005
*0.15 mm (6 mil) polyethylene film sandwiched between 11 mm plain fibreboard and 13 mm interior gypsum board	0.006
8mm plywood sheathing	0.007
16 mm waferboard	0.007
13 mm moisture-resistant gypsum board	0.009
*13 mm exterior gypsum board + compatible 11 mm waferboard	0.011
13 mm particle board	0.015
38 mm spray	87.0
tape at joint	0.015
*28 mm phenolic foam insulation + compatible tape at joints	0.018
reinforced non-perforated polyolefin geotextile	0.019
*11 mm asphalt -impregnated fibreboard covered with 76 mm sprayed polyurethane foam on one side - joints taped	0.019
13 mm gypsum board	0.020
*11 mm asphalt-impregnated fibreboard covered with 76 mm sprayed polyurethane foam on one side - joints untaped	0.025
16 mm particle board	0.026
3.2 mm tempered hard board	0.027
25 mm expanded polystyrene type 2	0.12
30 lb roof felt	
15 lb non-perforated asphalt felt *spunbonded olefin film on one face of a 25 mm glass fibre semi-rigid board + compatible tape at joints (with or without tape at nail heads)	0.30
15 lb perforated asphalt felt	0.40
spunbonded olefin film on one side of glass fibre semi-rigid board	0.49
*spunbonded olefin film sandwiched between 16 x 38 mm wood strapping @ 406 mm c/c and 11 mm asphalt-impregnated fibreboard	0.49
11 mm plain fibreboard	0.82
11 mm asphalt-impregnated fibreboard	0.83
spunbonded polyolefin film	0.96
3 mil perforated polyethylene (4.3-4.5 perforations/cm²)	3.2-4.0
25 mm expanded polystyrene insulation type 1	12.0
15 x 127 mm tongue-and-groove wood planks (8 joints)	19.0
152 mm glass fibre insulation	37.0
75 mm vermiculite insulation	70.0

List of Materials Tested for Air Leakage

Material		Air Leakage Rate @ 75 Pa (L/s = m²)
2 mm	smooth-surface roof membrane	no measurable leakage
2.7 mm	modified bituminous torch on grade membrane (glass fibre mat) aluminium -foil vapour barrier	no measurable leakage
1.3 mm	modified bituminous self-adhesive membrane	no measurable leakage
2.7 mm	modified bituminous torch on grade membrane	no measurable leakage
9.5 mm	plywood sheathing	no measurable leakage
38 mm	extruded polystyrene	no measurable leakage
25.4 mm	foil-back urethane insulation	no measurable leakage
24 mm	phenolic insulation board	no measurable leakage
42 mm	phenolic insulation board	no measurable leakage
12.7 mm	cement board	no measurable leakage
12.7 mm	foil-back gypsum board	no measurable leakage
8 mm	plywood sheathing	0.0067
16 mm	waferboard	0.0069
12.7 mm	gypsum board (MIR)	0.0091
11mm	waferboard	0.0108
12.7 mm	particle board	0.0155
	reinforced non-perforated polyolefin	0.0195
12.7 mm	gypsum board	0.0196
15.9 mm	particle board	0.0260

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Material		Air Leakage Rate @ 75 Pa (L/s = m²)
3.2 mm	tempered hardboard	0.0274
	expanded polystyrene type 2	0.1187
30 lb	roofing felt	0.1873
15 lb	non-perforated asphalt felt	0.2706
15 lb	perforated asphalt felt	0.3962
	glass fibre rigid insulation board with a spunbonded olefin fill on one face	0.4880
11 mm	plain fibre board	0.8223
11 mm	asphalt-impregnated fibre board	0.8285
	spunbonded olefin film	0.9593
	perforated polyethylene #1	4.0320
	perforated polyethylene #2	3.2307
	expanded polystyrene (type 1)	12.2372
	tongue-and-groove planks	19.1165
	fibreglass insulation	36.7327
	vermiculite insulation	70.4926
	cellulose insulation	86.9457

APPENDIX E

COMMUNITY EMERGENCY SHELTERS

Although commonly referred to as “community emergency shelters”, buildings intended for use by a community during a civil emergency should, in fact, be known as ‘reception’ or ‘evacuation’ centres. For information about the “Civil Emergency Measures Act of the Yukon” contact the Coordinator of Emergency Measures Organization, Department of Municipal and Community Affairs.

Building Designation

- there is no complete listing of designated buildings in Yukon communities, however MACA is currently collecting this information. Regional Superintendents (MACA) should be contacted to confirm buildings are designated in each community.
- the local authority determines which buildings in a community should be designated
- the Minister of MACA approves civil emergency plans submitted by the local authority (usually the municipal council, or the Native Band).

Building Requirements

- the Department of Social Services is responsible for operation of ‘reception’ or evacuation’ centres
- there are no written requirements for designated community shelters; it is recommended, however, that auxiliary power generators be capable of operating the entire building. There is no special requirement to increase water storage.

APPENDIX F

Building Efficiency - Definitions and Measurement of Floor Areas

The purpose of the following is to provide a common basis for measuring the efficiency of Yukon buildings, regardless of occupancy type. It is intended to supplement the BOMA standard, not to replace it. Please adhere to these guidelines and definitions when preparing architectural programs or analysing construction costs.

A. User Sought Area

Floor area that reflects the reason for building the facility in the first instance, and will be used exclusively by the tenant/users:

- user designated/programmed occupancy functions
- user occupied/owned/rented/leased space
- use controlled public or private areas

B. Use Support Area

Floor area which is precipitated directly by the users' functions, and although it may be shared it may be included in the rentable area, namely:

- horizontal circulation areas providing access to user functions i.e. corridors
- common or assigned storage
- janitorial spaces (mop sink closets, cleaning supply storage)
- interior demising walls and subdividing partitions

C. Design Support Area

Floor area that is consumed as a consequence of code requirements and is unassignable to tenants, namely:

1. Egress:
   - horizontal means of egress (vestibules to stairs, exit corridors, main lobbies)
   - vertical circulation (common stairs and elevators)

2. Enclosure and separation: perimeter walls and permanent partitions (loadbearing and non)

3. Building Services
   - mechanical and electrical rooms
   - building equipment rooms (emergency generator, elevator)
   - utility spaces (tankage, garbage, etc.)
   - utilities shafts (ducts, pipes, conduit, etc)

<u>Calculating Net and Gross Building Areas</u>

Net Area = A + B
Gross Area = A + B + C
BUILDING EFFICIENCY % = Net Area/Gross Area x 100

APPENDIX G

STANDARD COLOUR AND IDENTIFICATION SCHEDULE

MECHANICAL SYSTEMS

Standard Colour and Identification Schedule - Mechanical Systems is CGSB 24-GP-3a

An original colour copy of this Chart No. 15190.101-1 dated 01/06/88 is available from the Technical Support Unit.

APPENDIX H

LIGHTING LEVELS BY ACTIVITY, BUILDING AREA OR TASK

The principal source of recommended lighting levels is the Illuminating Engineering Society (IES) Lighting Handbook. However in general lighting levels are being reduced and it is realized that higher light levels are not necessarily better. These target values represent maintained values over the area where the task is being performed and are based on the assumption that the lighting will be properly designed to take into account the visual characteristics of the task. For tasks and activities not listed, please refer to the IES Lighting Handbook.

Lighting Level Adjustment
The light levels in the above table are based on the assumptions that the workers' age (average) is under 40. The speed and/or accuracy of the task is not critical, the reflectance of the task is not critical, and last reflectance of the task background is above 30% (greater than 70% in Health Centre Operation areas, examination and treatment rooms). The sum of the weighting factors (see the IES Handbook) is between -1 and 1, and the lighting levels in this table are appropriate. If there is a change in these assumptions, see the IES Handbook for guidance.

Task Lighting
The table lists light levels for specific tasks as well as location. In the cases where this task lighting level is very high, it is often impracticable and wasteful to light the entire room to the recommended value. The general lighting level for areas where tasks are regularly performed may be reduced, but not below a minimum of 200 lux. Supplementary lighting should then be used in combination with the general lighting to achieve proper illumination of the given task.

Activity , Building Area or Task	**Lighting Level (lux)**
Airports	
Hangar apron	10
Terminal building apron	
Parking area	5
Loading area (vertical illuminance)	20
Air terminal buildings	
Baggage checking	300
Boarding area	150
Concourse	75
Ticket counters	500
Waiting room and lounge	150
Auditoriums	
Assembly	300
Social Activity	75
Badminton	
Tournament	300
Club	200
Recreational	100
Basketball	
College intramural and high school	300
Recreational (outdoor)	100
Building (construction)	
General Construction	100

Activity , Building Area or Task	Lighting Level (lux)
Excavation work	20
Building exteriors	
Building surrounds	10
Entrances	
...	50
Inactive (locked, infrequent use)	10
Conference rooms	
Conferring (critical seeing, refer to individual task)	300
Curling	
Tournament	
Tees	500
Rink	300
Recreational	
Tees	200
Rink	100
Dance halls	75
Educational facilities	
Classrooms	
with all fixtures on (average)	350-450
with half the fixtures on (average)	>150
Industrial Shops, Hair Care Shops Drafting Areas and Sewing Rooms	
(where required for detail work – task lighting required to reach this range)	450-550
with all fixtures on (average)	>150
with half the fixtures on (average)	
Computer Areas	
with all fixtures on (average)	250-350
with half the fixtures on (average)	>100
Gyms	
with all fixtures on (average)	450-550
with half the fixtures on (average)	>200
Corridors, Washrooms, and Locker Areas	
with all fixtures on (average)	100-250
with half the fixtures on (average)	>50
Parking	
General parking area and pedestrian areas (average)	2-6
Vehicle use areas, including access roads, exists, entrances loading and pedestrian crossing (average)	5-11
Fire halls	300
Garages	
Parking only	55
Service Repairs	500
Health Care Facilities	
Corridors	
Nursing areas – day	150
Nursing areas – night	75
Dental Suite	
General	300
Instrument tray	500
Examination and treatment rooms	

Activity , Building Area or Task	Lighting Level (lux)
General	300
Local	500
Nursing stations	
General	300
Desk	300
Operating areas, delivery, recovery	500
Patients' rooms	
(good to high colour rendering capability to be considered in these areas)	
General (variable - switching or dimming	75
Critical examination	500
Observation	30
Reading	300
Toilets	300
Stairways	150
Toilets	150
Utility Room	300
Waiting Areas	
General	150
Local for Reading	300
Hockey, ice (indoor)	
Amateur hockey in NT (note: amateur hockey in IES is 500 lux)	300
Recreational	200
Libraries	
Reading & carrels, individual study areas (see Reading)	
Book stacks (vertical 760mm {30in.} above floor)	
Active stacks	300
Inactive stacks	75
Card files	500
Locker rooms	15
Offices	
General (see also Reading)	200-300
Lobbies, lounges and reception areas	150
Mail sorting	500
Off-set printing and duplicating area	300
Video display terminals (may need to shield or reorient task)	75
Parking (Depends on activity level)	5-20
Playgrounds	50
Reading	
Copied tasks	
Micro-fiche reader	300
Xerograph	75
Hand-written tasks	
#2 pencil and softer leads	300
Ball-point pen	300
Printed tasks	
8 and 10 point typeface	300
telephone books	200-300
typed originals	300
Residences	
General, conversation, relaxation	75
Passage areas	75

Activity , Building Area or Task	Lighting Level (lux)
Dining	150
Ironing	200-300
Kitchen work	
Non-critical	300
Critical seeing	500
Laundry	300
Reading	
Desk	300
Primary task plane, casual	300
Primary task plane, study	200-300
Schools (see Educational facilities)	
Skating	
Ice rink, indoor	100
Ice rink, outdoor	50
Stairways	150
Tennis, table	
Club	300
Recreational	200
Volleyball	
Tournaments	200
Recreational	100
Warehouses	
Active	
Small items	300
Rough, bulky items	150
Inactive	75
Washrooms	150

APPENDIX I

MOTOR EFFICIENCY LEVELS

Motors must meet the specified minimum efficiencies indicated below unless it can be shown that a lower efficiency motor will yield lower life cycle costs.

Motor Size (HP)	3600 RPM %	1800 RPM %	1200 RPM %	900 RPM %
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	88.5	88.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.8
30	90.8	91.9	92.4	90.7
40	91.4	92.5	92.8	90.8
50	91.9	92.7	92.8	91.3

The table applies to T-frame (NEMA specifications) AC three phase motors in the 1-50 HP range.

Motor efficiency shall be based on CSA C390-93

APPENDIX J

BUILDING PRODUCTS MANUFACTURED IN THE YUKON

Please note – this information is currently unavailable.

Information will be included in future

APPENDIX K
TABLE K-1
INTERIOR LIGHTING POWER ALLOWANCE

Lighting Power Density by Building Type W/m²					
Building or Area Type	Gross Lighted Area of Building or Area, m²(²)				
	0 to 200	201 to 1000	1001 to 2500	2501 to 5000	5000 to 25000
Assembly					
Food Service					14.1
Food/Cafeteria	16.2	14.8	14.4	14.2	
Schools					
School/Elementary	19.4	19.4	18.5	17.8	16.9
Jr. High/High School	20.4	20.4	20.4	19.7	18.9
Technical/Vocational	25.8	25.1	23.4	21.6	19.8
Business and Personal Services					
Offices	20.4	19.5	18.5	17.8	16.9
Industrial					
Storage Garages	3.2	3.0	2.6	2.4	2.3
Warehouse Storage	8.6	7.1	6.0	5.2	4.6

Note to Table K-1:

(1) This table is comprised of excerpts from the National Energy Code for Buildings 1995 Public Review 2.0 and is based on the ASHRAE / IES 90.1 tables.

(2) The values in this table are not intended to represent the needs of all buildings within the types listed.

APPENDIX K
TABLE K-2
LIGHTING POWER DENSITIES FOR SPACE FUNCTION (LDP $_{SF}$)

Lighting Power Densities for Space Functions (LDP $_{SF}$)(1)

Space Function	LPD_{SF} W/m²	Space Function	LPD_{SF} W/m²
Assembly Spaces		**Care or Detention Spaces.**	
Conference Centres		Hospitals, Nursing Homes	
Banquet, Multi-purpose rooms	25.8	Corridor	14.0
Conference, Meeting rooms	19.4	Dental Suite	
Lecture halls, Classrooms	21.5	Examination/Treatment	24.8
		General Area	22.6
Libraries		Emergency	24.7
Audio-Visual	11.8	Laboratory	20.4
Card File and Cataloguing	17.2	Lounge/Waiting Room	9.7
Reading Area	20.4	Medical Supplies	25.8
		Nursery	21.5
Stack Area (2)		Nurse Station	22.6
Stack Mounted Lighting	16.2	Occupational Therapy/Physiotherapy. r.	17.2
Ceiling Space Lighting	32.3	Patient Room	15.1
		Pharmacy	18.3
Museums		Radiology	22.6
General Exhibition Space	20.4		
		Surgical and Obstetrical Suites	
Passenger Stations and Depots		General Area	22.6
Baggage Area	10.8	Operating Room	75.3
Concourse/Main thruway	9.7	Recovery	24.8
Ticket Counter	26.9		
Waiting and Lounge Area	12.9	Jails, Penitentiaries, Police Stations, Prisons	
Sports Venues			
		Jail Cells	8.6
Seating Area, All Sports	4.3		
		Residential Spaces	
Badminton			
Club	5.4	Dormitories	11.8
Tournament	8.6	Bedroom	15.1
		Bedroom with Study	7.5
Basketball/Volleyball		Recreation, Lounge	19.4
College	14.0	Study Hall	
Intramural	8.6		
Boxing and Wrestling, Amateur	24.8		
Gymnasium			
General Exercising & Recreation Only	10.8		
Hockey, ice, Amateur	14.0		
Skating Rink, Recreational	6.5		
Swimming, Recreational	9.6		
Tennis, Recreation (Class III)	14.0		
Tennis, Table, Club	10.8		

APPENDIX K
TABLE K-2
LIGHTING POWER DENSITIES FOR SPACE FUNCTION (LDP_{SF})

Lighting Power Densities for Space Functions (LDP_{SF})(1)

Space Function	LPD_{SF} W/m^2	Space Function	LPD_{SF} W/m^2
Business and Personal Service Spaces		**General Spaces Cont.**	
Office Category 1		Stair	
Reading, Typing, and Filing	19.4	Active Traffic	6.5
Drafting	23.0	Emergency Exit	4.3
Accounting	22.6	Toilet and Washroom	8.7
Office Category 2		Unlisted Space	2.2
Reading, Typing, and Filing	20.4		
Drafting	31.2	Industrial Spaces	
Accounting	25.8		
Office Category 3		Service Station/Auto Repair	3.2
Reading, Typing, and Filing	23.7	Shop	
Drafting	36.7	Carpentry	24.8
Accounting	29.1	Electrical/Electronic	26.9
		Machinery	26.9
General Spaces		Painting	17.2
		Welding	12.9
Corridor	8.6	Storage Garage(3)	10.8
Electrical/Mechanical Equipment Room		Storage and Warehouse	
General	7.5	Active Storage, Bulky, General	3.2
Control Rooms	16.2	Active Storage, Fine, Museum Artifacts	7.5
Lobby (General)			
Elevator Lobbies	8.6	Inactive Storage, General	3.2
Reception and Waiting	10.8	Inactive Storage, Museum Artifacts	6.5
Locker Room and Shower	8.6	Material Handling	10.8

Notes to Table K-2:

(1) This table is comprised of excerpts from the National Energy Code for Buildings Public Review 2.0 and is based on the ASHRAE / IES 90.1 Tables.

(2) Appropriate Light Levels on vertical surfaces of library stacks would be difficult to meet with 16 W/m^2 power level when lighting is ceiling mounted. An alternative level of 32.3 W/m^2 is provided for ceiling lighting.

(3) The LPD_{SF} for storage garages includes lighting for parking, driving, and pedestrian walking areas.

APPENDIX L

MECHANICAL EQUIPMENT - STANDARD OF ACCEPTANCE

The following listed equipment manufacturers are considered to be equivalent and acceptable for specification purposes. However, they must meet or exceed all capacity ratings, performances, efficiencies, etc.. In addition, they need to be integrated into the system design without exceeding space limitations providing that their substitution for specified product does not result in changes to related equipment, which would increase the cost or reduce the overall performance of the system.

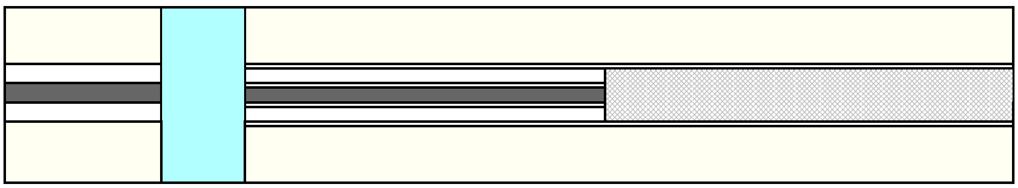
Acoustic Sealant....................................	Duro Dyne
Air Handling Units..................................	Engineered Air, Haakon, Trane
Automatic Air Vents...............................	Maid O'Mist, Amtrol
Automatic Temperature Controls	Honeywell, Johnson, Landis & Gyr
Boilers..	Weil McLain, Burnham, H.B. Smith and Veissmann
Circulating Pumps	Armstrong, Grundfos, B & G
Expansion Tanks...................................	Amtrol or Hamlet & Garneau Expandfle with EPDM bladder
Filters...	Farr Air, Fram, American Air
Flexible Connections	Duro Dyne
Grilles and Diffusers..............................	EH Price, Tuttle and Bailey
Heating Fluid..	Dowfrost HD propylene glycol
Insulation	Fiberglas Canada, Johns Manville, Knauf, Manson, Owns Corning, PlastFab
Oil Burners...	Riello, Beckett, Carlin, Powerflame, Aero
Side Stream Filters................................	Armteck
Sprinkler Equipment..............................	Viking, Grinnel
Tanks...	Clemmer, Maclin Westeel, Backbay Welding, Kingland
Time Switches	Paragon, Tork
Thermometers.......................................	Marsh, Taylor, Trerice, Weiss, Weksler
Valves..	Crane, Kitz, Toyo, Red & White
Domestic Hot Water Heaters..................	Aero, Ruud, John Woods
Outdoor/Exhaust Air Dampers................	Tamco, Westvent

APPENDIX ‘M’

PROPER METHOD OF INSTALLING HEAT TRACE CABLE

PVC or Plastic Pipe

1. 2" wide heat transfer tape applied to pipe wall first (parallel to pipe)



4. Apply aluminum heat transfer tape

style) over the heating cable lengthwise to achieve maximum heat transfer.

2. Apply approved braided and bonded to ground heat trace parallel to pipe (not wrapped around the pipe). This heat trace must have the termination kit and the end kit installed. This heat trace must be controlled by a thermostat and be on a G.F.C.I. circuit.

3. Attach heat tape to pipe using non-rusting, non-magnetic strap. Better heat transfer can be achieved by installing (taping) the heating cable with aluminum heat transfer tape.

APPENDIX “N”

GOVERNMENT OF YUKON

DEPARTMENT OF GOVERNMENT SERVICES

STRUCTURED WIRING SYSTEM STANDARDS

AND

IMPLEMENTATION CRITERIA IN YTG BUILDINGS

Date Issued: February 23, 2000
Revision: 2000/03/02
By: Department of Government Services
Information Services Branch and Property Management Agency

1 PURPOSE

The government recognizes that cabling has become a key networking component in an environment wherever increasing transmission speed is the norm. This standard assists departments and agencies in establishing a clear preference for non-proprietary, vendor independent, standards-based telecommunications wiring or cabling products and services in government-owned and leased buildings.

The standard provides a uniform approach to voice, data, and video telecommunications wiring (or 'cabling') in all buildings occupied by YTG departments and agencies. Its implementation provides an favourable return on investment, maximise the timeliness of the management and administration of moves, additions and changes of government personnel in the workplace, and reduce incremental and costly physical additions to the cable plant over its lifetime.

This Structured Wiring System Standard shall allow for the pre-wiring of premises and be capable of supporting voice, data, and video. This standard is mandatory for all new YTG buildings (owned and leased), and for retrofits of existing ones. All cabling installation must be in accordance with all applicable CSA standards and manufacturer guidelines. Additionally, installations must conform to the Canadian Electrical Code, the National Building Code, and Territorial Building Codes as appropriate.

1.1 DOCUMENT AVAILABILITY

This document may be obtained from:

> *Government of Yukon*
> *Department of Government Services*
> *Contract Services*
> *4141 – 4th Avenue Second Floor*
> *Box 2703, Whitehorse, Yukon, Y1A 2C6*
> *Phone: 867-6675383*

This standard replaces the following standard:

> *Government of Yukon*
> *Department of Government Services*
> *Structured Wiring System Standards - Section II: Specifications*
> *Issued April 1995 by Department of Government Services, Information Services Branch*

2 SPECIFICATIONS

2.1 Structured Wiring System Standard Specification

This document specifies the minimum technical requirements for telecommunication wiring systems used to provision voice, data, and video in government owned and leased buildings (hereinafter called ‘YTG buildings’). The provisions of the standard are effective immediately upon publication.

The following standard, with a number of restrictions and enhancements to better suit government requirements, has been adopted for use by the Government of Yukon. It shall be used in the installation of telecommunications wiring systems in YTG buildings:

- **Canadian Standards Association standard CSA T529-95: "Telecommunications Cabling Systems in Commercial Buildings"**[1]

The following enhancement shall be used in the design, installation, and testing of new UTP wiring systems in YTG buildings:

- **Enhanced Category 5 (Category 5E), as specified in TIA 568A-A5, is the minimum performance standard required for new UTP cabling installations in YTG buildings. It shall also be used when upgrading existing UTP wiring when ever possible.** [2]

TIA 568A-A5 is a normative document that provides the mandatory requirements for Category 5E performance and testing. The addendum addresses the minimum requirements to support applications that utilize full-duplex transmission schemes, such as Gigabit Ethernet.

The following standards shall also be used in the design, management and administration of telecommunications wiring systems in YTG buildings:

- Canadian Standards Association standard CSA-T528-93: "Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings";
- Canadian Standards Association standard CSA-T530-M90: "Building Facilities, Design Guidelines for Telecommunications";
- Canadian Standards Association standard CSA-T527: "Grounding and Bonding for Telecommunications in Commercial Buildings"
- Work must be performed in accordance with Canadian Electrical Code and Yukon Electrical Protection Act (and any other code of territorial or local application). In any case of conflict, or discrepancy, the more stringent requirements shall apply.
- All requirements or specified standards, codes and reference documents must be met.

---

[1] It is expected that later in 2000 the CSA T529-95 standard will be replaced by a new standard ‘Telecommunications Cabling Systems in Commercial Buildings’ which relegates category 5 to an informative annex and replaces it with category 5e as a standard.

[2] Formerly SP-4195, TIA 568A-A5 provides performance requirements for Enhanced Category 5 (Category 5E) components, cable, and links. It includes all the measurements in TSB-67 and TSB-95, but to stricter performance levels. It also includes power sum NEXT. All measurements are to 100 MHz.

2.2 Specifications in Tender Documents

Tender documents may specify cabling requirements that deviate from the Structured Wiring System Standard. Specifications in tender documents take precedence providing the installation is done to the minimum performance standard prescribed in this document. In any case of conflict, or discrepancy, the more stringent requirements shall apply.

2.3 Document Structure

Further refinements or enhancements to the CSA T529-95 standard are outlined within this document. Of significance is that the Government of Yukon standard recognizes only two telecommunications media types: unshielded twisted pair cable, and optical fibre cable. A Structured Wiring System shall be classified by the least performing component. This document is structured as follows:

- **STRUCTURED WIRING SYSTEM STANDARD SPECIFICATIONS** specifies the exception of a number of restrictions and enhancements to CSA-T529-95that are specific to the Government of Yukon standard.

- **Category 5E Test Specifications** Specifies the required minimum performance of high-speed data cabling links up to 100MHz.

- **IMPLEMENTATION CRITERIA IN YTG BUILDINGS** further details installation requirements and gives detailed instructions on how to implement the Government of Yukon standard.

3 STRUCTURED WIRING SYSTEM STANDARD SPECIFICATIONS

CSA-T529-95 "Design Guidelines for Telecommunications Wiring Systems in Commercial Buildings" have been adopted for use by the Government of Yukon. The exceptions and further refinements to CSA-T529-95 are as follows:

Section 1 **Scope** - as prescribed

Section 2 **Definition** - as prescribed

Section 3 **Reference Publications** - as prescribed

Section 4. **Horizontal Wiring**

4.4 Recognized Cables

Two types of cable are recognized in the horizontal wiring system.

a) four-pair 100 ohm unshielded twisted pair (UTP) Category 5E FT 4 cable
b) two-fibre, 62.5/125 µm optical fiber cable (12.2)

The specific performance characteristics are described in the exception Clause 10.

4.5 Choosing Media

The telecommunication outlets shall each be configured with cable as recognized 4.4

Section 5. **Backbone wiring** - changes to the following sub-sections

5.1 General

The backbone wiring system shall be provisioned at a density of:

a) three pairs of voice grade UTP cable per identified voice outlet in work area
b) one four-pair high-speed data grade UTP cable per identified data outlet in work area
or
c) one 12 strand multi-mode optical fibre cable as identified

5.3 Recognized Cables

This Standard specifies three transmission media that shall be used individually or in combination in the backbone wiring. The three media are:

a) 100 ohm UTP multipair backbone cable for voice

b) four-pair 100 ohm unshielded twisted pair (UTP) Category 5E FT 4 cable for data. This media will not be installed in situations where the distance between the main cross connect location and the telecom closet is greater than 90 meter.

c) 62.5/125 micron multimode optical fibre cable for high speed/long distance applications. NOTE: Optical fibre cable shall be installed where the distance between the main cross connect location and the telecom closet is greater than 90 meter.

Sections 6. Work Area - inclusion of the following sub-sections

The work area components shall consist of:

a) one duplex flush mount telecommunications outlet.
Surface mount jacks may be used in Pac Pole installations and retrofits. See 'Implementation Criteria in YTG Buildings' for installation specifications.

b) modular line cords (patch cord) to attach each work station. Line cords shall not exceed 3 meters in length. Each end shall be terminated with identical 8-pin RJ-45 modular plugs. Each plug shall be ISDN wired and maintain straight through polarity (polarized).

The modular line cord's (patch cord) electrical and performance characteristics shall match the horizontal grade UTP cable specifications. Patch cords must be factory made and tested. A standard telephone grade cord may be used for voice lines.

Section 7. Telecommunications Closet – as prescribed
All data cables shall be terminated on IDC wall mount systems with Category 5E RJ45 modular 8 jacks.

Section 8 Equipment Room - as prescribed
All data cables shall be terminated on IDC wall mount systems with Category 5E RJ45 modular 8 jacks.

Section 9 Entrance Facilities - as prescribed

Section 10. Cable Specifications - changes to the following sub-sections

10.1 General

The recognized UTP cable for new data installations is a four-pair 100 ohm unshielded twisted pair (UTP) Category 5E FT 4 cable.

10.2 Horizontal UTP Cable

The electrical and performance characteristic specifications shall meet the data cable requirements as outlined in exception clause 5.3.

10.3 Backbone UTP Cable

No multipair cables in pair sizes grater than 4 pairs may be used for high-speed data backbone cable. The electrical and performance characteristic specifications shall meet the data cable requirements as outlined in exception clause 5.3.

10.4 Connecting Hardware for UTP cable

Connecting hardware shall be installed in accordance with applicable CSA standards and manufacturer's requirements. Connecting hardware must be compatible with the installed cable.

10.4 Telecommunications Outlet/Connector Specifications

Each four pair cable shall be terminated on a telecommunications outlet shall be ISDN wired as outlined in Figure 10.1 CSA T529-95 (designation T568A).

10.5 UTP Patch Cords and Cross-Connect Jumpers - as prescribed

10.6 UTP Installation practices

Installation practices shall be in accordance with applicable CSA standards and manufacturer's requirements.

Section 11. 150 Ω Shielded Twisted-Pair Cabling Systems

Not used within YTG buildings

Section 12 Optical Fibre Cabling Systems - as prescribed

Section 13 Hybrid and Undercarpet Cables - as prescribed

Annex A to K - as prescribed

4 Category 5E Test Specifications

All Category 5E installations must be tested by the installer and must pass the basic link specifications (section 4.1). When patch cords and drop cables are supplied, the installation must also be tested according to the channel specifications (section 0). Test results shall be submitted in print and if requested in a Windows95 compatible electronic format on a CDR.

4.1 Basic Link Specifications

The basic link is the part of the cabling link from the telecommunication outlet in the work area via the horizontal cable to the first connection of the cross-connect in the floor distributor. The permanent link may optionally incorporate a transition point. A complete cross-connect is not part of the permanent link. Category 5E installations must meet or exceed the following specifications in the basic link test:

Parameter	**Category 5E Basic Link Test Specifications**
Specified frequency test range	1-100 MHz
Length	< 94 meters including test equipment cords
Wiremap	correct pin-to-pin connectivity (no opens, shorts, crossed, reversed, or split pairs)
Propagation delay	<548 nsec
Delay skew	<45 nsec
Attenuation	
@ 1 MHz	2.1 dB
@ 10 MHz	6.3 dB
@100 MHz	21.6dB
NEXT	
@ 1 MHz	64 dB
@ 10 MHz	49 dB
@100 MHz	32.3 dB
PSNEXT	
@ 1 MHz	60 dB
@ 10 MHz	45.5 dB
@100 MHz	29.3 dB
ELFLEX	
@ 1 MHz	61 dB
@ 10 MHz	41 dB
@100 MHz	21 dB
PSEFLEX	
@ 1 MHz	58 dB
@ 10 MHz	38 dB
@100 MHz	18 dB
Return Loss	
1 – 20 MHz	17 dB
20 - 100 MHz	17-7log(f/20) dB

4.2 Channel Specifications

The channel includes every cabling element necessary to pass data from a device at one end of the link to a device at the other end, including complete cross-connect, patch cord, and drop cables. Category 5E installations must meet or exceed the following specifications in the Performance Test:

Parameter	Category 5E Channel Performance Test Specifications
Specified frequency test range	1-100 MHz
Length	< 100 meters including test equipment cords
Wiremap	correct pin-to-pin connectivity (no opens, shorts, crossed, reversed, or split pairs)
Propagation delay	<548 nsec
Delay skew	<45 nsec
Attenuation @ 1 MHz @ 10 MHz @100 MHz	 2.1 dB 6.3 dB 21.6dB
NEXT @ 1 MHz @ 10 MHz @100 MHz	 63 dB 47 dB 30 dB
PSNEXT @ 1 MHz @ 10 MHz @100 MHz	 60 dB 44 dB 27 dB
ELFLEX @ 1 MHz @ 10 MHz @100 MHz	 59 dB 39 dB 19 dB
PSEFLEX @ 1 MHz @ 10 MHz @100 MHz	 56 dB 36 dB 16 dB
Return Loss 1 – 20 MHz 20 - 100 MHz	 17 dB 17-7log(f/20) dB

5 IMPLEMENTATION CRITERIA IN YTG BUILDINGS

5.1 Cabling Hardware:

- Follow manufacturer guidelines.
- Installed cabling shall be classified by the least performing component in the link.
- Connecting hardware must be compatible with the installed cable.
- Cables must be used with connecting hardware and patch cords of the same performance category or higher.
- Connecting hardware that is of a lower category than the cable must not used for high speed data installations.
- Use clip or barrel IDC (insulation displacement contact) connections such as those used in IDC blocks

5.2 Cabling Installation:

- Installation to be performed by or directly supervised on site by a manufacturer certified tradesperson.
- Follow manufacturer guidelines.
- To avoid stretching, pulling tension should not exceed 110N (25 lb$f$) for 4-pair cables.
- Cables should be tied and dressed neatly. Do not over-tighten cable ties, do not use staples to attach cables, do not make sharp bends with cables.
- Insure proper fire separations as per applicable codes
- Cabling should be placed at a sufficient distance from equipment that may generate high levels of electromagnetic interference.
- Minimum installed bend radii:
  - 4 times the cable diameter for horizontal UTP cables.
  - 10 times the cable diameter for multi-pair backbone UTP cables.
- Avoid cable stress, as caused by:
  - Cable twist during pulling or installation
  - Tension in suspended cable runs
  - Tightly cinched cable ties or staples
  - Tight bend radii

5.3 Cabling Termination:

- Cabling termination to be performed by or directly supervised on site by a manufacturer certified tradesperson.
- Each horizontal cable must be terminated on a dedicated telecommunications outlet.
- The twist of horizontal and backbone cable pairs must be maintained up to the point of termination. Any wire pairs may not be left untwisted.
- Pair twists shall be maintained as close as possible to the point of termination.
- Untwisting shall not exceed 13mm (0.5 in) for Category 5E links. Strip back only as much jacket as is required to terminate individual pairs.

- Follow manufacturer guidelines for category 3 products, if no guidelines exist, then untwisting shall not exceed 75mm (3.0 in).
- Connecting hardware shall be installed to provide well-organized installation with cable management and in accordance with manufacturer's guidelines.

5.4 Cabling Labelling:

- **Work Area:** All telecommunications outlets shall be clearly labelled with laminated, abrasion resistant adhesive tape (black print on white tape). The print must be minimum 10mm (3/8 in) tall. The labelling must be done by the pair count at the termination strip. First cable will be V001 for voice, D001 for data, second cable will be V005 for voice, D005 for data, and so on.
- **Cross Connect:** labelling corresponding to the work area must be used at the termination strip in the telecommunication closet or equipment room.
- **Backbone/Riser Cabling:** All riser cables shall have permanent labels at each end of the cable. Labels shall include floor#, closet#, and zone.

5.5 Pac Poles:

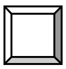
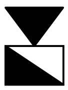
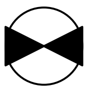
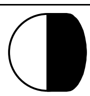
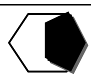
- Surface mounted jacks are acceptable on pac poles and for retrofits. The jacks must be securely bolted or screwed to Pac Pole (not taped) and data cables must not be exposed. The top of the jack must be a minimum of 85cm (34 in.) above the floor. The jack must be installed pointing sideways (not toward the wall or desk). Jacks must be labeled on the top.

5.6 Telecommunications Closet:

- Wherever possible, the telecommunications closet should be designed to accommodate a minimum of a 4' x 8' ¾" backboard and with enough depth to accept rack mount communications equipment (approx. 2'). The recommended minimal closet size is 10' x 11'. Minimum of two dedicated 120V 20A nominal, non-switched, AC duplex electrical outlet receptacles, each on separate branch circuits. Additional convenience duplex outlets placed at 1.8m (6 ft.) intervals around perimeter, 150mm (6 in.) above floor.
- The main cross-connect should be located near the centre of the building to limit cable distances. Cross-connects must not be located where cable distances will exceed the maximum.

APPENDIX O

FIRE ALARM SYMBOLS

C	FIRE ALARM CHIME
B	FIRE ALARM BELL
	FIRE ALARM BELL/STROBE COMBINATION
	FIRE ALARM HORN
F Z2	FIRE ALARM STATION & ZONE
 Z2	HEAT DETECTOR & ZONE
 Z2	SMOKE DETECTOR & ZONE “D” DUCT
	SMOKE DETECTOR INDEPENDENT UNIT
EOL	END OF LINE DEVICE
M	MAGNETIC DOOR HOLDER
FP	FIRE ALARM PANEL
ANN	FIRE ALARM ANNUNCIATOR