HVAC Building Pressurization Systems

Lessons Learned

ASHRAE
Distinguished Lecturer

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- More information on the DL program available at:
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ASHRAE Members who are active at their chapter and society become leaders and bring information and technology back to their job.

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Ventilation 2022: 13th International Industrial Ventilation Conference for Contaminant Control

June 22-24, 2022 Toronto, Canada

REGISTER NOW

TECHNICAL PROGRAM

The Ventilation 2022 Conference will take place June 22-24, 2022 at the Sheraton City Centre in downtown Toronto. Inaugurated in 1985, the "Industrial Ventilation Conference" takes place every three years allowing time to develop new research and technology applications and to document the findings. The conference has rotated locations and organizers between Europe, North America and Southeast Asia. The 2022 conference will be hosted by ASHRAE.

The conference theme is "leading edge industrial ventilation technologies for a low-carbon environment." The program includes conference papers presentations.

The goal of the conference is for international engineers, practitioners, researchers, scientists, and regulatory personnel working in the specialized industrial ventilation field to share recent advancements from a global perspective in the field of ventilation and contaminant control.

Ventilation 2022 will be co-located with the 2022 ASHRAE Annual Conference, also at the Sheraton.

Things to Consider

HOW Should Projects Be Built?:

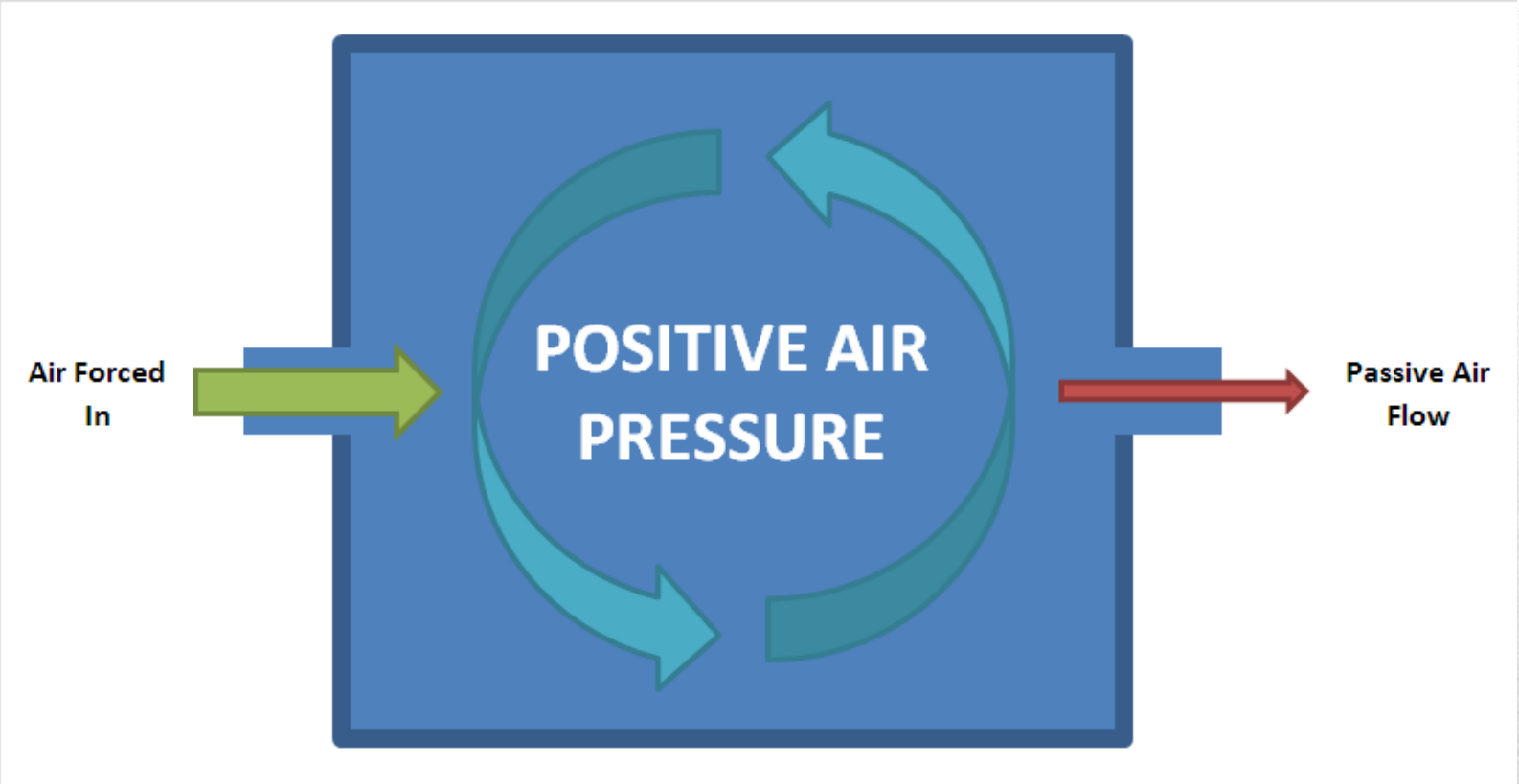
- **Where is it Engineered?**
- **Fit for Purpose** ?
  - Who's purpose?
- **Built to Meet Code** ?
  - Building Code is **absolute minimum requirement**.
- **To meet Industry Standard** ?
  - A Hodge Podge of Packages vs Modules vs Stick Built
- **To Meet Industry Best Practices** ?
  - Usually the Best Option?

- Human life & property safety must be thoroughly considered in all types of industrial project design, construction, installation, start-up, testing, operation, and maintenance.
- We should include but not be limited to fire & hazardous gas prevention, detection and alarm systems, active fire protection systems, room-to-room pressurization, smoke control, homeland security and emergency response plans

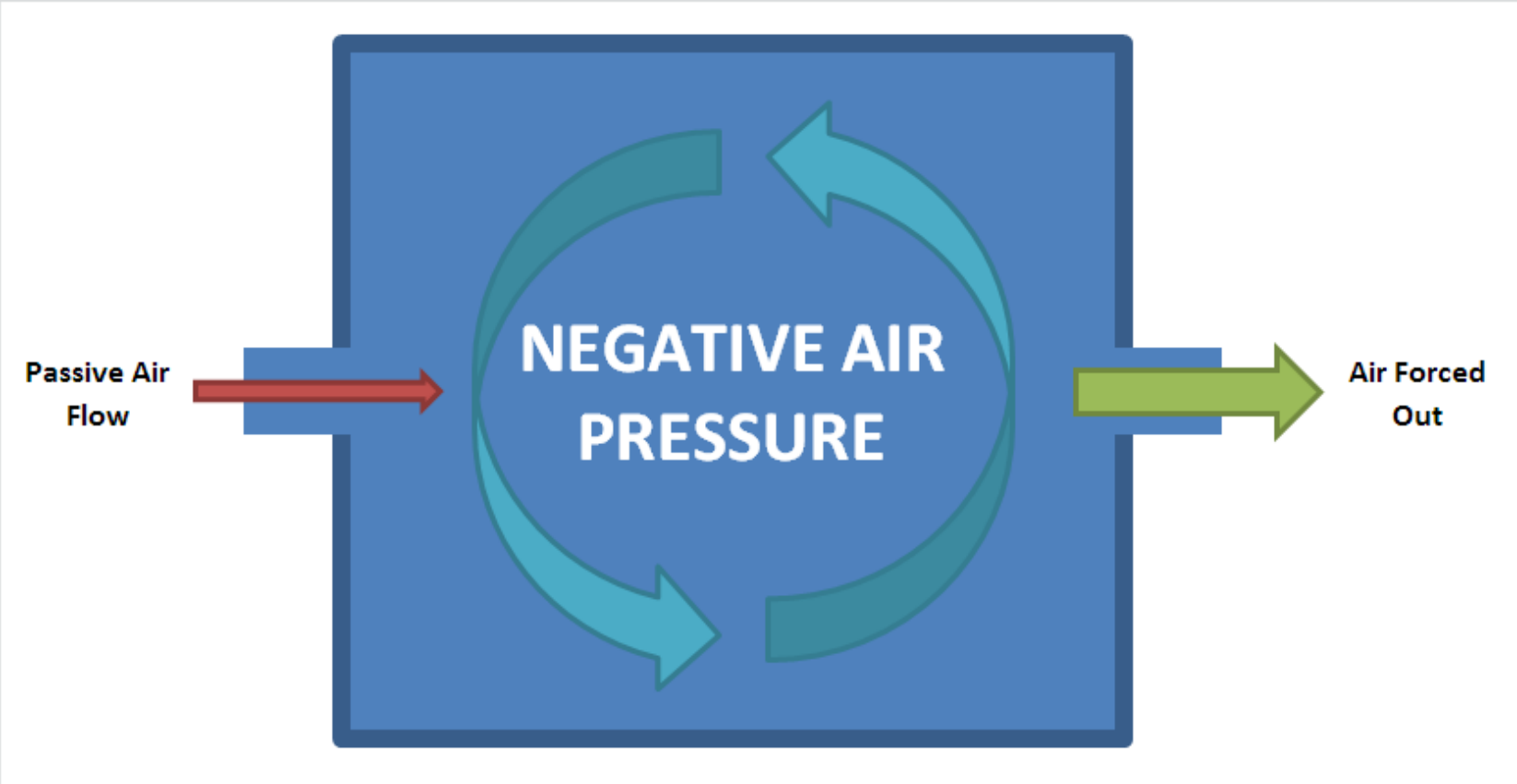
Industrial HVAC is a Health & Safety Systems First.

Pressurization Design

- **Pressurization is a critical for maintaining room cleanliness** in plant Process Control, Computer, MCC, VFD & Electrical Buildings, etc.
- **Design margins should be incorp**orated in the pressurization system to allow **for building envelope seal degradation**.
- When pressurization is required for safety or code compliance, **make provisions for periodic surveillance & testing**.
- **Critical facilities require a leak test of exterior & interior walls**, partitions, doors, and windows between two adjacent areas with different pressurization levels & any building elements between two areas with different pressurization levels.



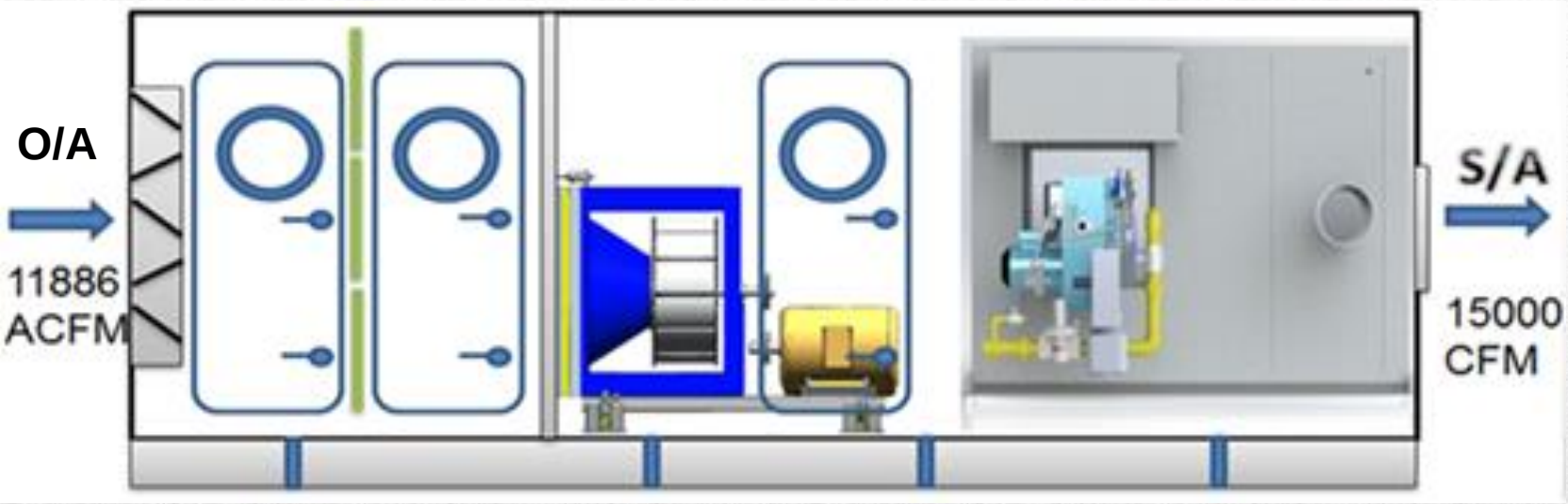
Positive Pressurization



Negative Pressurization

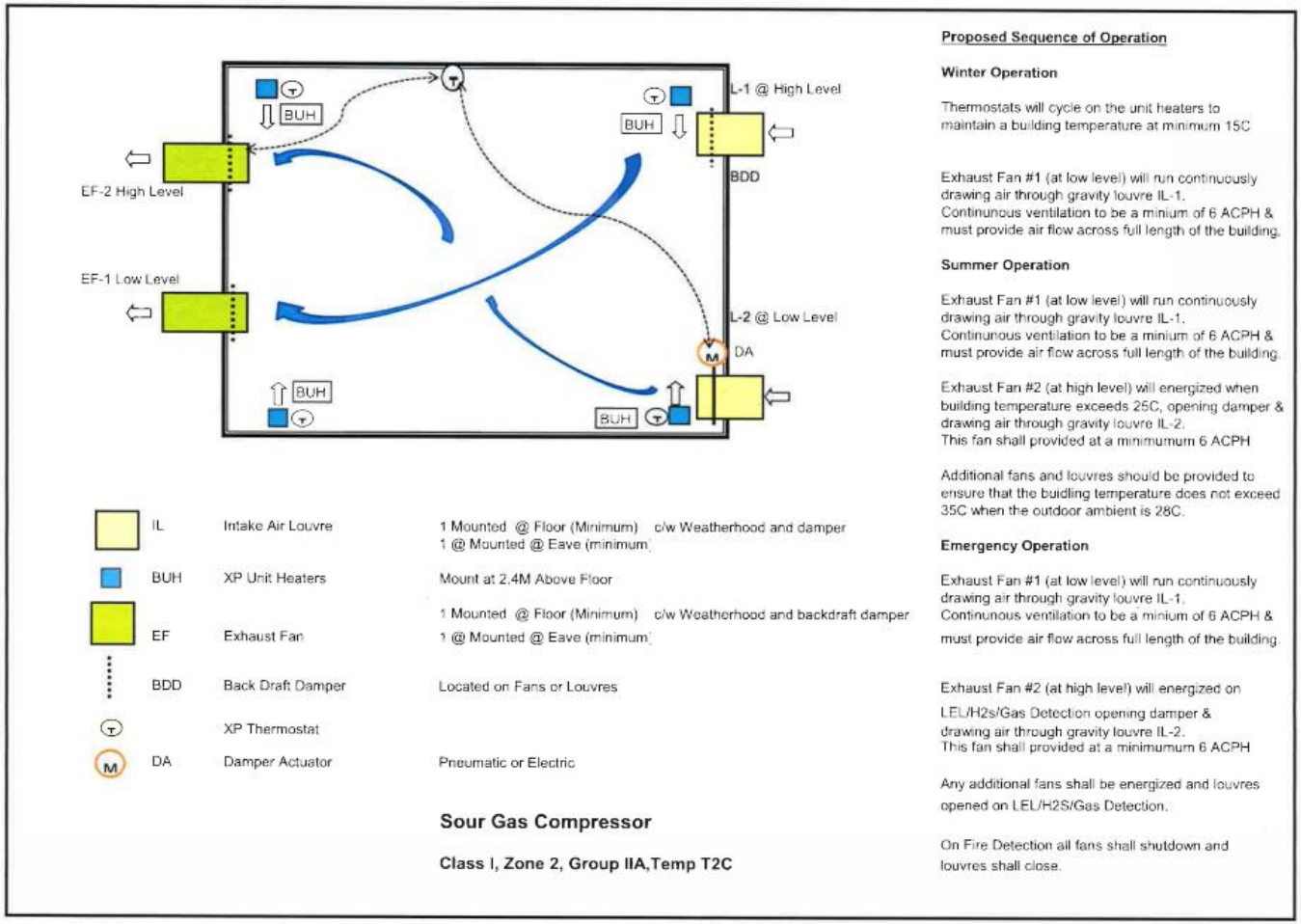
Pressurization Design

- **Without pressurization, surrounding contamination** (e.g., dust, snow, rain, particulates, gases, hot or cold air, etc.) **can enter the room by infiltration** through doors, windows, cracks, pass-throughs and penetrations for pipes, conduit or ducts, etc.
- **The cleanest room should have the highest room pressure**, with decreasing pressure corresponding to decreasing cleanliness. A differential pressure around 0.05 or 0.10 in. of water (12.5 or 25 Pa) is often used.
- **All major leaks must be eliminated** before HVAC systems start-up.



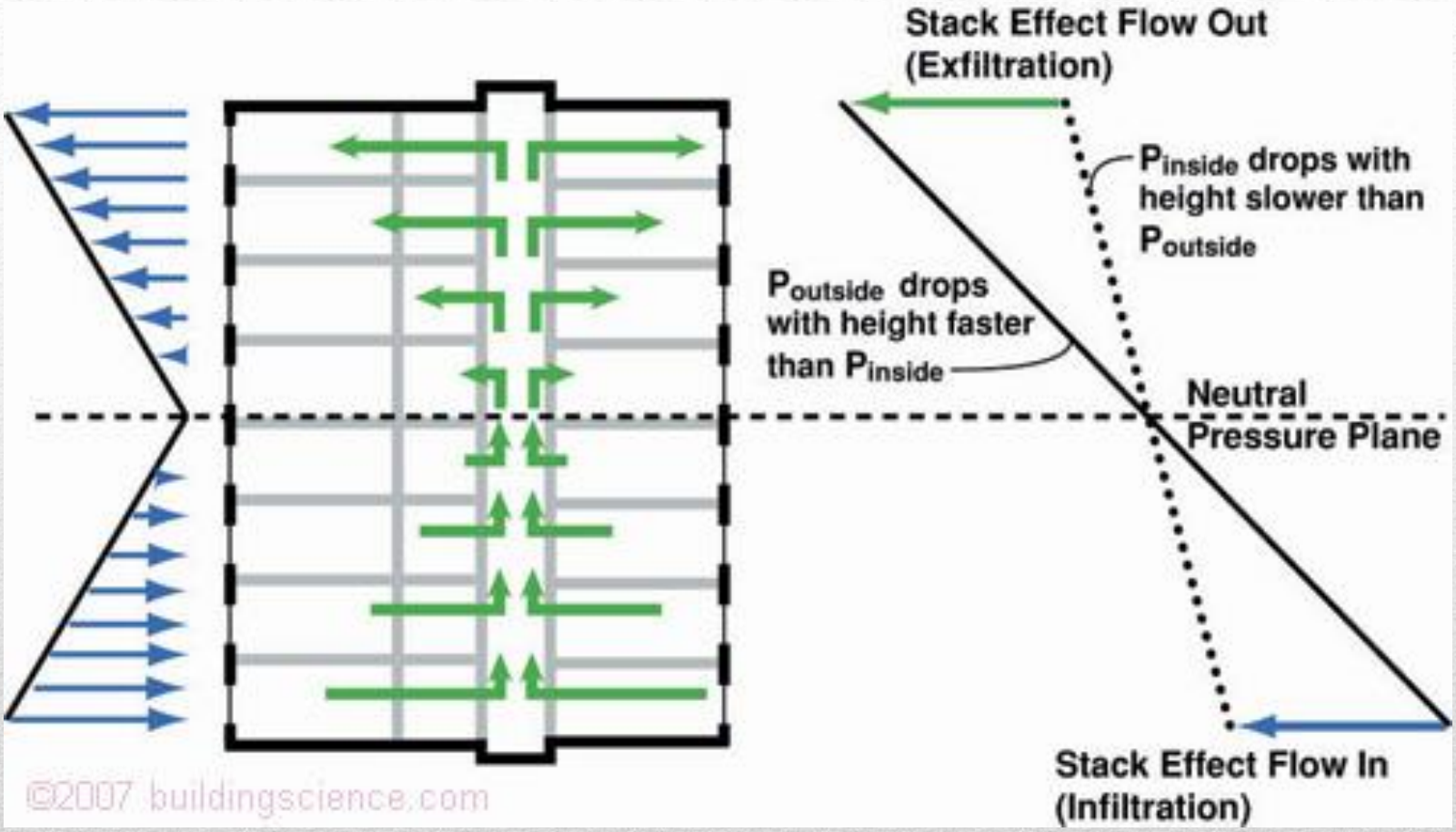
Airflow increases 25% when outdoor air temperature is raised from -40C to 30C

Combustion or Outdoor Air Volume Increases at -40C



Air Change Rate Vs Air Flow

Organized Confusion



Natural Ventilation

Ridge Vents

Louvers

Natural Ventilation

Open Door Ventilation

Keep Door Closed

Poor HVAC Design Results Pressurization Issues

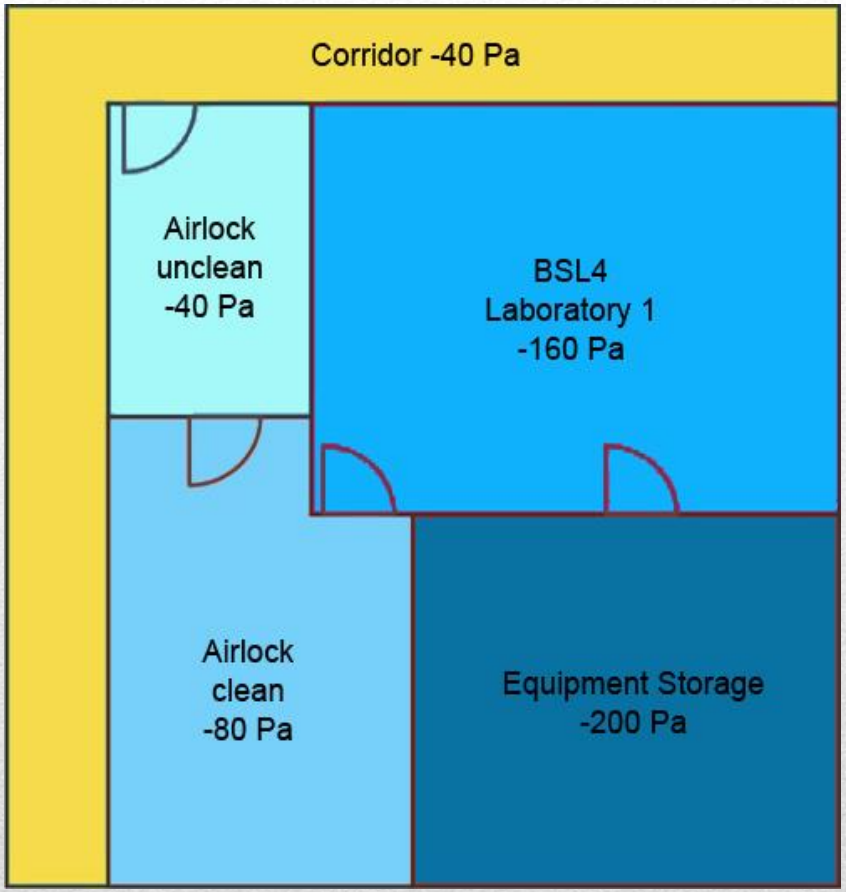
- **Despite–30C outside temperature, doors to compressor were left open** to disperse heat generated by the compressor.
- Heat build up known to have adverse affect on the liquid crystal display screens on the compressor.
- **Extreme outside temperature created blockage in discharge line of the second stage suction scrubber.**
- **Poor Ventilation & Poor Pressurization**

H2S fumes kill operator due in part to faulty HVAC

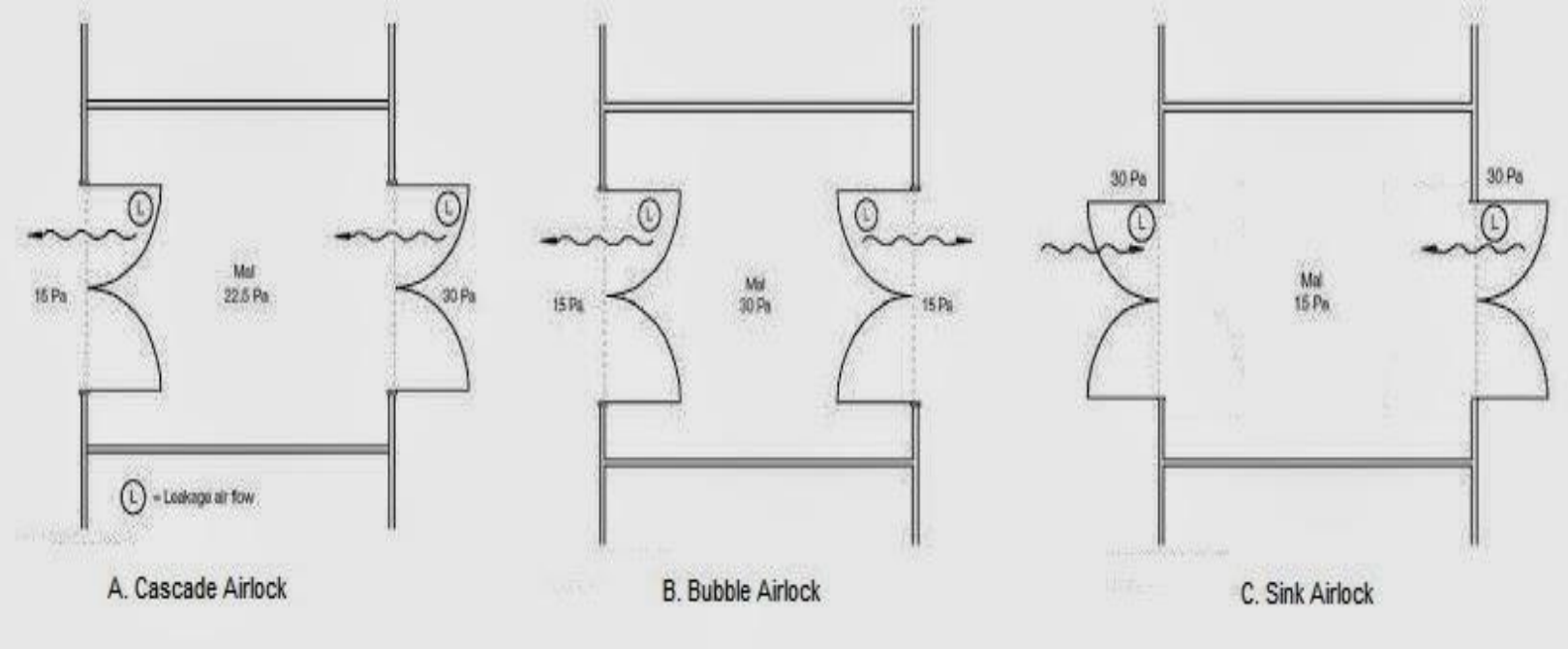
Pressurization Vs
Physical Barrier

BIO SAFETY LEVELS

- BSL 1 – Laboratories should have doors
- BSL 2 – Doors should be self-closing
- BSL 3 – Series of two self-closing doors
- BSL 4 – Airlock with air tight doors



Physical Barrier Controls



Air Locks Types

Purging Units

- **Some plants have enclosures in hazardous areas which must be purged with air or other gas (nitrogen)** and maintained at a pressure above atmospheric pressure.
- Some examples include **electrical equipment enclosures, enclosures for analyzers** such as control rooms or other occupied rooms.
- The **enclosures are maintained at a pressure** above atmospheric so that any flow through openings or **leaks** in the enclosure will be **from inside the enclosure to the outside atmosphere.**
- This **prevents flammable vapors or gases getting into the enclosure**, where the electrical equipment might be an ignition source for a fire or explosion.
- **Usually these enclosures are purged with clean air,** but alternatively, or from a backup system, they may have a **nitrogen purge** and atmosphere.

- Purging “the process of supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce concentration of any flammable gas or vapor initially present to an acceptable level.”
- Before an area can be pressurized, it must be purged of the current contaminated air.
- Pressure must be maintained at a level of at least 25 Pa with all openings closed, and must “provide a minimum of 0.305 m/s through all openings capable of being opened.”

Purge & Pressurization HVAC Units

Filtration Options

- Indoor air quality is important in unoccupied buildings as well as occupied.
- The equipment inside e-houses & control rooms is costly and often sensitive to dust and other particulates in the environment.
- ASHRAE standards for industrial areas recommend outside air to be filters with (MERV 8) pre-filters at 30%

  (MERV 11-14) final filters.at 85% to 90%
- Some filter options are:
  - Particulate filtration
  - Chemical filtration
  - Centrifugal dust/moisture filters
  - Condenser inlet debris filtration

Chemical Filtration

IAQ is for Equipment Too

- Gas ingested into Electrical building thru conduit.
- Installed a continuous positive pressure Makeup Air unit drawing air in from a from a non-hazardous source.
- Exhaust ventilation fans provided to automatically activated upon gas being detected .

Fire & Explosion Incident

- CCBDG provides a comprehensive source of technical information to assist designers achieve successful schemes in cold and extreme cold climates

ASHRAE Cold Climate Building Design Guide

ASHRAE and SCANVAC
HVAC Cold Climate Conference 2023

March 6-8, 2023

Marriott Anchorage Downtown, Anchorage, Alaska

Now Accepting Abstract Submissions: SUBMIT

Unique Challenges & Solutions for Climate Change in Cold & Arctic Communities

CONFERENCE FLYER

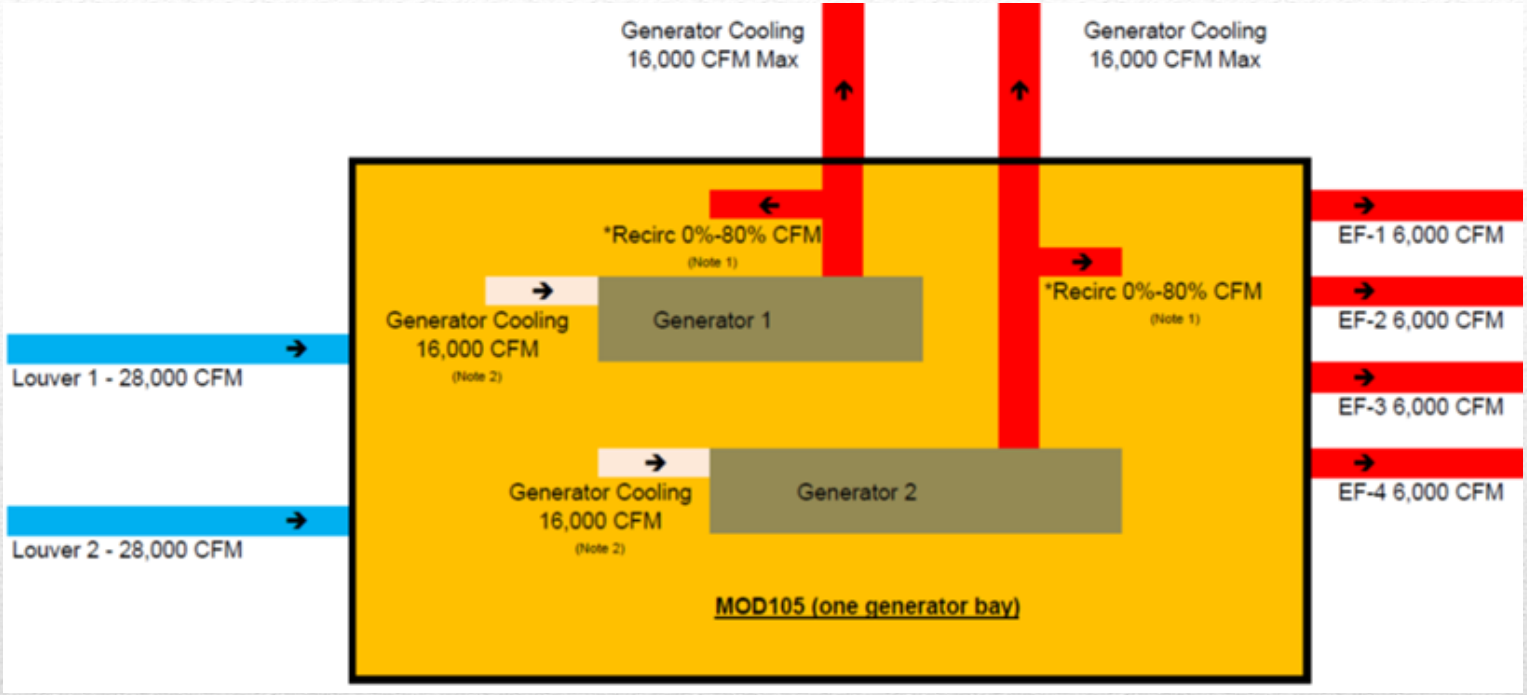
The goal of this International conference is for Built Environment engineers, practitioners, researchers, scientists, owners and government officials working in Cold Climate regions to share recent solutions and advancements addressing changes in climate; while experiencing the warmth, hospitality and culture of Alaska.

" Net-zero energy and sustainability goals pose special challenges for cold climates, climates with large swings in temperature and where ever-changing climate and shifting weather patterns result in colder temperatures in areas where winters are typically mild. Harmonizing human comfort with the climatic realities of these environments is a balancing act, and strategic design is key to building, commissioning and operating efficient and long-lasting cold-climate structures. "

- Erich Binder, conference chair.

- Building systems need to be maintained to keep the building operational.
- In cold climates, this can be especially difficult when encountering freezing temperatures, wind, and frozen precipitation.
- Various strategies will be explored to enable equipment maintenance in cold climates

ASHRAE Cold Climate Building Design Guide



Generator Waste Heat Recovery

Blocked Off Intake

Poor Design Issues

- Insufficient Heat in Winter.
- Could negatively effect Pressurization in Building.
- Could cause over heating is still blocked on warm day.

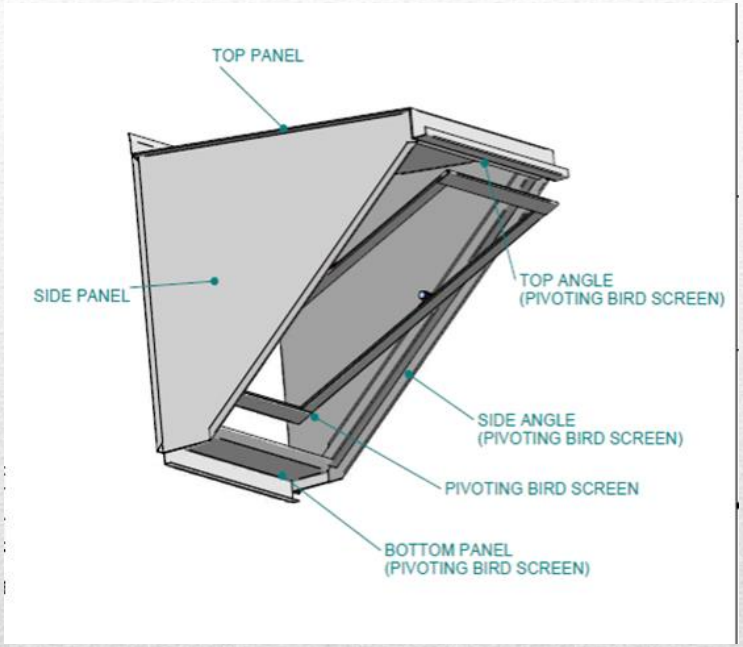
Poor HVAC Design Results Pressurization Issues

Hoar Frost - Intake Hood

Intake Hood Collapse

Excessive Negative Pressure

Pivoting Screen



Self Cleaning Screen

- When hoar frost builds up on screen, increased static pressure & weight causes birdscreen to pivot down & smack against bottom panel to remove frost.

Great Solution for Hoar Frost

Make Up Air Unit

Exhaust Air

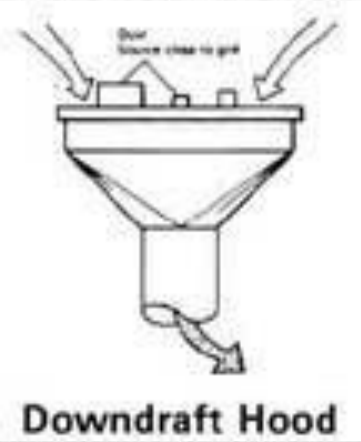
Slurry Prep Building

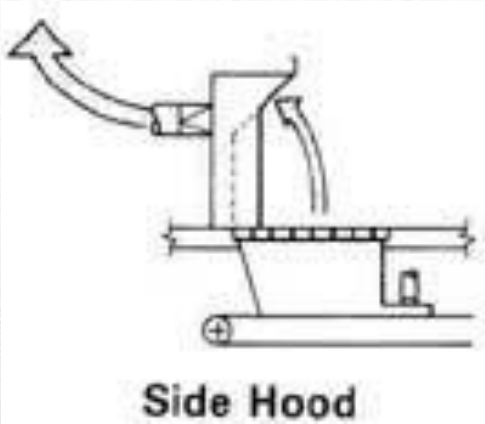
Positive Ventilation

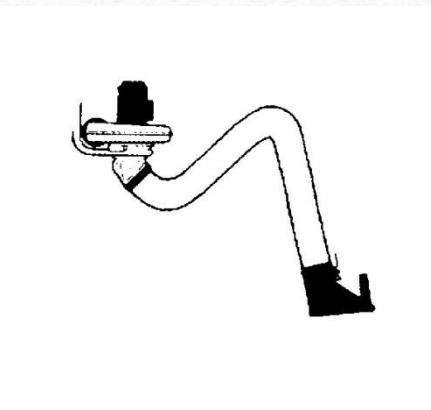
Negative Ventilation

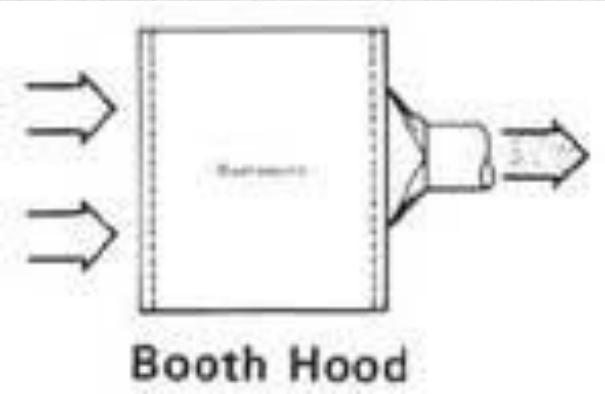
Slurry Prep Building

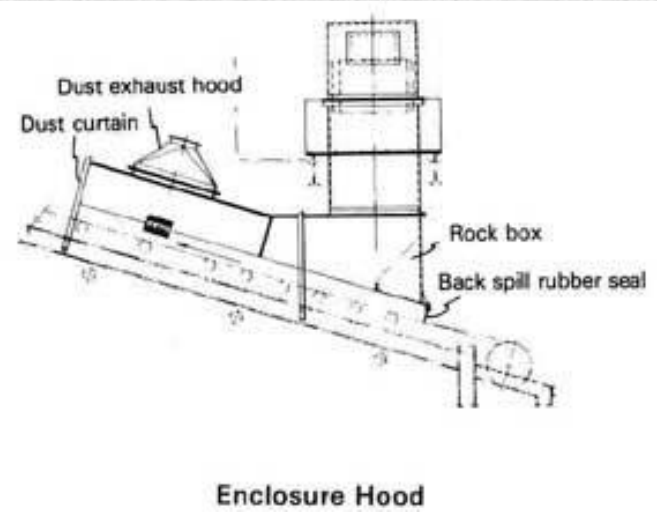
Local Exhaust Ventilation Hoods:

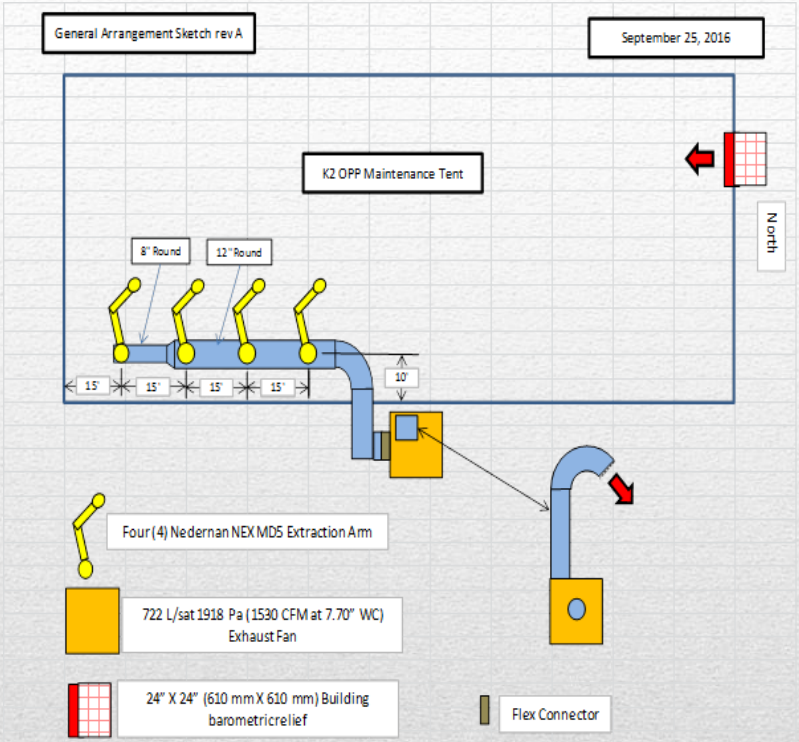








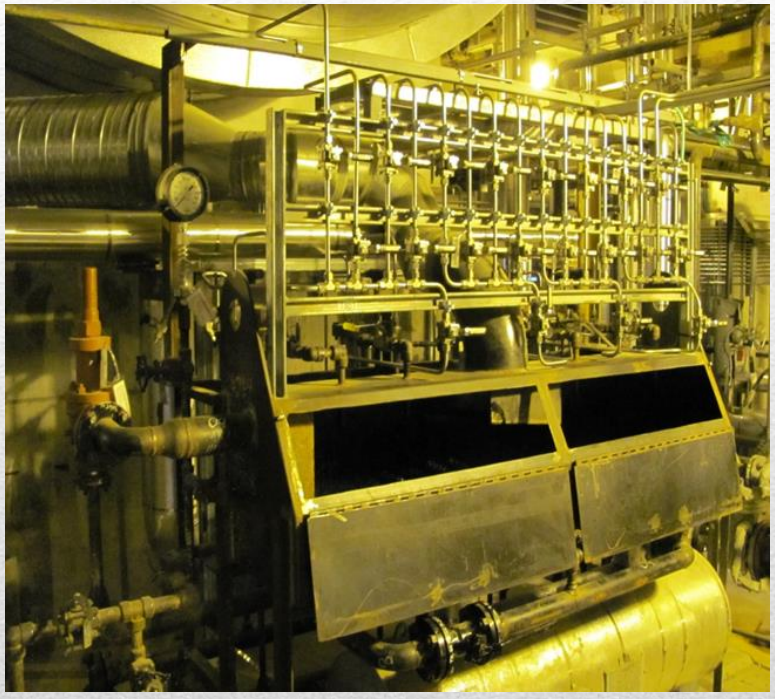




- OH&S poor air quality concerns from lack of ventilation.
- Welding Shop Make Up Air Unit is required to off- set welding exhaust.
- Heating, Ventilation & Pressurization concerns.
- Make-up air for the welding exhaust shall be via inlet barometric dampers.

Welding Ventilation

LAB & Sample Stations



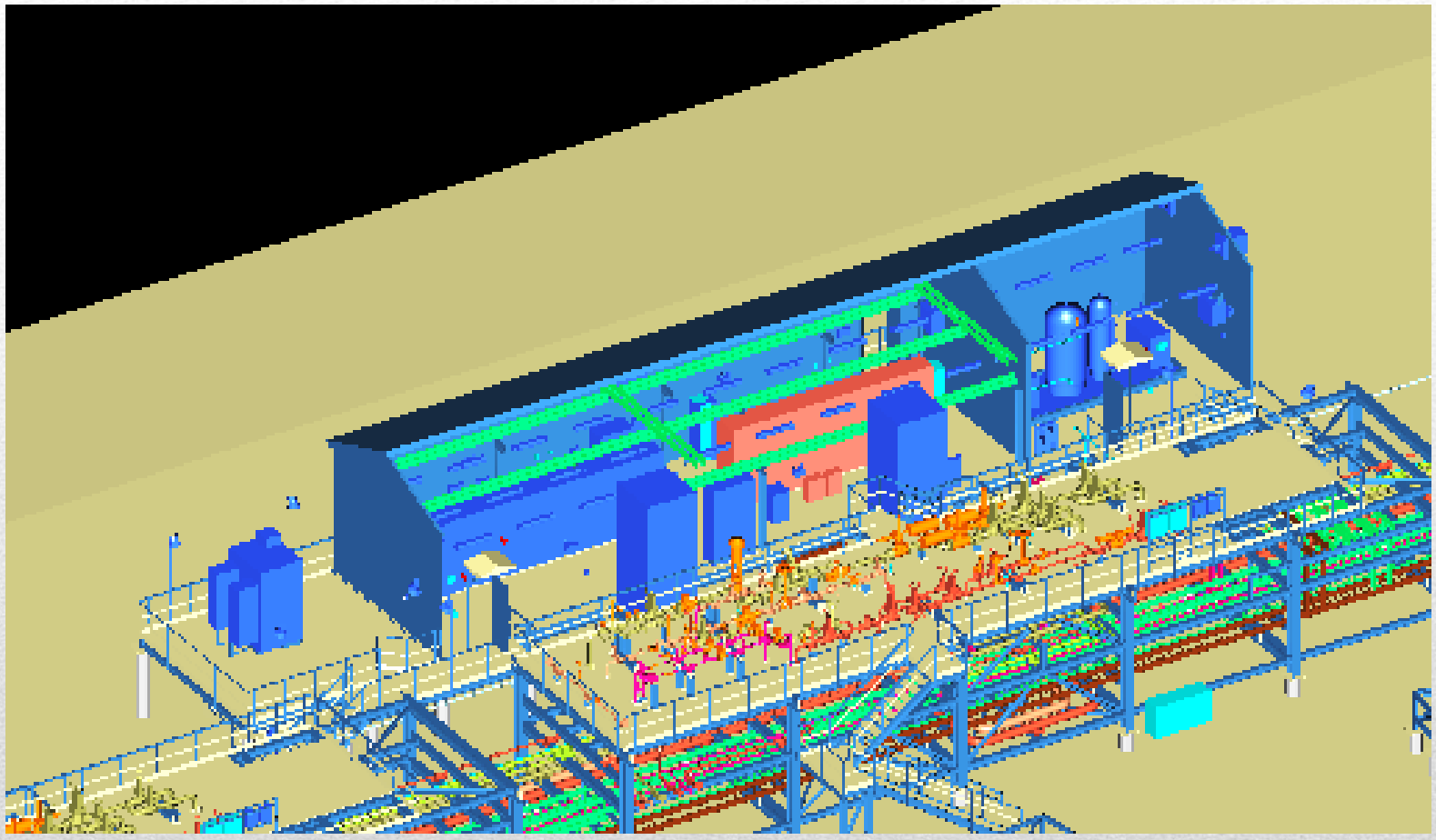
- Providing adequate localized ventilation greatly reduces energy consumption for ventilation systems.
- Re-use building heated air as makeup for fume extraction in lieu of heated outdoor air
- Adequate drains of hazardous liquids are also required.

Sampling Stations

Restricted Intake Air

VFD Exhaust with Recirc

Large VFD Drive Cooling



E-House & XP Pumphouse

- Battery Rooms should be under continuous negative ventilation.
- XP fans required in larger installations. Fans should be XP
- Smoke detectors and or Hydrogen detectors should be installed.
- ASHRAE Guideline 21

GUIDELINE 21-2018 -- GUIDE FOR THE VENTILATION AND THERMAL MANAGEMENT OF BATTERIES FOR STATIONARY APPLICATIONS (IEEE STANDARD 1635-2018)

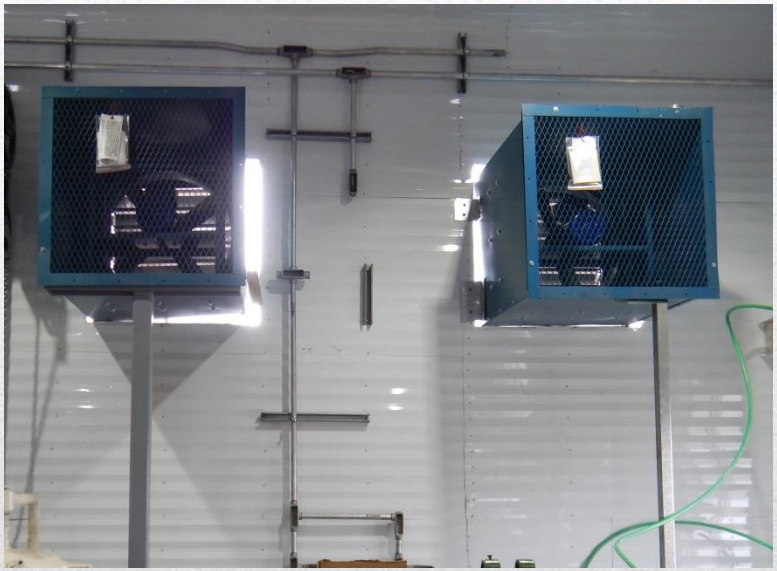
STANDARD by ASHRAE, 2018

Battery Room Ventilation

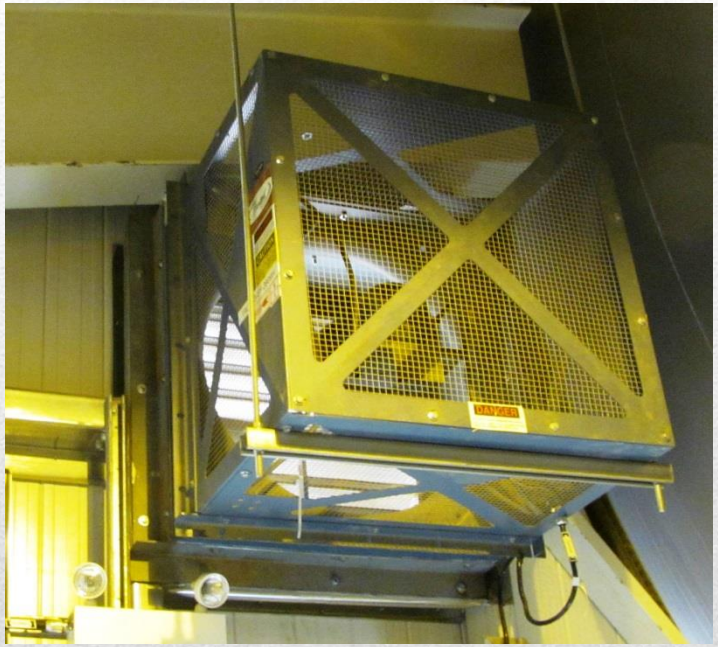
- Over Pressure Condition Make Up Air Unit operates & OTSG shuts down.
- Under Pressure Condition OTSG operates and Make Up Air Unit Shuts Down

OTSG Make Up Combustion Air Incidents

Poorly Sealed Fans



Well Sealed Fans



Poor Construction & Equipment Selection

Cold Weather Design

Dampers w/o Seals

Operating Temp Range

-57C to 93C

Proper Wall Penetration Seals

Door Leak Test

Smoke Test

Pressurization Testing

Recent Audit of Oil Sands Facility

- 35 existing buildings have known pressurizations issues.
- Over Pressure of buildings often to much make up air.
- Under Pressure in building due to leaks, inadequate HVAC, poor construction, on site modifications.
- Improper HVAC Economizers operation (waste heat recovery.)
- Poorly controlled, designed and or constructed relief systems.
- Commissioning and Operation issues.

Best Practices

- Provide Sequence of Operations for normal, winter, summer, emergency & fire shutdown HVAC also for hard & soft shutdown & start up after hard & soft shutdowns.
- Seal all round piping and penetrations on outside walls or between rooms.
- Sealant required at both ends of the Teck cables running between buildings.
- Use Door Test to check building seal as part of commissioning process

FUTURE CHALLENGES

International Building Decarbonization 2022 Conference

October 6 - 7, 2022 | Athens, Greece

Call for Papers and Presentations Announced – Abstracts due April 18, 2022

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ASHRAE Hellenic Chapter

QUESTIONS

Thank You

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