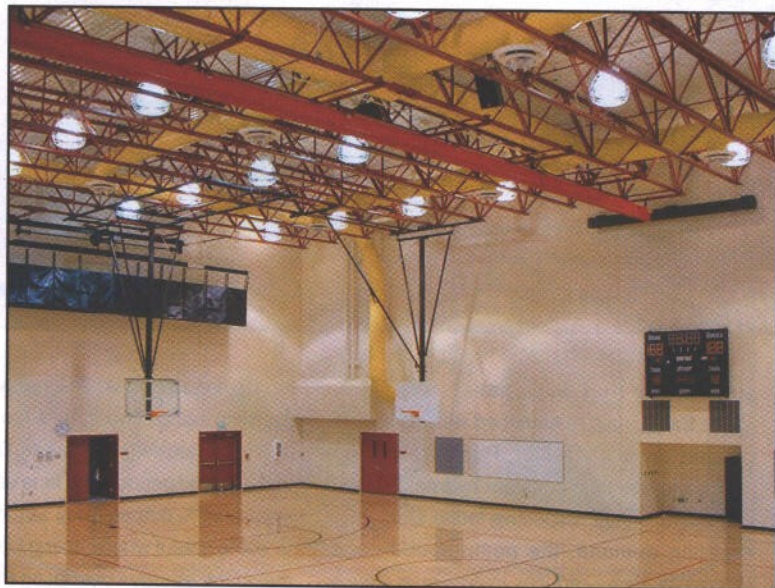


Houston ... No Problem



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New Alaskan high school effectively **incorporates energy-efficient technology** in a remote area known to wreak havoc on mechanical and electrical systems

Houston, we have a problem! Those, of course, are the immortal words uttered from the cold void of space by Jim Lovell, commander of the seemingly doomed, yet miraculous Apollo 13 lunar mission of 1970. Some 30-plus years later, in another very cold place, similar words were uttered when school officials in the city of Houston—Alaska—decided to build a new, energy-efficient high school.

Boxed in on three sides by rugged mountains, including Mt. McKinley, the town lies within the Matanuska-Susitna Valley, an area representing some 23,000-sq.-mi. The problem for any building in this region is dealing with temperatures that can dip below -30°F in the winter and rise to more than 80°F in the summer. These extremes, combined with relentless glacial winds, play havoc with mechanical and electrical systems.

It's hard to imagine meeting such a design task, but with the smart application of current technology, including occupancy sensors, timing/sequencing devices, outside air-intake sensors and variable-speed fan and pump drive motor controllers, the designers were able to deliver the goods.

Heating in the Arctic

So how was it done? For starters, the school receives its heat from a central hydronic heating plant, which includes two gas-fired, cast-iron boilers, each with a dedicated in-line circulator pump and separate exhaust stack. The boilers connect in a primary-secondary loop to the building's secondary heating loops. A necessity for Alaska's climate, boiler redundancy allows normal building heating under most conditions with one boiler off-line for preventive maintenance or repair. Two secondary heating loops provide hydronic heating throughout the building. The first loop serves the building's perimeter heating elements and can typically maintain unoccupied night setback temperatures with the ventilation systems off. The second heating loop serves the forced ventilation system heating coils and is interlocked to operate only when the ventilation systems are operating. The heating system uses a 50% propylene-glycol solution to prevent freezing of idle heating loops.

For further system redundancy, each secondary loop includes two vertical in-line circulator pumps, each sized for 100% loop design

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Good HVAC and lighting schemes, including the use of multi-use HID metal-halide ballasts, helped the Houston High/Jr. High School achieve energy efficiency in a climate with extreme winter conditions. *Photo: Courtesy of AMC Engineer*

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flow. Each pump is equipped with a variable-speed drive controller. Pumps modulate speed to maintain constant hydronic system pressure in their respective loops. During low heating demand, the pump speed—and, therefore, flow—reduces to conserve energy. Pumps are automatically rotated on a monthly basis to normalize wear.

Single-duct, variable-air-volume terminal units control the majority of heating zones. Each VAV terminal includes a duct-mounted hydronic reheat coil to temper supply-air temperature in order to meet space heating set-point requirements. Reheat coils are oversized to account for arctic heating. Rooms with exterior walls and windows also receive perimeter fin-tube auxiliary heat.

Unit heaters provide heat to the school's vestibules, mechanical and electrical spaces as well as miscellaneous storage areas.

In the realm of ventilation, five separate and independent central air-handling units ventilate the building. Two AHUs share a common penthouse fan room and support classrooms, the media center and art and music rooms. The remaining three AHUs support the administration area, the centrum, cafeteria and gymnasium.

Three AHUs include VSD fan motor controllers. Similar to their pump counterparts, these fans modulate AHU speed to maintain a constant-supply duct system static pressure. To save energy, the fan automatically reduces speed during low heating and cool-

ing demand periods. The remaining two fan systems utilize two-speed fan motors and serve the large-volume areas. During normal low-demand periods, the fans each run at low speed, 66% output. They automatically shift to 100% output when cooling loads cannot be met in the energy-conserving mode.

All the ventilation systems use the "gravity return air" method. Fan rooms are used as return air plenums and are controlled to a slightly negative pressure by high-volume wall-mounted relief fans that exhaust air. Return air is drawn back to the fan rooms

through return grilles, ceiling plenums and silencers by this slight pressure differential. Relief air is modulated with respect to outside air intake, taking into account exhaust air volumes, to maintain a slightly positive building pressure that helps control building infiltration and reduces cold winter drafts. Gravity return air systems eliminate the need for return fans, reducing first cost, avoiding system complexity and saving energy.

In art classrooms, which includes equipment for ceramics, the ventilation system provides eight to 12 air changes per hour of continuous exhaust ventilation. Wall-mounted exhaust intake grilles, located at the clay work counter, reduce airborne silica particulates at the source.

The wood shop features an industrial-grade centralized sawdust collection system and several ceiling-mounted recirculating filter systems to provide students with a safe breathing environment. The sawdust collection system is designed with additional filtration to allow full recirculation of exhaust air back to the shop to minimize zone heat loss. A separate general exhaust fan keeps air pressure slightly negative with respect to the adjacent areas of the building. A dedicated exhaust fan also serves the school's commercial paint booth.

Roof-mounted exhaust fans provide exhaust for the commercial kitchen hoods. An interlocked indirect gas-fired make-up air unit provides hood make-up air. To prevent heat loss through the hoods, motorized fire dampers, located in the hood duct collars, shut whenever the hood fans are off. All roof-mounted equipment incorporates low-temperature belts and lubricants specifically designed for arctic use.

The school's science laboratories, on the other hand, must be fully exhausted. In Alaska this can result in a lot of wasted energy. To minimize such losses, the labs are fully controlled using advanced direct-digital control (DDC) equipment. Both supply and exhaust air flow rates are continuously monitored and controlled to maintain a slightly negative pressure. Specialized induction-type, laboratory-grade roof exhausters pro-

A DDC BAS provides remote monitoring and control of the building's M/E/P systems.

vide an effective stack height of approximately 40 ft., preventing exhaust air from re-entering the building. Fume hoods incorporate automated sash monitors and alarms, which indicate when sash velocities fall outside safe operating ranges.

Lighting

Besides HVAC systems, lighting provided another opportunity for energy savings. T8 lamps with electronic ballasts are standard, but additional conservation is gained by automatic control of lighting in corridors, restrooms, offices and storage spaces via occupancy sensors. A switchable breaker interfaces with the

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building automation system to control night-lights, corridor fixtures and site lighting. Lighting automatically energizes upon an alarm from either the security or fire-alarm system.

Occupancy sensors are carried over to the gym, as well, but with multi-level HID ballasts, which automatically switch to half power during unoccupied periods. This provides significant energy savings. The lighting controls also

izes the wet-type fire sprinkler system protecting the entire building. The fire alarm system takes advantage of the latest technology, including broadcast polling and addressable/intelligent detectors. The security system includes glass-break detectors on ground-level windows and motion sensors in the corridors. Security keypads are conveniently located at key entrances around the building to facilitate the school's operations.

capacity for the regularly operating loads plus the fire pump.

Finally, the telecommunications system was designed to comply with EIA/TIA Category 5e standards, and to meet the current and anticipated future expansion needs of the facility. Multiple telecommunications rooms accommodate the size and layout of the building and the facility's future plans for expansion. These rooms interconnect using 62.5/125-micron multi-mode optical fiber cable so that none of the Category 5e data cable runs exceeds the distance limitations as set forth in the EIA/TIA standards.

The M/E system stresses simplicity, flexibility and efficiency for ease of operation.

provide a three-position manual override.

The cafetorium is designed with attractive, pendant-mounted HID metal-halide fixtures, recessed HID metal-halide fixtures and fluorescent can fixtures, creating a stylish, comfortable and functional meeting space. If desired, the school could easily add theatrical lighting because the lighting system, which has multi-scene controllers, is located strategically throughout the space.

Plumbing and fire protection

As noted earlier, the school's HVAC system is hydronically based, thus, plumbing systems play a key role in building operation. A local well is the main water source for domestic water, as well as water for fire protection. Pumped from an underground 25,000-gallon holding tank, the water travels through underground insulated-arctic pipes to the building. The fire main pipe connects at the base of the tank, while the domestic water line connects near the middle of the tank. This prevents the water in the tank from falling below the emergency supply level of water required in the event of a fire. The holding tank is located on a hill, which provides the necessary net positive suction to both the domestic-water pressure pumps and fire pump.

Two gas-fired water heaters combined with a hot-water recirculation system ensure dependable hot water. The science classrooms have a separate and backflow-protected tempered water system supporting laboratory and preparation area emergency eyewash and shower stations.

A natural gas-fueled emergency generator supports the electric fire pump, which pressur-

Electrical distribution

Redundancy and flexibility are also notable features of the building's electrical systems. The electrical design was envisioned with expansion in mind and allows for upgrades without the need to remove walls, floors or ceilings. With the community in mind, a power-monitoring system was designed that will be able to network to a future district-wide system through the main distribution and motor control centers. These devices will serve the community, as they will allow school staff the ability to monitor the electrical load profile, gather historical load data and rapidly respond to electrical problems.

For maintaining power quality and reliability, branch circuit panel boards that feed computers and other sensitive electronic equipment include integral TVSS devices, which protect the equipment from voltage surges. Also, the electrical design includes an emergency generator sized to meet both the emergency and standby loads. An electric fire pump, that has load-shed capability, provides additional safety backup. If the building is operating on generator power and the fire pump is required to run, the fire pump controller closes a pre-signal set of contacts that shunt trips (off-loads) the standby power loads prior to the start of fire pump. This design methodology provides a value-added cost savings because it allows the generator to be sized to meet the regularly operating loads with accommodation for the fire pumping, as opposed to sizing the generator with

Ready for the next generation

In general, the M/E designs stress simplicity, flexibility, efficiency and ease of repair and maintenance. Built-in redundancies in the HVAC systems allow uninterrupted heating and ventilating system operation in the event of equipment failures. This simple backup practice is very important for the safety of students and faculty during the dark, harsh Alaskan winters. Disruptions to modify the facility's electrical systems are minimal because the design infrastructure interfaces wiring and telecommunications and data systems.



Due to the flexibility of the M/E systems, the new \$14.3 million facility, which currently serves 563 students, can easily expand in the future to accommodate up to 1,200 students. The engineers worked closely with the other members of the design team and end users to develop detailed mechanical and electrical plans and specifications that were economical, yet that did not compromise design quality, maintainability or programming. In addition, the production of clear and concise contract documents resulted in a very low percentage of change orders. **icse**