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Indoor Environmental Air Quality - Implications with Heating and Cooling Systems Found within Finger Plan School Designs in Connecticut, A Brief History, Causations, and Corrective Actions.

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The purpose of this CONN-OSHA Quarterly contribution is to bring a higher level of awareness to public school superintendents and administrators, facilities managers, Boards of Education (BOE), local public health officials, and school health program managers about the serious and pervasive indoor air quality (IAQ) problems being discovered within many elementary and middle school buildings of the finger plan school (FPS) design in Connecticut. CONN-OSHA routinely investigates IAQ complaints within schools and public buildings.

The Connecticut Department of Public Health has stated that poor indoor air quality in schools is a major public health issue both nationally and in Connecticut [1]. Connecticut Public Health Code, Section 19-13-B1(i) states that "Buildings or any part thereof which are in a dilapidated or filthy condition which may endanger the life or health of persons living in the vicinity" are "specifically declared to constitute public nuisances."

This photo gallery, http://www.ctdol.state.ct.us/osha/Dust/DustinSchools/dustinschools.htm, displays the conditions described herein. The intended audience is encouraged to evaluate their school building inventories under their control to determine if personnel are being exposed to poor indoor environmental air quality due to these conditions.

A brief history of school building design is in order. Prior to the 1940s school buildings were multi-storied stone and brick structures having Georgian, gothic, and classical design features using oil fired boilers to supply steam heat. During the 1950s and 60s modern architectural trends were implemented in school design while new schools were being built to support the exponential growth of post WW II student populations, also know as the Baby Boom. [2]

It was during this building boom that the concept of the FPS gained popularity. These types of buildings were modern one story, flat roofed, concrete slab structures enclosed in glass or metal window wall systems with brick or block walls. These designs began to introduce for the first time air conditioning systems with standard building facades comprised of continuous full height ribbon windows that provided natural light along the outer walls; some having doorway access directly to the outside. This configuration provided better acoustic performance and allowed each classroom to have access to maximum amounts of natural light and fresh air at a time where energy conservation was a low priority [2].

Modern architects were mostly confident in the logic and efficiency of school construction during this era. The modern school building, as it developed in the United States, was determined to have a number of practical and functional advantages over the traditional two or three story stone or brick school house. Their light weight construction utilized new building technologies and was less expensive to build. Although their life expectancy was considered to be short, it was the attitude of the time that new schools needed to be built periodically anyway[2]. Considering our economic history over the last thirty years, school rebuilding programs are not so high a priority and BOEs and school districts are holding on to their vintage building inventories beyond intended life expectancies. Thus many of these buildings are in various states of deterioration and demonstrating chronic indoor environmental quality problems, which are generating complaints of chronic and sometime serious respiratory illnesses by staff and students.

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Within finger plan school design, hot water based coils were installed along lengths of the exterior classroom walls to radiate heat over the length of the window wall glazing surface and across the room. The heated coil radiators are usually housed within metal panels and more often, to provide more efficient use of space for classroom materials, they were housed within louvered book case cabinets and shelving units along these exterior walls. Usually, classrooms are fitted with air extraction ducts to remove stale air while pulling in a fresh air return via loosely fitting window framing. As modern designs improved and more energy efficiency was desired, individual classroom fan drive unit ventilator systems were incorporated into designs or retrofitted into existing buildings. When maintained correctly unit ventilators provide individualized classrooms with access to thermal comfort and humidity control while re-circulating room air with a source of outside air.

This created buildings with multiple individual heating and cooling systems to be maintained with an assumption that the required maintenance manpower would follow the life of the building. The more technically advanced Heating Ventilation and Air Conditioning (HVAC) systems were not yet being implemented.

Keeping up with the general maintenance and cleanliness of schools has become difficult enough. There appears now to be noticeable and historic reductions in custodial performance standards within public school buildings where occupancy, visitation and multiple uses are both heavy and have increased. This is likely the consequence of "Economic Downsizing - doing more with less" business management mantra of the past two U.S. economic recessions.

Within these vintage school buildings it has been discovered invariably that the interiors and coils of unit ventilators and heating registers throughout a school reveal many years of gross accumulations of dirt, dust, debris, insect carcasses, mouse droppings, and cobwebs rendering them contaminated and energy inefficient. It has been found that post construction retrofitted bookcase cabinetry was installed in a permanent manner with no intention to make them accessible to interior cleaning and maintenance. Air flow louvers are routinely found to be covered and obstructed by clutter, stored and horded classroom materials and fasteners such as screws and bolts are painted over and the seams and panel sections are glued shut by paint. The result is that these interior components become inaccessible and "out-of site-out-of-mind." This is perhaps why these pervasive conditions are not being revealed to personnel. Inspecting schools for these conditions require tools, a flashlight, the use of a mirror, a camera, and some knowledge of a building's design and mechanical systems.

During inspections interviewed personnel did not know how or when to dismantle component cabinetry. In most cases these components are not included in any routine cleaning regimen or job task lists. We discover conditions where no person can recall, if ever, that these heating system components had been cleaned. One interviewed custodian stated that she had been working in a school for twenty three years and that other than quarterly filter changes the interior surfaces of unit ventilators and registers had never been opened, inspected, or cleaned.

Compounding these problems are seasonal temperature and humidity fluctuations. The coolness of masonry wall construction and concrete slab floor to wall junctures serve as natural cold temperature conductors creating moisture via humidity condensation within this type of cabinetry. Moist and humid conditions are prime environments to support mold growth where wetted dusts may serve as a growth medium and create seasonal fluctuations in a micro-ecology supporting dust mite populations, predatory spider mites, and larger spiders. Spider webs, spider egg casings, mite carcasses and mite fecal waste accumulate within such inaccessible areas and are notorious sources for allergens to become constituents of airborne dust. The result is that the entire compliment of unit ventilators, fan housings, and heating registers throughout a school building require decontamination procedures.

CONN-OSHA recognizes that it cannot abate these conditions within schools throughout Connecticut piece by piece, and only after complaints are investigated. In an effort to reduce future IAQ complaints and illnesses, school superintendents are encouraged to direct facilities managers to survey their schools for similar construction design anomalies and to train and equip their custodial and maintenance personnel to begin to address this problem.

When these conditions are found CONN-OSHA proposes a violation of section 1910.141(a)(3) of the CONN-OSHA "Housekeeping" standard, which states that "All places of employment shall be kept clean to the extent that the nature of the work allows." To abate these conditions when found, CONN-OSHA has been directing that these heating and cooling system components be decontaminated. Over the past eight years CONN-OSHA has required the abatement at finger plan schools and other post-modern designs for dust contamination. Over this past 2018 summer recess period CONN-OSHA has abated three finger plan school buildings.

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Hazard Corner... Not a job to die for! By: David Boutin

Many people find that construction work is exciting. It uses big equipment and cool tools. It "makes stuff" like buildings, bridges and roads and "destroys stuff" like buildings, bridges and roads. It is dynamic; each day you might work at a different job site, use different tools and work with different people. Unfortunately, construction work exposes employees to serious hazards, such as falling from rooftops, unguarded machinery, being struck by heavy construction equipment, electrocutions, silica dust, and asbestos. For employees who work in trenches and excavations, it is frequently becoming a job that people will die for.

After many years of decline, the number of trenching and excavation related fatalities are moving in the wrong direction, up! In 2014, 23 people died while working in trenches. In 2015 the number jumped up to 42. It jumped again in 2016 to 70. That is a 313% increase in fatalities since 2014. When a trench wall collapses, it can happen in the blink of an eye, sometimes faster than a person can react to. Employees can be buried under tons of dirt, unable to breath. Buried employees will usually suffocate before rescuers can stabilize the trench enough to even enter. Even when people aren't completely buried, the pressure on your chest can prevent you from breathing. Many times emergency response efforts end up being body recoveries, not rescues. What is the corrective action? It is identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees and controlling these hazards and conditions.

A trenching and excavation National Emphasis Program has been in place since 1985. The compliance directive (CPL) 02-00-069 provides instructions for when and how the Compliance Safety and Health Officer (CSHO) performs the inspection. For trenching and excavation work that has not been inspected within the previous 30 days, the CPL **requires the CSHO perform an inspection** unless it is apparent that the trench or excavation is less than 5 feet in depth or is in compliance with all OSHA standards governing such operations.

As an employer, you are required to take all necessary precautions to make trenches and excavations compliant *AND* safe, including training your employees on the hazards they are exposed to. Not all methods will work for all situations. If the method you normally use doesn't work for present circumstances, you must use another method. Requirements to protect personnel are published in the OSHA Construction regulations, 29 CFR 1926, Subpart P - Excavations.

How to protect against trench and excavation hazards:
Read and understand the requirements of 29 CFR 1926 Subpart P-Excavations.

- Perform a Hazard Risk Assessment. Including the surrounding hazards:
  - ◊ Overhead and underground utilities
  - ◊ Buildings, telephone poles,
  - ◊ Traffic,
  - ◊ Etc.
- Contact Call Before You Dig, https://www.cbyd.com/#
- at least 2 days before you need to start digging. DIAL 811 or 1-800-922-4455
- Hand dig over gas lines, electrical and other underground utilities as necessary.
- Perform at least one visual test and one manual test of the soil to establish the soil class. Perform additional testing if necessary.
- Select an appropriate method for employee cave-in protection. Use one of the approved methods:
  - ◊ Sloping and benching
  - ◊ Shoring
  - ◊ Shielding (trench box)
  - ◊ System designed by a Registered Professional Engineer (RPE)
- Establish an appropriate protective system.

Assure trenches and excavations and protective systems are inspected for hazards by a competent person before entry by personnel. Reassess conditions as work progresses and whenever a change in working conditions or site occurs.

When trenches and excavations are 4 feet deep or more, employers must assure that a ladder or other safe means to exit trenches and excavations is always located within 25 feet of where the employees are working. Ramps must have a reasonably firm surface and be a walkable slope that does not require using hands to climb out. Access to ladders, ramps and stairs must not be blocked by holes, precast concrete structures, pipes or other features. Egress ladders may not be removed from the trench while employees are in it; even if the ladders are in the way. Ladders should extend at least 3 feet above the top of the excavation.

Trenching and excavation activities require a competent person. A "Competent Person" is someone who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, **AND** who has authorization to take prompt corrective measures to eliminate them. When conditions change, the competent person must re-inspect the trench and correct any hazards before employees reenter.

Most employees have kids, parents, brothers, sisters and spouses that would like to see them come home at the end of the work shift. To protect their workers, employers must follow all applicable requirements of 29 CFR 1926 – Subpart P. For employers that don't do this voluntarily, expect OSHA to educate you on CPL 02-00-069.

Fatality & Casualty Reporting

State & Town: CONN-OSHA (860) 263-6946 (local) or 1-866-241-4060 (toll-free)
Private Employers: Report to Federal OSHA at 1-800-321-OSHA(6742)

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Effective procedures to achieve decontamination have been to disassemble the panels and cabinetry to expose the interior surfaces, removal of bulk debris with vacuum and brush application, then using a wet method with mild water pressure velocity, to wash the heater coils and interior surfaces with a mild cleaning solution. When components can be moved to an outside work area power pressure washers with mild detergents are used. A wet/dry vacuum application can be employed to retrieve waste wash debris along the length of the treated surfaces. An approved coil cleaning biocide agent can be dispensed to provide a disinfected finish. Such an initiative is time consuming and can disrupt school operations. This requires planning, assembling manpower and equipment, which is better scheduled during summer and holiday recess periods.

Electrical safety standards require that lockout/tagout procedures be followed for energized equipment prior to this process. Reference Section 1910.147 "Lockout/tagout of Hazardous Energy" and Section 1910.333(b) "Electrical Safety-Related Work Practices" of the State of Connecticut, Department of Labor, Division of Occupational Safety and Health (CONN-OSHA) General Industry Standards.

All housing components should be reassembled so as to make the interiors regularly accessible to future cleaning and maintenance. All interior surfaces to the units should be cleaned at least annually during the summer recess or prior to the heating season. Filter changes should be more frequent than once per year. Depending on filter efficiency, load burdens, and air flow velocity, filter changes are usually recommended once a quarter or at least three times per year.

These procedures have proven to be effective. Complaints of illnesses consistent with poor IAQ subside after these decontamination methods. Respirable indoor dust is a common irritant in the indoor environment. They can cause chronic upper respiratory and eye irritation, acute and chronic asthmatic and allergic reactions, weakened immune systems, and can exacerbate those conditions. Employing routine dust management methods with effective periodic maintenance enhances indoor environmental quality creating a more healthful environment for affected employees and students.

CONN-OSHA offers on-site consultation services for IAQ problems and other safety and health issues. Requests for consultation can be made in writing or by phoning (860) 263-6900.

Additional resources and information on managing IAQ in the workplace is found in:

- "Indoor Air Quality in Commercial and Institutional Buildings." OSHA 3430-04 2011. Go to www.osha.gov and select OSHA's Publications link.
- U.S. EPA publication "An Office Building Occupants Guide to Indoor Air Quality," EPA-402-k-97-003
- CONN-OSHA Quarterly May 2012 pub. #68 Hazard Corner-"Dust and Indoor Air Quality in Office Environments

References:

1. www.csiert.org – See CT IAQ Laws, 2015 CT DPH Commissioner's Letter to Superintendents of Schools.
2. Baker, L. "A History of School Design and its Indoor Environmental Standards, 1900 to Today," National Institute of Building Sciences, National Clearing House for Educational Facilities, January 2012.

CONN-OSHA~ Training Update...

The Control of Hazardous Energy (Lockout/tagout) September 13, 2018, from 10:00 a.m. to noon This two-hour course will help to satisfy the requirements for training as detailed in the OSHA regulation for those who are working in areas where Lockout programs are in place, or whose job requires them to actually perform the Lockout and isolation of the energy sources.

OSHA Recordkeeping September 27, 2018 from 9:00 a.m. to noon This interactive session will discuss the rules and ensure confidence that you have properly recorded and reported occupational injuries and illnesses, including how to fill out the OSHA 300 Log of Work-Related Injuries and Illnesses accurately and correctly. The new electronic reporting requirements will also be discussed.

Walking Working Surfaces in General Industry **October 26, 2018 from 10:00 a.m. to noon**

Falls are among the most common causes of serious work-related injuries and deaths. During this training we will examine best practices for elimination or controlling hazards associated with walking and working surfaces in the workplace.

Breakfast Roundtable This discussion group meets the third Tuesday of every month from 8:15 am to 9:45 am. Pre-registration is required. Visit our web page for more information: http://www.ctdol.state.ct.us/osha/Breakfast/index.htm To be placed on the e-mail distribution list, contact John Able at John.able@ct.gov

Classes are free and are held at 200 Folly Brook Boulevard, Wethersfield, CT in Conference Room A/B (unless otherwise noted). To register, contact Catherine Zinsser at catherine.zinsser@ct.gov Pre-registration is required. A Photo I.D. is also required to allow entry into a public building. For