GENERAL BUILDING OPERATION

Daily/Weekly O&M Tasks

- Speak to Users (Teachers, etc.) daily and ask about changes in systems you may not notice.
- Encourage Users to contact Facility Staff immediately once they identify an issue.
- Ensure that Users know how to contact Facility Staff.
- For distributed campuses like School Districts, provide remote site BPOs with iPads/tablets and use video Facetime to troubleshoot issues.
    - Also good to scope maintenance/repair work in advance of traveling to the site including verification of what parts and tools need to be brought to complete the repair.
- Documentation
    - Use District web page to share information, O&M manual information, and training manuals and videos.
    - Keep record drawings and O&M manuals electronically. Scan existing paper documents so that they don't get lost.
    - Develop Standard Operating Procedures (SOP) for regular maintenance activities.
- Training
    - Train Users on how to utilize the systems in the building (i.e. thermostats).
    - Provide training for all new facility staff as well as Users.
    - Provide regular refresher training for all staff. For schools, complete it annually as part of the before-school in-service days as there are always new teachers.
        - Develop a Users' training packet/handout on how to operate the thermostat or other controls. Have Facility's contact number prominently displayed.
- Require DDC and other service agencies to operate and maintain the systems based on maximizing energy efficiency and not just keeping the facilities operating. Include in your service agreements.
- Develop Emergency Preparedness manual that includes the following activities:
    - How to operate standby generator
    - Inspection checklist for structural elements within the building including roof trusses and foundation. Check for cracks that may indicate failed structural elements.
    - Wall mechanical room looking for leaks.
    - Inspect fuel fired equipment and fuel distribution piping/equipment.

Capital Improvement Upgrades

- Develop a five-year Capital Improvement Plan (CIP) for each facility
    - Integrate escalation costs into CIP plan for inflation, bid market, etc.
    - Staff writing and approving grants need to consult with proper Facility Staff prior to submission.
    - Make and keep good communication with the Districts and schools for ongoing issues they need to know about and as changes in status occur.

- Develop a Master Plan for the future development and renovation of the facility and site. Include all stakeholders in development of the plan.
- Purchasing
    - For School Districts, create state-wide purchasing agreements with suppliers to improve buying power and reduce costs.
    - Collaborate with other facilities in the region to share:
        - Regularly scheduled maintenance (i.e. generator overhauls, boiler tuning)
        - Maintenance service providers for immediate or even planned maintenance. May be less expensive to have someone fly in from nearby village than from hub-city.
        - Parts availability.
- Have an energy audit completed at the same time as an inventory and condition survey. Integrate results into CIP plan.
    - For smaller communities, prioritize upgrades that lower fuel consumption. Savings from reducing electrical power usage in large facilities like schools are often offset by immediate increases in electrical utility rates by local provider.
    - Weigh all energy efficiency gains with additional maintenance costs. Most higher efficiency systems/equipment are more complicated and harder/costlier to maintain.
- Upgrades
    - Include ADA/Accessibility upgrades within the building and the surrounding site access at every opportunity.
    - Add more storage space.
    - Install technology that allows remote metering and trending of fuel and electricity usage. Match with outputs meters (such as BTU meters) to evaluate energy efficiency of the facility.
        - Consider creating an “energy dashboard” for each school and have it viewable by staff and students so they can see the real-time energy use of the facility.
        - Institute power monitoring and include sub-monitoring. At a minimum monitor 120, 277 and 480 volt feeds and keep histories to find irregularities.
- Preventive Maintenance
    - Do not defer Preventative Maintenance. It costs four times more to repair/replace than prevent.
        - Fix things when they are small issues before they become big issues.
    - Generate annual maintenance checklists for the facility that include the inspection/maintenance task, the frequency, and ways to identify who and when the task was completed. This is often integrated into maintenance software packages.
    - Purchase a software package that tracks Work Orders and automatically generates work orders for regular maintenance work.
        - Integrate age and life expectancy of each system (i.e. roof) and piece of equipment (boiler, lights, etc). Proactively add expected replacement into CIP plan.
        - Integrate warranty expiration dates for all systems and equipment. Schedule an inspection 1-2 months prior to expiration.

    - Invest in low-cost infrared cameras for each facility. This is an invaluable inspection and troubleshooting tool.
- Design Team Selection/Contracts
    - Ensure design team has cold-region experience.
    - Ensure design team has experience unique to your project/location including high seismic requirements, high winds, snow drifting, rural/remote construction, and limited construction seasons.
    - Require Record Drawings.
    - Require in your design contract that the design team provide CAD drawings (AutoCAD or Revit format) of the record drawings at the end of the project. This will save future design costs as design teams will not need to redraw the floor plan and systems.
    - Require in contract deliverables and expected levels of completion in the design for each milestone. Requiring the design to be more complete in the earlier submittals provides a better and more thorough review for the Owner.
        - For specifications, it is recommended that all sections be edited specific to the project and at least 80% complete at the 65% milestone and 98% complete at the 95% milestone including a Sequence of Operation.
- Construction Contracts
    - Require Record Drawings.
        - This also includes contractor shop drawings for sprinkler system, fire alarm, BAS control diagrams, and other performance-based designs.
    - Withhold a significant amount of money in the contract Schedule of Values for Contractor Record/Redline Drawings to ensure it gets completed and submitted. Contractor will skip small amounts of money at end of project.
        - Consider naming the line item as “Contract Close-Out” and also including Owner Training and O&M manuals.
    - Have all O&M and As-builts delivered in electronic format in order to make available remotely.
    - Receive and archive close out documents electronically.
    - Look into alternative project delivery mechanisms such as CMGC/CMAR (Contractor at Risk) in place of traditional design-bid model. Leverage knowledge and experience of your construction team during the design process to make for a cost-effective facility and easier construction.
- Construction
    - Be wary of Contractor “Value Engineering” suggestions. These often times provide lesser quality materials or systems that require more long-term maintenance.
        - Be sure design team has an opportunity to review and provide input on suggestions.
    - Require the Contractor take daily/weekly construction photos of the construction progress and post them to a cloud based, file sharing service.
        - Have the design team review the photos weekly.
        - Especially important for remote projects.

    - Have Facility Staff complete inspections of the site. Critically at the rough-in and substantial completion stages.
- Emergency Preparedness:
    - Consider setting up term contracts for emergency inspection services with local engineering firms. For situations like a major earthquake, it is imperative to have the facility quickly assessed to ensure it is safe to occupy. This is critical for facilities used as disaster shelters. Having contract in place makes process immediate and also pre-warns engineering firms that they need to go to the facility rather than wait for a call.
    - Have contact emergency contact information readily available in facility Disaster Preparedness documentation.

Design Best Practices to Support O&M

- General
    - All communication is to be constructive with the intent to collaboratively create a better facility.
    - All team members to keep an open mind about recommendations from all parties and not take things personally.
- Planning Stage / Early Design
    - Plan for future expansions/renovations. Ensure all stakeholders have been asked about their future plans.
    - Consult Facility Management Team at the very beginning of a project.
    - Identify design guidelines and review them with staff to verify they are up to date.
    - Work with owner to identify the level of complexity that the User and Facility Staff can use and maintain.
    - Acquire local knowledge and help when orienting the building. Particularly in regards to wind directions and snow drifting.
- Design
    - Design for durability and maintainability.
    - Use readily available materials.
        - Select equipment based on readily available parts and knowledgeable technicians.
        - Replacement will be faster.
        - Some European materials and equipment can have very long lead times for new and replacement parts. Typically cost more money.
    - Use standardized manufacturers and products to simplify replacement and reduce maintenance materials (spare parts). Typical for all building systems.
    - In general, do not use new industry systems/materials/equipment unless the Owner has full buy-in on the pros and cons of the proposed solution.
    - Have Facility Staff involved in milestone design reviews and attend design review meetings.
    - Utilize cost analysis tools for system selection
    - Don’t use “boiler plate” specifications. Specs need to be written specific to the job and the equipment being used.

    - Request from Owner past project "Lessons Learned".
    - Learn design concepts from industry leaders in similar climates such as Northern European countries.
- Construction
    - Bring younger designers to the jobsite inspections so that they can learn about constructability. (At no cost to the Owner)
- Commissioning
    - Integrate Commissioning into the design close-out for anything that has an automatic function.
    - This goes beyond traditional mechanical building automation systems including lighting controls and building envelope testing.
- Training
    - Provide extensive training for Facility Staff.
        - Repeat training, at least on BAS systems, at 6 months.
    - Provide training for Users.
    - Video tape training and digitally store training so it is easily accessible for future reference.
    - Consider having design team provide introductory training session to facility staff to explain the systems, the design intent, and how the systems are intended to operate.
- Close Out Documentation
    - Require contractor record drawings. Have design team update drawings based on contractor red lines as well as all field changes (RFIs, etc).
    - Develop thorough Operation and Maintenance Manual for all materials and equipment that will require replacement and maintenance.
        - Require cover sheet for each piece of equipment with the manufacturer, specific model number, installing contractor contact information, contact information for local source of replacement parts, and warranty information including when the warranty expires.
        - Consider developing a pictorial maintenance reference document specific to the site and for each piece of equipment. Document would have written step-by-step operating procedures on how to turn on/off and maintain the system with arrows pointing at what needs to be operated or what the interface should look like.
    - Digitize O&M manual and keep readily available to staff.
        - with pictures/images of the equipment, operating panel, or other interface. Note
- Post Construction
    - Owner should contact design team with issues that arise after construction.
    - Design team may know solutions and will learn how to improve future projects.

Additional Resources/Literature

- ASHRAE

  - ANSI/ASHRAE/ACCA Standard 180-2018, Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
    - This has a thorough list of regularly scheduled maintenance procedures/checklists for numerous mechanical pieces of equipment.
- Illinois Association of School Business Officials (IASBO)
  - Facilities Operations Program. Onsite training for Facilities, Maintenance, Grounds, and Custodial. https://www.iasbo.org/iasbo/facilities/facprograms/fop Based on the Good School Maintenance book.
  - Good School Maintenance, Fourth Edition, 300 page manual. Available at www.IASB.com

BUILDING ENVELOPE AND EXTERIOR

Daily/Weekly O&M Tasks

- General
  - Immediately address vandalism.
- Envelope
  - Walk the grounds daily
    - Ensure windows are closed.
    - Identify peeling siding
    - Ensure lights are off.
    - Ensure facility is bird/rodent proof.
    - Look for wall panel warping.
  - Semi-annually inspect windows to ensure proper operation and that they have good seals.
  - Annually inspect door seals.
  - Use an infrared camera to inspect the building envelope annually.
    - Will identify leaking gaskets/seals as well as settling that may have created gaps in the envelope.
- Roof
  - Walk flat roofs at least once a month.
    - Ensure membrane is still secure.
    - Remove debris including dirt that may start growing vegetation.
    - Remove any sharp objects immediately.
    - Use infrared camera early in the morning to locate wet insulation. Wet insulation will appear warmer than dry insulation.
  - Have roof warranties, including project number and manufacturer contact info, laminated and prominently affixed at all roof accesses.
  - For sloped roofs, look for ice damming and warm spots. May be a sign of damage to the roof/insulation system that may expand to rot and mold if not fixed.
  - Annually check cold attics for mold, insulation integrity, and condition of structural trusses.
    - Check cold attic venting system to ensure baffles are clear and system is operable.
  - Annually clear the roof, roof gutters, downspouts of debris at the end of fall.
  - Ensure heat trace systems are working.
- Site
  - Walk the grounds daily
    - Pick up litter.
    - Verify handrail integrity.
  - Sweep the parking lot in the spring to remove excess gravel.
  - Identify and fill cracks in concrete and asphalt as soon as possible. Freezing during Winter can further expand crack.
  - Do not use salt on sidewalks.
  - Manage gravel usage to minimize interior finish damage.

- Maintain fencing.

Capital Improvement Upgrades

- General
  - Upgrade materials with vandal proof coverings or systems.
- Windows
  - Replace windows after 20 years.
- Roof
  - Consider replacing mechanical equipment and other systems that are on the roof near the end of their useful life as part of a roof replacement project.
  - Add/Upgrade interior roof access during roof projects.
- Doors
  - Replace exterior doors after 20 years.
  - Replace corroded doors.
- Replace windows that are single pane, leaky, or non-functioning.
- Repair exterior gaps in walls to protect building envelope.
  - Ensure gaps are not due to building settlement.
- Include ADA/Accessibility upgrades at every opportunity.

Design Best Practices to Support O&M

- Massing
  - Orient building, entries with predominant wind direction in mind.
  - Identify snow drifting locations.
  - Set building heights to provide adequate above-ceiling space for maintenance of lights and future renovations.
    - Congested ceilings add to maintenance costs due to difficulty of reaching/maintaining systems. This may include the need to remove and reinstall piping, ductwork, lights, conduits, and/or ceilings to gain access to the item needing repair.
    - Do not design building height around specific mechanical systems such as VRF or DOAS. Future renovations may require routing piping or ductwork through limited space.
  - Locate mechanical fan rooms and air intake locations with good indoor air quality in mind. Watch for proximity of idling vehicles and boiler flues. Look at wind patterns that occur throughout the year.
- Materials
  - Be mindful of corrosive environments such as coastal locations.
  - Be mindful of winter temperatures and do not use exterior materials that may catastrophically fail if impacted or torqued during cold temperatures (PVC).
  - Use vandal-resistant material coatings.

    - Use aluminum or fiberglass materials in corrosive environments
- Building Envelope
    - Design a robust building envelope with insulation values that exceed ASHRAE 90.1 requirements.
        - High insulation values and a well designed vapor barrier will make the mechanical systems smaller as well as reduce long term utility costs.
    - Select siding appropriate for the environment, i.e. be mindful of corrosive environments.
    - PVC/Vinyl siding is brittle in cold temperatures and can be easily broken by rocks, hands, or balls.
        - The material is cost effective and maintenance free, use in areas not prone to impact.
    - Design walls that can't be climbed.
    - Assume all sealants will fail.
    - Clearly detail door and window sealant systems
    - Detail and clearly specify vapor barrier sealing.
        - Consider having building envelope testing/commissioning either via blower door or thermal imaging inspection. Include testing performance requirements in construction and commissioning documents.
        - Vapor barriers must be continuous around the perimeter and the roof prior to interior studs being installed.
            - Plumbing walls that are perpendicular to exterior walls sometimes have non-continuous vapor barriers and will freeze under high wind conditions. Same with non-continuous cold roof vapor barriers on internal plumbing walls.
- Windows
    - Use high quality glazing and window systems.
    - Do not use "Tilt-Turn" windows.
    - Design for passive solar opportunities.
    - Use smaller size operable windows that can be more easily operated and replaced.
    - Use smaller size window modules that, if broken, do not cost a lot of money to replace.
- Roof
    - Sloped Roofs
        - Provide steeper pitch roofs – be mindful of snow/ice shedding zone.
        - Metal is a durable material for roofs but the design team must control snow and ice shedding for safety and property damage.
        - Mechanical penetrations need to be as close to the peak as possible, detail in the drawings diverters/"crickets" upstream of penetrations to protect them from damage from shedding ice.
            - Ensure crickets are designed for the snow load. Larger is better.
        - Do not slope big roofs onto small roofs or flat roofs without design for handling snow/ice shedding.

    - Flat Roofs
        - Provide anchor points where applicable to support maintenance access/activities.
        - Avoid roof payer systems. It is difficult to locate leaks.
        - PVC roofs should be avoided – slippery. Surface not as durable.
        - Specify heavy 80-90 mil membrane EPDM
- Site
    - Slope the grade away from the building and sidewalks.
    - Eliminate hiding spots around building.
        - Ensure vehicle site lines are clear.
    - Provide heated sidewalks rather than salt and gravel. Use waste heat if possible.
    - Design steps and railings to facilitate snow removal.
    - Design parking lots to facilitate snow removal and storage.
        - Ensure enough parking places still existing with snow piles.
    - Design for ADA/Accessibility including access to school, playground and other areas.
    - Provide security fencing around the building perimeter of raised structures.
- Playgrounds
    - Design equipment that is age-appropriate.
    - Use non-flammable materials (particularly surfacing materials).
    - Use surfacing materials that stay resilient year-round.
- Landscaping
    - Do not put landscaping (trees, bushes, etc) next to the building.
    - Select vegetation that does not require regular maintenance or irrigation.
- Provide covered walkways, stairwells, and entries.

INTERIOR FINISHES AND FLOOR PLAN

Daily/Weekly O&M Tasks

- Have in place infection control protocols.
- Utilize all-in-one cleaning carts.
- Clean walk-off mats daily.
- Maintain custodial equipment.
- Regularly reevaluate cleaning products.
- Look for frost or damp interior surfaces as that may be an indication of failing vapor barrier or building envelope system.
- Training
    - Consider the capability of staff to complete maintenance tasks.
    - Have training programs for custodial staff
    - Ensure that staff knows what chemicals to use and how to clean/maintain surfaces.

Capital Improvement Upgrades

- Evaluate finishes regularly to identify if they need to be replaced or just renewed.
- Replace seals with high quality materials.
- Flooring
    - Repair/Replace walk-off mats regularly.
    - Upgrade gym floors. Rubber/urethane floors can be restored by just adding a thin-layer of new material rather than having to replace the whole floor system.
    - Replace classroom carpeting with vinyl flooring. It is healthier, better for indoor air quality, and easier to clean.
    - Replace carpet and walk-off matts with modular/carpet squares.
- Purchase custodial equipment specifically appropriate for the surfaces/materials in that facility.
- Complete small upgrades to finishes such as patch/paint surfaces.
- Provide new signage.
- Replace chalk boards with whiteboards
- Recapture facility square footage by reworking storage

Design Best Practices to Support O&M

- Involve custodial staff in design conversations.
- Consider the capability of staff to maintain the finishes.
- Floors
    - Utilize subfloor moisture mitigation techniques/coverings.
    - Incorporate extensive walk-off mats.
        - Consider ways to minimize gravel/dirt coming into the facility to eliminate walk-off mats such as snow melt or grating.
    - Use carpet squares.

- Finishes
    - Design around durability
    - Design around standard paint colors already in use in the facility.
    - Use vandal and impact resistant surfaces.
    - Use color/patterns that are timelessness
    - Design bathroom wall and floor finishes to facilitate hose spray-down cleaning techniques.
- Materials
    - Design around durability.
    - Select materials that look the same throughout such as wood and terrazzo so that sanding/refinishing can be done with minimal notice.
    - Do not specify systems with wax finishes. They require regular maintenance.
    - Use quality solid surfaces for counters and flat surfaces that the public can reach.
    - Do not use soft surfaces. They increase allergies, the spread of disease, and other pathogens.
- Ceiling:
    - Use 2x4 ceiling tiles rather than 2x2 tiles to improve above ceiling reach and maneuverability.
        - Do not use oversized tile sizes that are difficult to raise, can easily become damaged when accessing, or will be difficult to find replacements in the future.
    - Use standardized ceiling tile pattern and color that is readily available for future replacement.
    - Specify fiberglass ceiling tiles. They are lighter, have the same durability, same Noise Reduction Coefficient (NRC) and have the ability to dry out if there is a leak.
    - Coordinate ceiling plan to provide access to MEP systems.
        - Designate access tiles on the Reflected Ceiling Plan sheets so that sprinkler heads, smoke detectors, and other performance specified items are not located in key access locations (i.e. VAV box access).
    - Locate lights so they are accessible for maintenance and can be replaced.
- Furniture, Fixtures and Equipment (FFE):
    - Design with future flexibility of room layout and use in mind.
    - Coordinate FFE with all design disciplines, specifically electrical for power and data connections.
    - For schools, standardize classroom technologies (smart boards, computers, etc)
    - Select furniture that is easily reconfigurable without having to call maintenance.
    - Design versatile classrooms that can be used for different activities and teaching styles.
- Casework
    - Use plywood with veneer surface rather than particle or press board.
    - Use institutional grade casework for high-use areas.
    - Design lots of storage space into classrooms.
- Doors
    - Utilize owner standardized hardware

  - Use Five Knuckle – Ball Bearing type hinges
  - Coordinate power, security, and communications requirements with electrical engineer.
- Floor Plan
  - Provide more storage for school and maintenance functions.
  - Provide adequate storage for janitorial supplies.
  - Do not build arctic entries with really high ceilings.
  - Ensure building has space for a workshop for onsite repairs and maintenance support.
  - Minimize the use of moveable walls/partitions.
  - Do not put plumbing fixtures on exterior walls. Exception is if a furred plumbing chase is provided interior of the warm side of the vapor barrier.
  - Utilize arctic entries with ceilings.
    - Provide space for wall mounted, inverted flow cabinet unit heaters so that they can melt any tracked in snow and ice.
    - Provide double stud wall to fully recess the cabinet unit heater to minimize enclosure damage. Coordinate depth with mechanical engineer.
- Sound
  - Identify sound/privacy sensitive areas.
  - Provide sound batt in all mechanical room walls.
  - Provide sound batt on restroom walls as appropriate.

MECHANICAL SYSTEMS

Daily/Weekly O&M Tasks

- Walk through mechanical rooms daily
    - Record/Document mechanical system performance (system pressures, operating temperatures, etc) on a daily/weekly basis.
    - Be sure staff who complete the walk through know what to look for including leaks and abnormal sounds.
- Walk through occupied spaces once a week to identify warm/cold spots.
- Verify doors between heated and temperate/non-heated spaces (such as vestibules and garages) remain closed.
- Look for open windows. This may indicate an unreported HVAC space temperature issue.
- Plumbing
    - Ensure seals between plumbing fixtures and floor/wall surfaces are in good condition.
    - Annually take domestic water samples and send them in for testing. Get samples at water entrance and end of line fixtures. High minerals and/or copper can be signs of corrosion issues.
    - Immediately isolate and fix any leaking pipes, faucets, and fixtures prior to additional damage.
        - Water overfilling inside tank-type water closets can result in significant water usage costs.
    - Ensure that plumbing Vents-Through-Roofs (VTR) do not frost over.
    - Do not use 'Y' fittings on janitor sink or hose-bibb hose thread connections. These counter the backflow prevention device and can cause cross contamination as well as hot/cold migration.
        - For exterior hose bibbs, this will keep it from draining and freeze/burst the hose bibb.
    - Traps
        - Every couple of years, power wash through floor drains to clear debris and built up snow.
        - Inspect to ensure trap primers are working.
        - If trap primers have failed, regularly top off traps with mineral oil as it will not evaporate like water and will not go rancid like vegetable oil.
            - There are some mechanical trap seals on the market, such as the Trap Guard, that reportedly allow water to go through.
- Heating System
    - Provide isolation valves on automatic air vents and keep them isolated in most locations.
    - Have heating system fluid annually tested for pH and inhibitors. For glycol, check glycol concentration. Take sample and mail it in for testing and recommended treatment.
        - Never refill glycol systems with water or have a water connection used as make-up.

        - Always use the same type and preferably brand of glycol. Mixing inhibitor packages can be very detrimental to the heating system.
    - Verify fuel fired condensate neutralization systems and any lab acid neutralization systems have adequate neutralization media. Mix up neutralization media to ensure liquid has good contact with the media before being discharged into the waste system.
    - Make sure that all boilers and pressure vessels are registered with the State of Alaska.
        - Annually test the safeties.
    - Replace inoperable gauges. Ensure that replacement gauges are of the right temperature/pressure range to accurately show performance.
    - Annually check expansion tank for bladder failure. Pressure relief activation is likely a symptom of a failed expansion tank.
- Ventilation
    - Document locations and replace air filters on set schedule.
    - Complete bearing lubrication at recommended intervals.
    - Annually check motors for vibration and belt tension.
    - During the winter, regularly check for frosting of intakes and filters.
- Fuel
    - Check fuel storage tanks for water regularly.
    - Do not let standby fuel get old. Operate standby generators and dual fuel boilers regularly to both use the fuel and ensure system will be operable when needed.
    - Annually inspect storage tanks for signs of corrosion.
    - Have all fuel fired devices be annually inspected, particularly heat exchangers.
    - Regularly check flue caps to ensure they are not freezing.
- Fire Suppression
    - Complete inspections and fire pump tests at recommended intervals.
    - Do not let staff hang anything below skylights that have sprinklers in them. Covering will pool the heat and set off the sprinkler.
- Corrosion
    - Identify and fix leaking valves and piping immediately.
    - Do not let copper or steel piping touch ceiling grids or other structure. Stray currents from lights will create electrolysis.
    - Complete ultrasonic testing (UT) on water and heating pipes every couple of years to check for interior corrosion/scaling or thin walls from aggressive water.
    - When pinhole leaks occur in piping, remove the section of pipe and send it to the Facility Manager for inspection. Cut pipe in half and identity why there was a leak. One leak may be a symptom of a greater issue and give you time to schedule a major CIP replacement before eminent system-wide leaks/failures occur.
- Building Automation System (BAS)
    - Look at alarms and automation reports daily.
    - Look at room temperatures at least once a week.
    - Have extensive trends setup for all troubleshooting/diagnostic points.

    - Check trends of system operating/discharge temperatures twice a month.
    - Check occupied/unoccupied trends twice a month to ensure systems are off.
    - Do not override alarms unless item is fixed.
    - Do not put normally automatic functions in manual override.
    - Ensure night time/unoccupied mode setbacks are in place.
    - Closely monitor building humidification levels and have alarms. Too high of humidity (such as in pools) can quickly ruin a building envelope.
    - Closely monitor building pressure.
        - Too low of building pressure will increase infiltration which will increase utility costs.
        - Too high of building pressure may push water vapor into the building envelope and ruin the envelope.
- Training
    - Train facility staff on how the systems are intended to operate. No two facilities operate the same.
    - Train Users on how to use and properly set thermostats.
        - Minimize setpoint range through BAS system from 68-72 degrees F.
    - Train Users on how to maximize energy efficiency (lights, thermostat setpoints, etc).
    - Ensure that staff understands not to put books or other obstructions on top of baseboard, floor vents, or unit ventilators that will block heat or ventilation from getting into their space.

Capital Improvement Upgrades

- Replace equipment, particularly boilers, on a preventative-maintenance schedule.
- Install Variable Frequency Drives
    - Ensure that shaft grounding gets installed at the same time.
    - Consider replacement of motors with ECM technology.
    - Protects motors from brownout conditions.
    - Remove all inlet vanes from fans.
- Consider replacement of equipment with higher efficient equipment.
    - Oil fired boilers should all now be 3-pass designs rated for 87% efficiency.
    - Gas fired equipment can be “high efficiency” but consider the operating conditions/temperatures and if the additional maintenance costs associated with condensing operation is worth the utility savings.
- Identify waste heat opportunities from within facility as well as within community.
    - Look for air-to-air heat recover opportunities.
    - Consider Combined/Heat Power (CHP) solutions.
- Provide under/over voltage protection for equipment with circuit boards or prone to failure.
- Ensure that Record Drawings include field measurements for exact locations and depth of interior and exterior below grade piping, particularly waste piping systems that may be connected to in the future.
- Building Automation System

Please send additional comments to Craig Fredeen at Cold Climate Engineering, LLC: cfredeen@coldeng.com

- Upgrade pneumatic controls to electronic or full Direct Digital Controls.
- Integrate night/unoccupied mode setbacks.
- Replace or recalibrate sensors on recommended intervals. Particularly CO2 sensors.
- Simplify systems.
- Add automation and remote monitoring.
- Select contractors based on performance during construction and most importantly on support after construction. Complete research on firms from other School Districts.
- Specify "open" communication protocols such as BACnet or LonTalk. Specify system architecture to reduce proprietary networks that keep you locked into a specific vendor.
- Consider installing analytics-driven monitoring software, sometime referred to Monitoring-Based Commissioning, Ongoing Commissioning (OCx), and Fault Detection and Diagnostics (FDD) software. These systems can be separate party from the BAS provider and constantly monitor the BAS communication looking for abnormalities that may be symptoms of failure or excessive energy use. This is a new service in the industry.

Design Best Practices to Support O&M

- Keep it simple.
- Planning stage
  - Engage facility staff at the beginning of a project. Consider having a mechanical-specific design charrette.
  - Identify zoning for off-hours use, plan equipment accordingly to minimize energy use for unoccupied areas.
  - Identify temperature setpoints/conditions for each zone. Some spaces, such as storage rooms, may be able to be kept at lower temperatures or even non-heated.
    - Be sure to provide insulation and potentially a vapor barrier in the walls around these rooms.
- Design
  - Meet with Facility Staff and review the design at major milestones. In addition to Facilities Director, include staff who will be maintaining the facility.
  - Design simple, easy to maintain systems.
  - Design for the end user.
    - Bigger, more pieces and parts are not always better.
    - Not all maintenance personnel can operate all equipment. Design complexity around the capabilities of the staff on site.
  - Utilize 3D/BIM software to identify tight installations.
    - Show valve tree locations for coils. These are often times not shown and extend into walk-ways and other maintenance access points.
    - Design with the structural and electrical lighting models incorporated into the model so spatial issues that will impact maintenance can be identified.
  - Drawings
    - Locate/Notate all isolation valves on the drawings

        - Consider putting Sequence of Operations on the drawings rather than in the specifications. All equipment and performance information should be on the drawings. Specifications get lost.
        - Coordinate wall/ceiling access panels with architect. Specify sizes and ensure they are large enough to complete desired maintenance through.
        - Coordinate designated access ceiling tiles with architect for RCP.
        - Show manufacturer's recommended maintenance clearances around equipment.
        - Show NEC clearances in front of electrical equipment. Coordinate panel locations.
        - Provide schematics/diagrams for boilers, water heaters, air handlers, and other mechanical systems. Show BAS sensors, gauges, thermometers, drains, vents, and other maintenance related items.
        - Consider having a separate return and relief air path drawing that identifies above-ceiling transfer openings. This sheet is easy to share with the carpenters and sheet rock installers.
        - Keep all piping and ductwork within the thermal envelope.
    - Specifications
        - Clearly identify training and commissioning requirements.
        - Clearly identify robust O&M and training requirements.
        - Specify low point drains and high point vents.
    - Consider making a mock up of complicated installations for Users and Facility Staff to be familiar with.
- Equipment
    - Select equipment and systems based on durability and maintainability.
        - Additional accessories that complicate the system may be more hurtful than helpful.
    - Locate all equipment on the floor or walls within 6 feet of the floor so that they can be reached and maintained without ladders.
        - Do not put anything heavier than 100 pounds more than 8 feet in the air.
        - Strive to keep all MEP maintenance items out of the ceiling.
    - Centralize equipment in mechanical rooms.
        - Ensure mechanical rooms have both interior and exterior access.
    - Avoid putting equipment on the roof in extreme cold or high snow level locations.
    - Consolidate equipment.
        - Better to provide two pumps in a primary/back-up configuration than 15 terminal pumps that need to be maintained.
        - Same with exhaust fans.
    - Make sure all equipment can be removed and replaced through doors. Provide other openings, such as removable wall panels, for larger equipment.
        - If using large louvers to remove equipment, ensure louvers are of appropriate size and provisions have been made on how to get equipment elevated through opening. Be mindful of water entrainment from snow drifting against louvers that are extended to the floor.

  - Redundancy
    - Provide redundancy for critical systems (i.e. multiple boilers, primary/back-up pumps, etc.).
    - Discuss if manual bypasses should be provided on VFDs.
    - Design redundancy and turn-down into the system to maximize efficiency during non-design conditions.
  - Put structural rails/pull points above motors 15 hp and higher to facilitate motor replacement. Coordinate with structural.
  - Avoid 1,200 RPM motors. They are a very long-lead item. 1750 RPM motors are most readily available for replacement.
- Fuel Fired Appliances
  - Minimize the number of fuel oil fired pieces of equipment. Typically use central boilers, quantity based on providing appropriate redundancy.
    - Utilize indirect fired water heaters and hydronic unit heaters.
    - Diesel spills are very expensive to fix and cause significant indoor air quality issues.
  - Flues
    - Do not route flues up the outside of the building. The cold flue will create hard starts and condensate will corrode the stack.
      - Route flues within the warm envelope until the roof termination.
    - Locate flues so that they are never upwind of the outside air intake.
      - Temperature inversions can keep products of combustion low along the roof during the winter so do not rely on convection for separation.
    - For condensing gas appliances, consider using high velocity exit cones for flue terminations instead of caps. Caps tend to collect condensate which freezes and creates a maintenance/safety issue.
      - This is the preferred installation for liquid fuel fired appliances in Antarctica as well.
      - Be sure that the flue has a tee at the bottom with a drain so that any precipitation that comes down the flue does not go into the appliance. Route drain to a condensate neutralizer.
    - Do not locate condensing sidewall flue terminations above public ways as condensate will drip and create ice below.
    - Be mindful of sidewall vents in high-wind locations.
- Pipe and Pipe Accessories
  - Consider using Aquatherm (manufacturer of PP-R piping) in place of steel or copper on new or major replacement projects. It is lighter and easier to install, is fused like HDPE and therefore reduces fire risk from torches during construction, and has a 10 year warranty against leaks.
    - Consult with an engineer and other School Districts (such as Mat-Su School District) familiar with this product.

        - Do not use PP-R with systems that have a lot of copper pipes still in the system as the copper can lead to catastrophic failure of the PP-R pipe.
        - Ensure that first project includes providing the School District the installation tools used at the jobsite. They are expensive tools to purchase through operating budgets and are needed for maintenance.
        - Plumbing rough-in terminations (angle stops and flush valves) need to be supported to structure. Otherwise flush valves will move and be prone to leaking.
    - Specify tracing/locating wire for all buried piping outside the building.
    - Valves
        - More valves on all mechanical system distribution piping.
        - Provide valves upstream and downstream of all replaceable parts.
        - Valves, valves, valves. More isolation valves!
        - Do not use gate valves.
    - Provide more unions/flanges at equipment and in the mechanical piping to facilitate maintenance.
        - Do not allow dielectric unions. Use dielectric nipples with bronze unions or flanges with isolation gasket kits.
    - Specify and show on the drawing details more high point vents and low point drains.
    - Specify and show on the drawing details ample uses of thermometers and pressure gauges.
- Plumbing
    - Provide isolation valves on pipe mains outside of all restrooms and major fixture groups.
    - Provide isolation valves on all major branches of the building so that sections can be isolated without shutting down the whole building.
    - Locate waste pipe cleanouts in accessible locations.
    - Plumbing Fixtures
        - Do not put plumbing fixtures on exterior walls. Exception is if a furred plumbing chase is provided interior of the warm side of the vapor barrier.
        - Select age-appropriate fixtures.
            - Note that accessibility heights are different in schools and day care centers for youth.
        - Hardwire infrared faucets and flush valves.
        - For public restrooms, provide heavy-duty water closet carriers.
            - Use wall carriers for urinals and wall mounted lavatories.
        - Utilize hydration stations instead of drinking fountains.
        - Provide cold water hose bibb (in locked cabinets) in restrooms to allow cleaning through hosing down the surfaces.
        - Specify floor-mount janitor closets.
        - Provide ABS/PVC waste piping on waterless urinals until point of dilution.
    - Floor Drains
        - Ensure design team shows floor slopes to floor drains.

        - Provide floor drains in all restrooms accessible to the public or youth regardless of code requirement.
        - Include in specifications that floor drains and floor sinks shall be installed flush with the floor.
        - Provide drains directly below emergency eye wash stations and showers. Hard-pipe discharges if possible.
        - Locate drains immediately outside of shower stalls and ADA roll-in showers.
    - Trap Primers
        - Consider using the type that come off of flush valves and flush tanks. They will last longer than traditional diaphragm type units.
            - Careful using sink drop tube units as debris from the sink may clog the trap line.
        - Use electric type units when not near flush valves. Diaphragm type may not operate away from flush valves.
        - Provide detail with branch off top of supply main and access doors.
        - Coordinate locations so that access is maintained.
        - Consider mechanical trap seals if the local AHJ will allow its use.
    - Heat Trace
        - Design solutions that do not require heat trace if possible.
            - Slope roof so that roof drains are located over warm portions of the building.
        - Provide installation detail for heat trace on overflow spouts. Securely fasten heat trace to inside of pipe to minimize vandalism.
- Heating
    - Provide isolation valves on all major branches of the building so that sections can be isolated without shutting down the whole building.
    - Provide drains on all four pipe connections of a heat exchanger to allow for back-flushing.
    - Avoid central air heated systems for occupant comfort. More expensive to operate during unoccupied hours.
    - Terminal Heating Units
        - Use inverted flow cabinet unit heaters in vestibules to melt snow/ice.
            - Fully recess units or provide sloped tops to reduce damage from sitting or drinks.
        - For baseboard in high impact areas, specify brackets and additional wall fasteners be installed every 32 inches (or two studs). Use minimum 18-gauge enclosures.
        - Locate unit heaters so they are easily accessible with ladders.
    - Locate perimeter hydronic heat valves in the ceiling space.
        - If not possible, coordinate access points for casework with interior designer and casework design.
    - Air vents

        - Provide isolation valves on manual and automatic air vents. They are typically isolated.
        - Specify high quality air vents such as the Spirovent system.
        - Consider detailing manual air vents as 1/4" isolation valve and 180 degree bend with a hose connection so that discharge can be directed to a bucket.
    - Design snowmelt systems with insulation underneath and on the edges.
        - Provide enough heat that vaporizes water rather than just melts it and becomes ice in an adjacent location.
        - Be mindful that interfaces between heated and non-heated surfaces will have sudden changes in elevation due to compacted snow/ice which may create access issues.
        - Provide conduit out to the snow sensor so that the thermocouple and wiring can be replaced in the future.
- Ventilation
    - Design fan rooms such that you can gain access everywhere without having to climb over ducts.
        - Provide easy access to air handling units.
        - Minimum 30" wide x 60" high access corridor to all parts of the mechanical rooms.
    - Outside Air Intakes
        - Design outside air intake systems appropriately for wind and snow conditions to keep snow from entering the building.
        - Locate air intakes with good indoor air quality in mind. Watch for proximity of idling vehicles and boiler flues. Look at wind patterns that occur throughout the year.
    - Return Air System
        - Manage the return and relief air paths.
        - Verify during construction that all transfer air openings were installed.
    - Exhaust/Relief Air System
        - Locate discharges away from walkways where it may create icing.
        - Do not discharge exhaust or relief air near thermosyphon fins. Heat will keep the refrigeration system from fully working.
        - Recognize that variable speed kitchen hood/exhaust fan systems are hard to maintain and may not be suitable for all applications.
    - Distribution
        - Evaluate sizing ductwork systems at low pressure verses medium pressure. This will have higher first cost from larger ducts but can result in significant reductions in static pressure, fan horsepower and long-term energy usage.
    - Filters
        - Provide appropriate filters in the appropriate (and maintainable) locations
        - Provide permanent sliding ladders for filter banks higher than 7 feet.
    - For VAV boxes, provide minimum, heating, and maximum flow rates. Minimum rates should be significantly lower than 50% max rates.

    - Detail access doors on at least one side of duct coils for inspection and cleaning.
    - Consider heat recovery, DOAS systems for energy efficiency.
    - Most ECM fan motors are integral to the fan assembly, requiring replacement of the entire assembly. Design for fan removal. This is more expensive than traditional motor replacement. Note this is not typical for pumps with ECM motors.
    - Consider displacement ventilation systems or other vent location solutions that allow the designer to reduce heat loads associated with lights and people as well use a Zone Air Distribution Effectiveness factor of 1.2 which reduces minimum ASHRAE 62.1 outside air volumes. Results in smaller systems and lower ventilation heat loads.
- Cooling
    - Locate and address all sources of heat including pumps, refrigerators, freezers and transformers.
    - Consider locating condensers in areas that can utilize the heat during the winter. Consider summer conditions and ability to remove heat from that space.
    - Use refrigeration based occupant cooling only where skilled technicians will be available for service. Verify with Owner.
        - Note that the use of DX cooling can significantly reduce airflow as well as infrastructure and distribution costs.
        - Smaller fans will be more efficient during the winter compared to oversized summer economizer based fans on low speed.
- Fuels
    - Locate fuel tanks so they do not get damaged by falling snow/ice. Note that snow can curl around the edge of a roof and fall on tanks located right up against a building.
    - Protect fuel lines between ASTs and the building, particularly those located 5 feet and beyond the building so that fuel lines are not accidentally damaged while being covered with snow.
    - Specify oil safety valves and anti-syphon valves for fuel lines to mitigate spills.
    - Design normally closed solenoid valves for day tank fill lines as secondary precaution against overfilling.
    - See ADEC website for recommended fuel tank design for long term spill prevention.
- Specialty Systems
    - For locations prone to brown-outs, install VFDs, high/low voltage protectors, or other protective items on all equipment that is susceptible to damage from power fluctuations.
- Corrosion Control
    - Ensure that pipe hangers and accessories clearly note to isolate/insulate copper pipes from steel Unistrut and hangers and in general against dissimilar materials.
    - For exterior buried piping or tanks, test soils for corrosive conditions.
    - Ground your water, heating, and sprinkler piping systems to reduce electrolysis.
- Energy Efficiency
    - Use demand ventilation control strategies.
    - Use variable frequency drives and ECM motors.

- Building Automation Systems
    - Keep the control systems simple.
    - Use sequences that the owner has standardized or used on other facilities.
    - Provide simple systems.
    - Monitor relative humidity and provide alarms for high levels.
    - Setup trending points for all room temperatures, motor operation, and major system analytics such as temperature and flow.
    - Provide lots of remote and local monitoring points as well as overrides.
        - Limit overrides through user access level.
        - Require override activities to note who, when, and why the override condition was made.
        - Make override conditions obvious in the graphics.
    - Provide simple user interfaces outside of the BAS graphics such as spring-wound timers for temporary occupancy and green/red colored LED status/condition panels. Clearly label their use.
- Inspections
    - Ensure access to all equipment.
- Commissioning
    - Ensure commissioning is covered in the specifications for all disciplines.
    - Re-verify commissioning at the 10 month point. This will identify warranty items prior to contract close-out as well as incorrect control changes completed by staff that were done before they were familiar with the system.

ELECTRICAL SYSTEMS

Daily/Weekly O&M Tasks

- Walk electrical rooms daily.
    - Maintain NEC clearances in front of electrical panels (6'-6" vertical, 30" wide and 36" in front for 120/208 volt panels and 42" in front of 480 volt panels)
- Walk the rooms weekly to identify burned out lamps.
- Power
    - Annually trip all interior and exterior GFCI receptacles and verify wiring integrity with GFI wall plug tester.
    - Annually cycle all circuit breakers.
    - Inspect exterior electrical outlets and equipment for corrosion from salt water or other corrosive environments.
    - Ensure that grounding at water main, gas line, and rest of building is secure.
    - Complete inverter and UPS unit battery system maintenance & repair at recommended intervals.
    - Verify heat trace is operational prior to the winter.
    - Annually inspect panels and electrical connections with infrared camera to to identify overloaded circuits and failing equipment.
- Generator
    - Complete Generator and Automatic Transfer Switch (ATS) testing on recommended schedules.
- Lighting
    - Turn off the lights.
    - When replacing lights, verify color/temperature match surrounding lamps.
    - Annually clean exterior light sensors.
- Security
    - Regularly check security system and camera system to ensure it is operational and recording.
- Communication/Data
    - Manage the WiFi system including after-hours use
- Fire Detection
    - Check emergency/egress lighting batteries annually.

Capital Improvement Upgrades

- Keep up with technology and efficiencies when replacing equipment.
- Power
    - Phase monitoring and protection from loss of phases.
    - Consider UPS systems for critical infrastructure.

    - For locations prone to brown-outs, install VFDs, high/low voltage protectors, or other protective items on all equipment that is susceptible to damage from power fluctuations.
    - Upgrade transformers to higher quality models.
    - Add power monitoring through BAS upgrades.
    - Add universal generator connections on exterior of the building so that portable/mobile generators can be used. Provides redundancy for standby generators.
    - Upgrade automatic transfer switches/switchgear.
    - Investigate replacing electric heat trace with hydronic heat trace.
    - Investigate upgrading power service and motors to more energy efficient 3-phase power if available.
- Lighting
    - Upgrade lighting to LEDs.
    - Upgrade site lighting to protect against vandalism.
    - Install motion sensors.
    - Upgrade internal lighting controls including natural light harvesting, multi-level switching, higher quality front end equipment, and wireless retrofit options.
    - Upgrade to a centralized emergency/egress light power system rather than distributed batteries.
- Security
    - Upgrade security.
    - Add motion sensors at secure locations.
    - Add exterior cameras to ward off vandalism.
- Upgrade access to electronic

Design Best Practices to Support O&M

- Planning Stage
    - Identify surplus power opportunities from within facility as well as within community.
    - Work with owner to identify the level of complexity that the User and Facility Staff can use and maintain.
    - Identify power quality from local utility and if standby power generation and power quality protection needs to be added to the facility.
- Design
    - Meet with Facility Staff and review the design at major milestones.
    - Specify commissioning for automated systems like lighting control.
    - Specify underground power and data lines be provided with tracing wire for field locates.
- Equipment
    - Simplify and minimize pieces of equipment.
    - Design around simple and durable systems.
    - Select equipment based on lifecycle and availability of manufacturers support.
    - Locate in easily accessible locations. Minimize locating access points above ceilings or in concealed locations.

  - Use stainless steel fasteners/hardware for external equipment.
  - Be mindful of corrosive environments both outside the building (salt water) and inside the building (chlorinated pools).
- Power
  - Confirm available service power and phase capabilities early in design.
  - Provide three-phase service if feasible.
    - Design motors ¾ HP and higher to have three-phase power.
  - Use high efficient transformers
  - Future proof the design
    - Provide plenty of spare capacity in panels.
    - Provide spare breaker locations in MDP and switchgear for future renovations/expansions.
    - Provide provisions for Combined Heat/Power (CHP) and renewable energy tie-ins to power system.
  - Consider Combined Heat/Power or battery storage systems to minimize demand charges.
  - Metering
    - Institute power monitoring and include sub-monitoring. At a minimum monitor 120, 277 and 480 volt feeds and keep histories to find irregularities.
    - Monitor power usage through BAS system. Allow remote monitoring.
  - Motors and Disconnects
    - Avoid 1,200 RPM motors. They are a very long-lead item. 1750 RPM motors are most readily available.
    - Use VFDs or soft starts on motors.
  - Variable Frequency Drives
    - Coordinate manual bypass requirements with mechanical. Reference additional requirements under that section.
    - Locate VFDs as close to motors as possible.
    - If VFD is remote, wire power to disconnect first, then to VFD, then to equipment.
      - If power first goes to VFD, add permanent placard at equipment disconnect that power needs to be first disconnected at VFD or circuit breaker prior to shutting down equipment.
  - Provide ample number of receptacles in mechanical spaces for maintenance usage.
  - For public spaces, consider using receptacles with integral USB power ports.
- Generator
  - Verify if generator is standby or emergency.
  - Locate generator in area that will not be a noise issue when regularly tested.
- Lighting
  - Use LEDs. Consider lighting controls/lighting levels in selection.
  - Select lights based on quality.
  - Coordinate light color/temperature with Owner and rest of facility.

  - Locate lights where they can be easily accessed. Avoid locations such as over stairs or multi-story openings where access is difficult
  - Avoid site light pollution.
  - Be careful of complex lighting control systems. These get turned into on/off switches.
  - Higher reflectance finishes to use natural light more efficiently
  - Use centralized emergency/egress light power system rather than distributed batteries.
- Security
  - Use motion sensing
  - Do not purchase server type security systems. Use a dedicated system.
- Communication/Data
- Fire Detection
  - Select contractors based on performance during construction and most importantly on support after construction. Complete research on firms from other School Districts.

STRUCTURAL SYSTEMS

Daily/Weekly O&M Tasks

- Identify new wall, floor, or window cracks.
    - Small cracks are generally not an issue
- Look for doors and windows that don't close properly.
- Don't let staff cut, modify, or drill holes in wood, steel and concrete structural members.
- Develop guidelines for concrete floor cracking
- Identify and fix building envelope (roof, exterior wall, windows) leaks. They lead to dry rot and cost a lot of money in the long run.
- Paint rusting steel.
- Use infrared camera to identify water penetration or condensation locations. These can rot/damage structural members over time.
- Foundations
    - Identify and remove vegetation that may be growing around foundations.
    - Keep up on yearly shoring of foundations/piling.
    - Annually verify thermosiphons and active freeze-back systems are charged and operational.
- Examine welds and bolted connections. Particularly where exposed to the weather.
- During routine maintenance activities, verify that seismic restraint systems are in place including equipment, ceiling systems, and lights.

Capital Improvement Upgrades

- Complete Tier 1 Seismic Evaluation of the facility.
    - If deficiencies are identified in the Tier 1 report, there may be grant money available from FEMA to complete a more in-depth evaluation.
- Fund/perform structural maintenance to correct known failures before they cause major issues.
    - Particularly on thermosiphon and active-freeze back systems.
- If buildings are settling, schedule annual shoring of the system.
- Install system to monitor building movement.
- Install thermostat strings to monitor ground temp.
- Evaluate and plan for climate-change related impacts to structural foundations.
- Evaluate storage areas for allowable weight capacity and post signs with maximum loading.

Design Best Practices to Support O&M

- Design for the specific location including seismic, wind, snow, flooding, soils and potential future changes in soil conditions.
- Provide an adjustable foundation where settling may occur (climate change)
- Design:
    - Design for future expansions/renovations.
        - Avoid using load bearing walls as it makes renovations difficult and more costly.

Please send additional comments to Craig Fredeen at Cold Climate Engineering, LLC: cfredeen@coldeng.com

  - Specify exterior fasteners to be galvanized or stainless steel.
  - Design to avoid thermal bridging between exterior structure and interior structure
  - Coordinate supports for piping and heavy equipment. Coordinate anchor load points for piping system expansion.
  - Ensure mechanical engineer has seismic restraint covered in their specifications including the requirement for deferred submittals on seismic bracing and calculations.
  - Specify signage to be posted in storage areas noting maximum PSF loading.
  - Coordinate columns, shear walls, and brace framing to ensure equipment removal access is maintained.
- Foundations:
  - Have Geotech survey completed to verify permafrost, ice lenses, and other soil abnormalities.
  - Sensors to monitor foundations
  - Rural Alaska Small School Foundation will a shallow concrete foundation work: yes or no
  - Design adjustable pile foundation in permafrost areas.
  - Avoid concrete slab on grades in areas of permafrost
  - Triodetic foundations are fantastic for shirting ground and flood zones for smaller buildings, (< 10,000 SF).
- Avoid timber and beam construction. Use structural Steel for long term durability
  - However timber framing provides a warmer and softer feel for the building occupants
- Framing
  - Light frame construction is less expensive and may be a better option for smaller facilities, however it does have a higher long-term maintenance cost compared to heavier construction.
  - Larger facilities should be constructed with more durable materials such as steel or concrete.
- Coordinate structural design for anticipated snow drifting areas. Strengthen structure as opposed to building roof wedges
- Exterior Construction
  - Galvanize exterior steel
  - Avoid exposed exterior beams, particularly structural steel members, that penetrate the thermal envelope
- Cover/Conceal wooden structures that would otherwise be exposed to the weather.
- Exposed structural steel is easier to inspect.