Bridgeway

The Mechanics of Genset Installations




ON SITE POWER SYSTEM APPLICATION REVIEW (DIESEL/600VAC AND LOWER)

Date: _____ Location: _____

Owner/Operator: _____

Generator Set Model: _____ Serial Number: _____

Transfer Switch Model: _____ Serial Number: _____

Project/Order Number: _____

Review Performed By: _____

Mounting/Noise/Isolation

[ ] Flexible power output conduit, supported by bldg.
[ ] Isolators/pad (integral to set)
[ ] Isolators/pad (external to set)
[ ] Isolators/spring-pad, adjusted correctly
[ ] Flexible stainless steel exhaust connection
[ ] Flexible fuel lines (supply& return), secured
[ ] Flexible power output conduit, supported by bldg.
[ ] Flexible auxiliary power connections
[ ] Flexible control connections
[ ] Flexible exhaust air duct
[ ] Seismic restraints (where required)
[ ] Provisions for draining oil/coolant
[ ] Clearance around genset (3ft/1 meter min.)
[ ] Fire alarm provisions
[ ] System covers/shields all in place

Exhaust

[ ] Silencer close to genset
[ ] Exhaust connections sealed
[ ] Exhaust insulated
[ ] Proper personnel protection provided
[ ] Exhaust run slopes away from genset
[ ] Condensate trap with valve on exhaust silencer
[ ] Provisions for thermal expansion
[ ] Raincap/birdscreen on exterior of building
[ ] Exhaust thimble
[ ] Correct pipe size, supported by building
[ ] Facility vent air intake, windows, doors not close to exhaust outlet
[ ] No combustible materials, or fire system components near uninsulated pipe

Cooling System

[ ] Filled with soft water/E.G./DCA mixture
[ ] Jacket water heater provided
[ ] Valves to isolate jacket water heater
[ ] Power supply to heater from normal power

Ventilation System

[ ] Inlet air duct properly sized (approx. 1.5x radiator)
[ ] Exhaust air duct properly sized (effective open area not less than radiator area)
[ ] Heat sources in room insulated
[ ] Recirculation of radiator exhaust air unlikely
[ ] Access door to room opens in (or vented)
[ ] Vent dampers powered from emergency power supply
[ ] Direction of prevailing winds

Fuel System

[ ] Piping is not galvanized or copper
[ ] Manual shut-off valve
[ ] Solenoid valve on fuel supply, power from set
[ ] Fuel returns to main tank
[ ] Fuel line size adequate
[ ] Fuel line high loops
[ ] Day tank/vent at highest point
[ ] Day tank/location below return lines
[ ] Day tank/strainer-filter
[ ] Day tank/level alarms
[ ] Main fuel tank below set
[ ] Fuel transfer pump/power from genset
[ ] Main fuel tank above set
[ ] Solenoid valve
[ ] Sub-base tank
[ ] Level gage
[ ] Vent

Electrical System

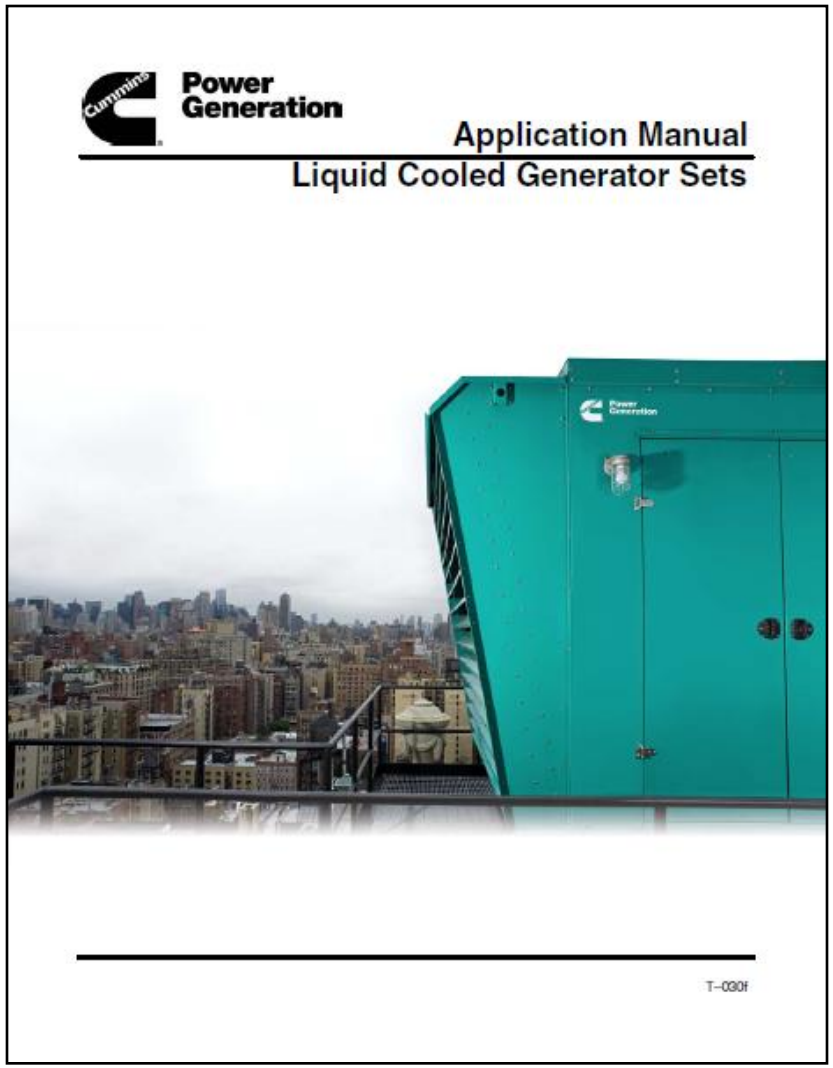
[ ] Control connections isolated from power
[ ] Control connections use stranded wire
[ ] Conductor size OK (power & control)
[ ] Proper battery size/filled with electrolyte
[ ] Battery rack isolated from floor
[ ] Battery charger/power from utility
[ ] Start signal wired to ATS
[ ] Generator frame grounded (bonded)
[ ] Neutral connection (where/how)
[ ] Power/control conductors torqued
[ ] Wiring accuracy/matches drawings

Other

[ ] Oil installed in engine
[ ] Posted operating instructions
[ ] Generator/ATS manuals, drawings provided
[ ] Generator room/control boxes cleaned

- Which boxes should you check?
- How are you to decide?
  - Where?
  - Ventilation/Cooling
  - Exhaust
  - Vibration
  - Fuel Systems
  - Electrical

Reference



- Material in this presentation is covered in Cummins Power Generation's *Generator Set Application Manual*
- A full copy is in Power Suite or at www.cumminspower.com

>Application Engineering >Technical Information

>T-030

Where to Put It

- For Emergency Systems, Genset Must Be In it's Own Room.
- Consider Ability to Service
- Potential for Flooding
- Physically Isolated from Normal Power Source
- Negative Impacts on Neighbors
  - Exhaust gas
  - Noise

Indoor vs Outdoor Sets

- Outdoor
  - Lower Cost
  - Security
  - Ease of Monitoring
  - Fuel Heating (prevent waxing)
  - Battery Heating
  - Coolant Heater Changes
  - Anti-Condensation Heaters for Alternator and Controls
- Indoor
  - More stable environment
  - More difficult service access
  - Air flow issues
  - Noise
  - Still need coolant heaters

Reducing the Noise by Site Design

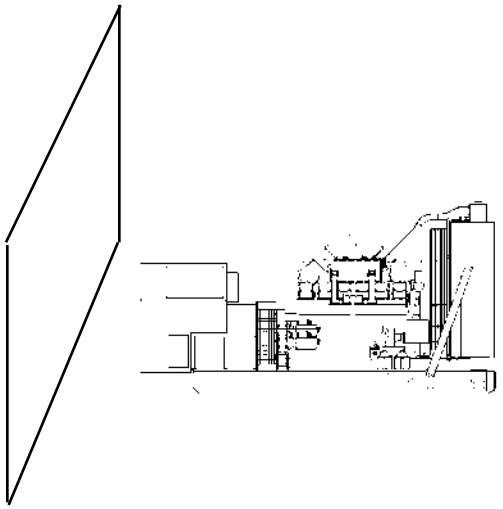
- Increase Distance from Receiver

Rule of Thumb:
Sound power drops 6dBA at 2 times distance.

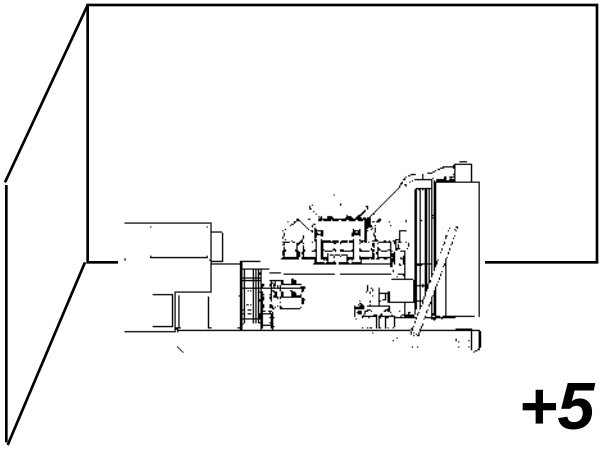
- Insert High Mass, Absorptive Barriers
- Direct Noise Away From Sensitive Locations
- Watch for Hard, Reflective Surfaces

Rule of Thumb:
Sound power increases 3dBA for two equal sources.

Effect of Reverberation



+3 dBA

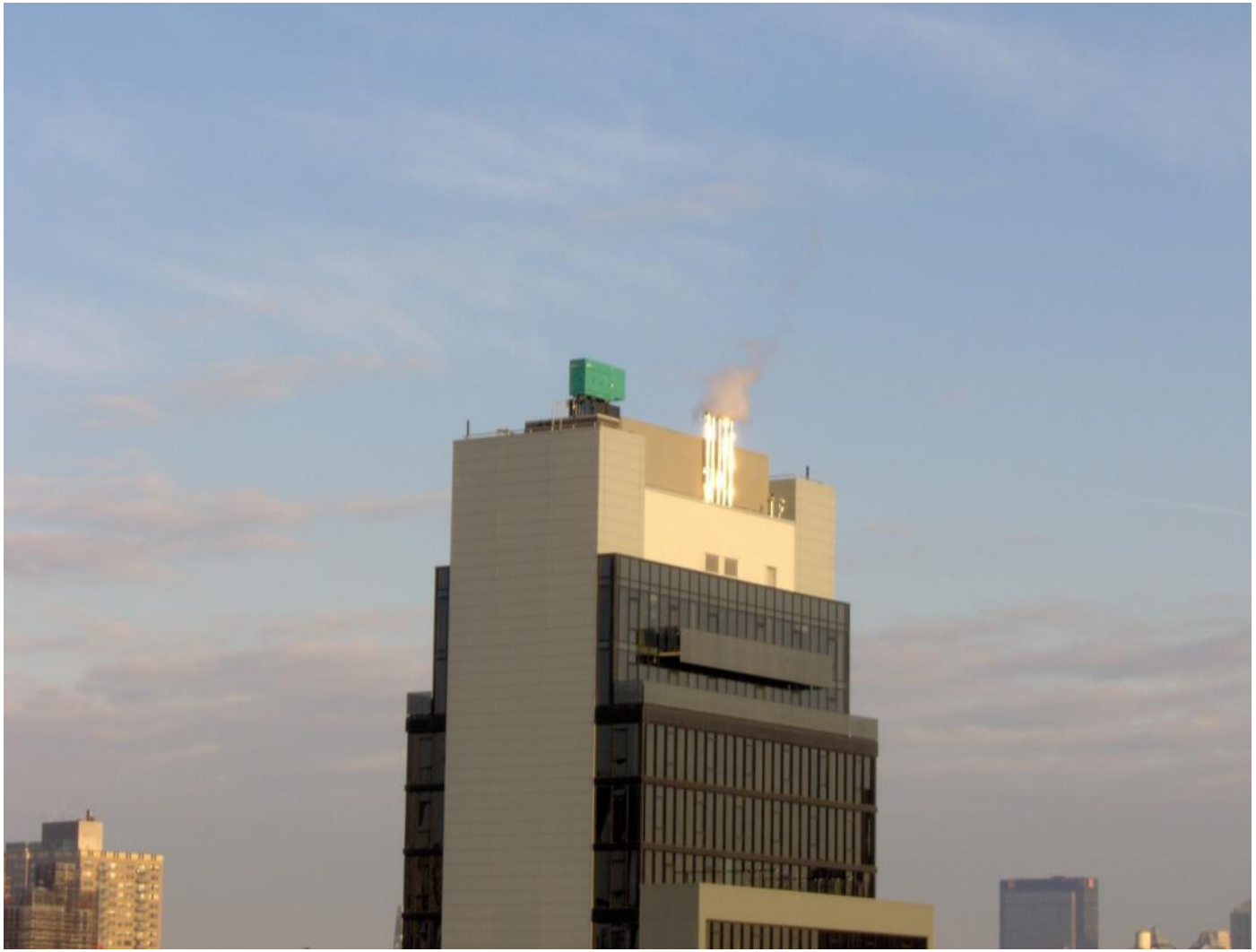


+5 dBA

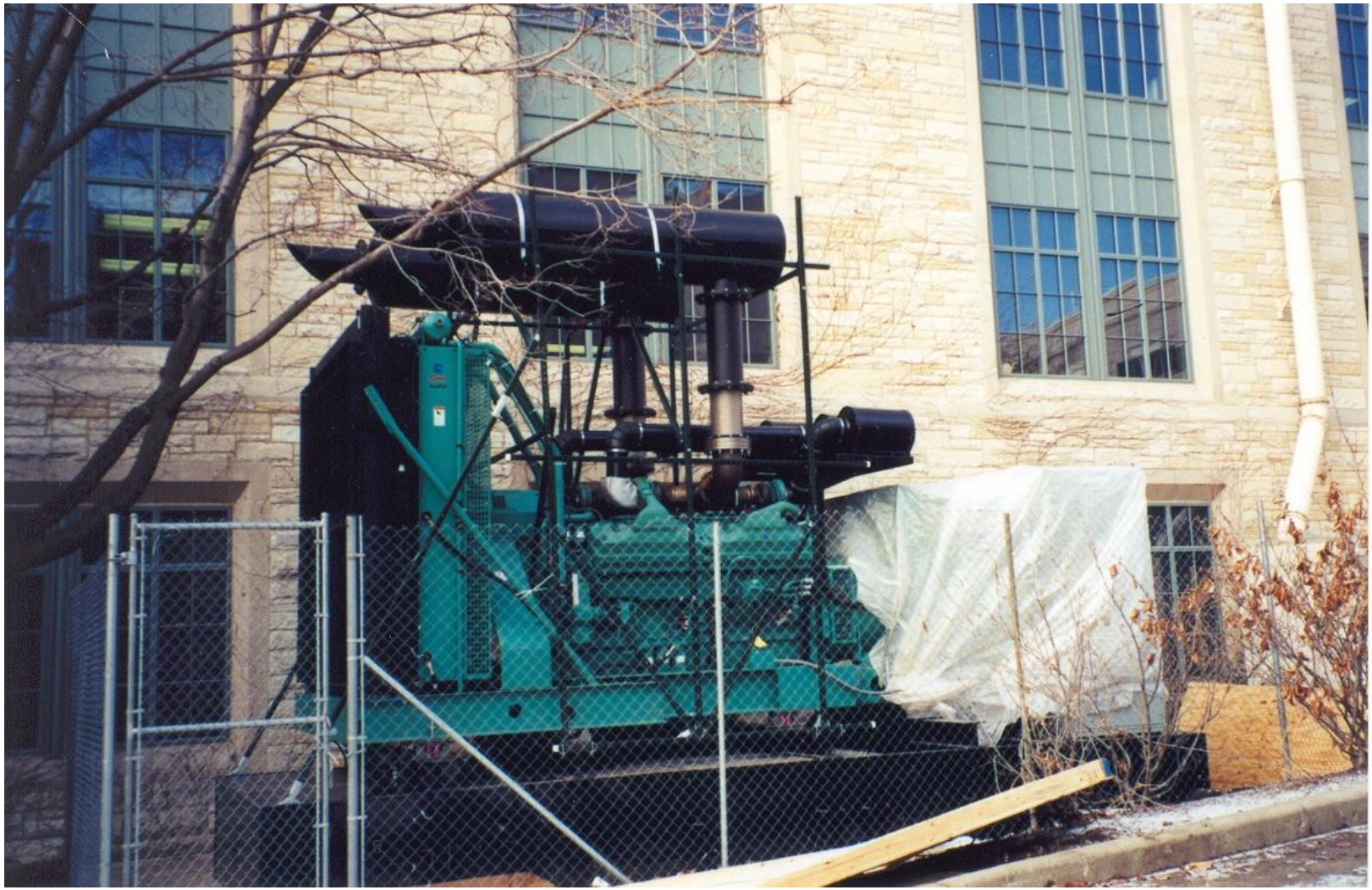
- The noise source is effectively duplicated by hard walls.

And the problem here is…?

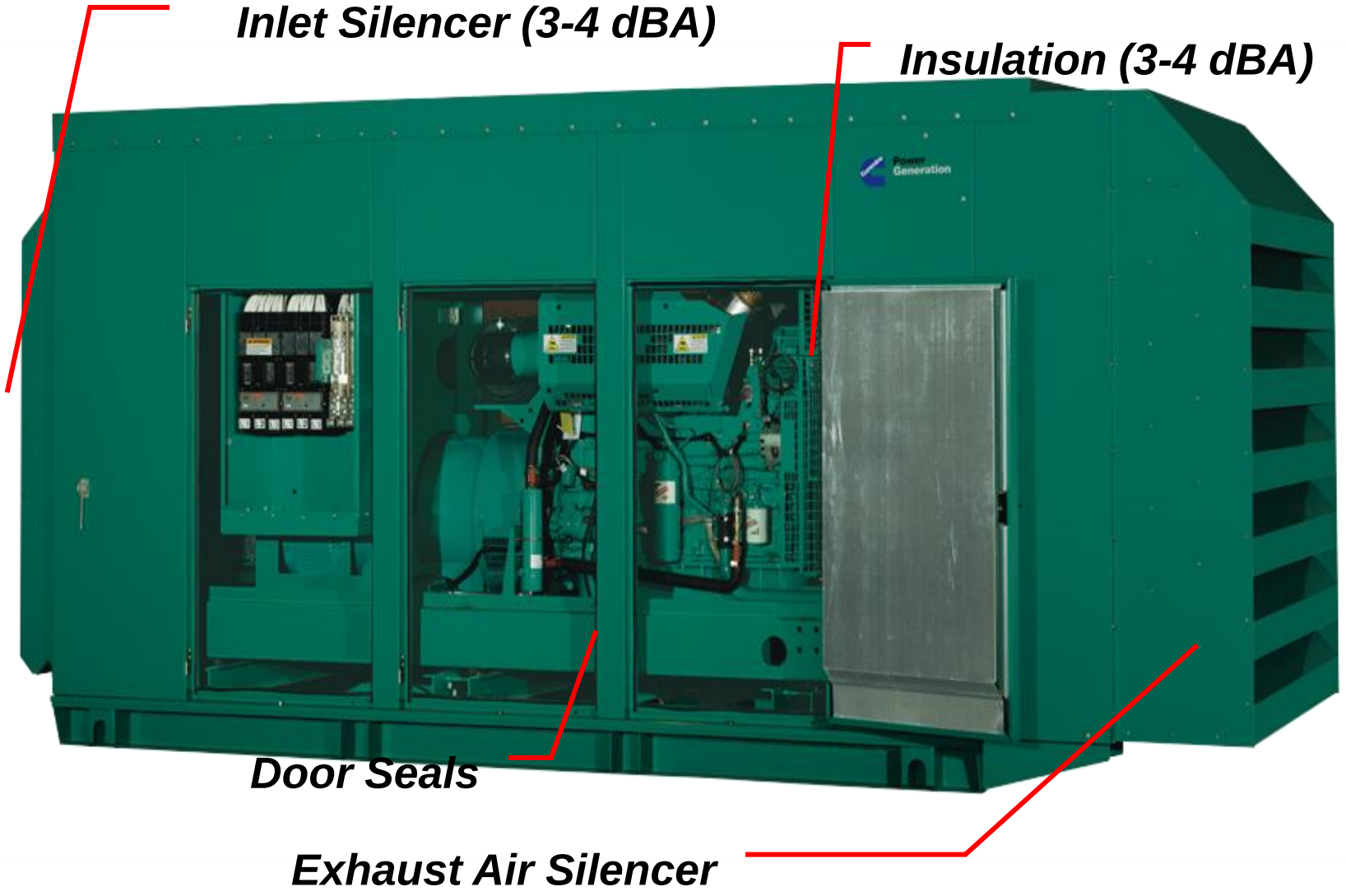
Of course, that was an isolated problem…



What's wrong with this picture?

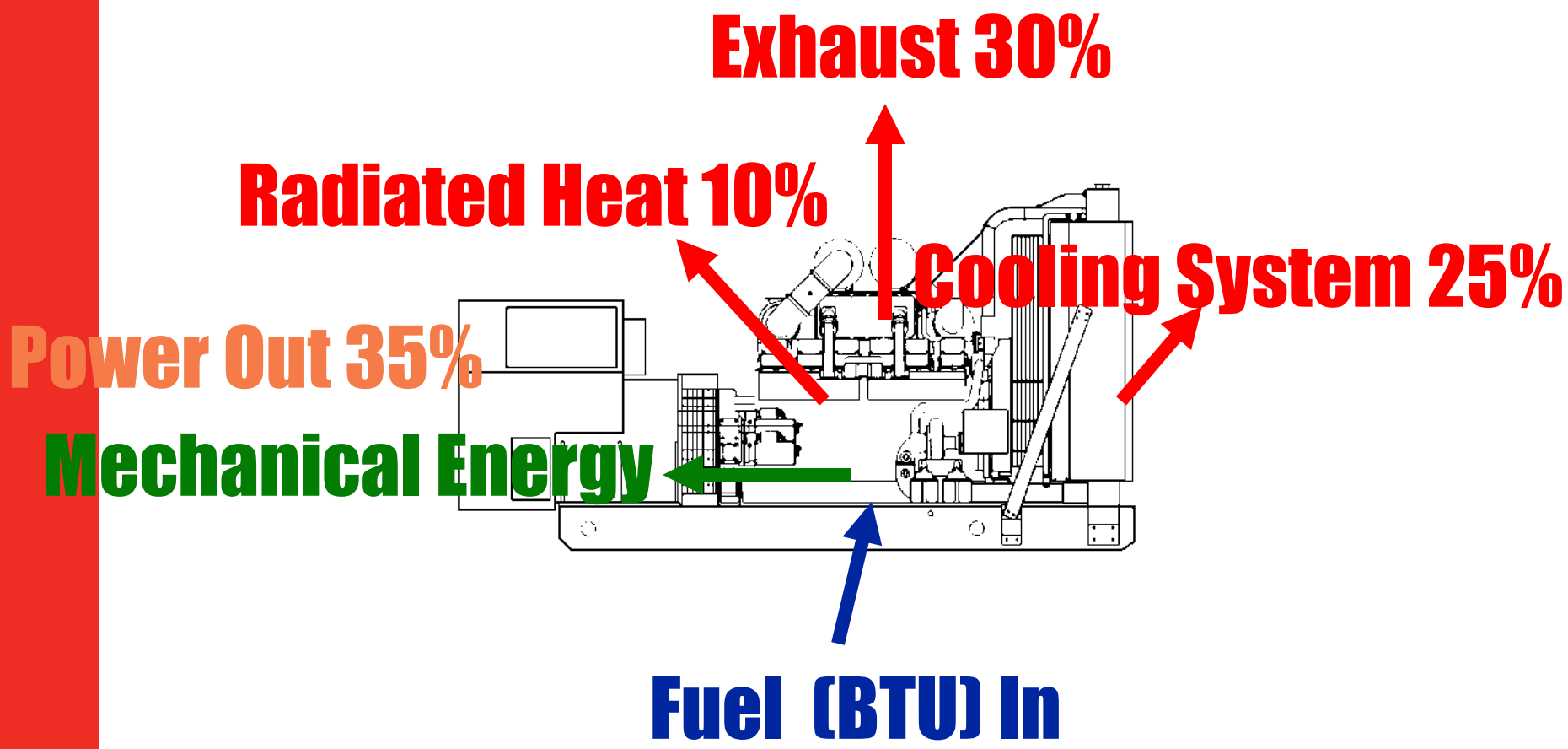


Sound Attenuation Features

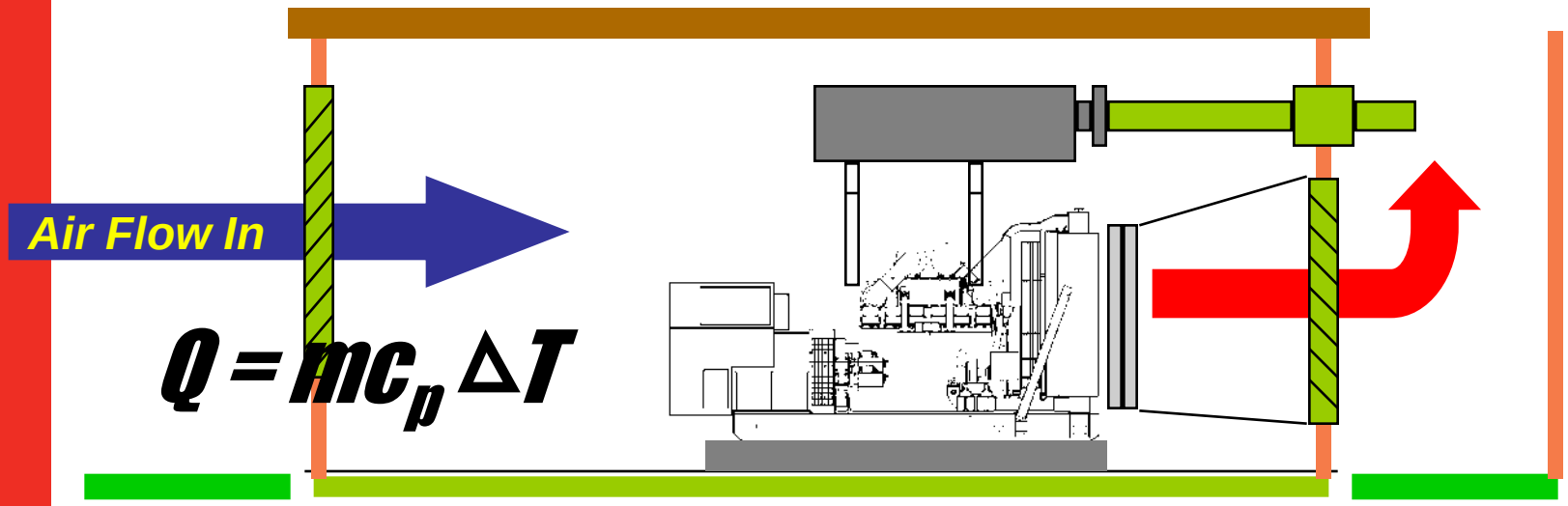


GenSet Energy Balance

- Engine Burns Fuel--creates:
  - Rotating mechanical energy/electrical power
  - Heat

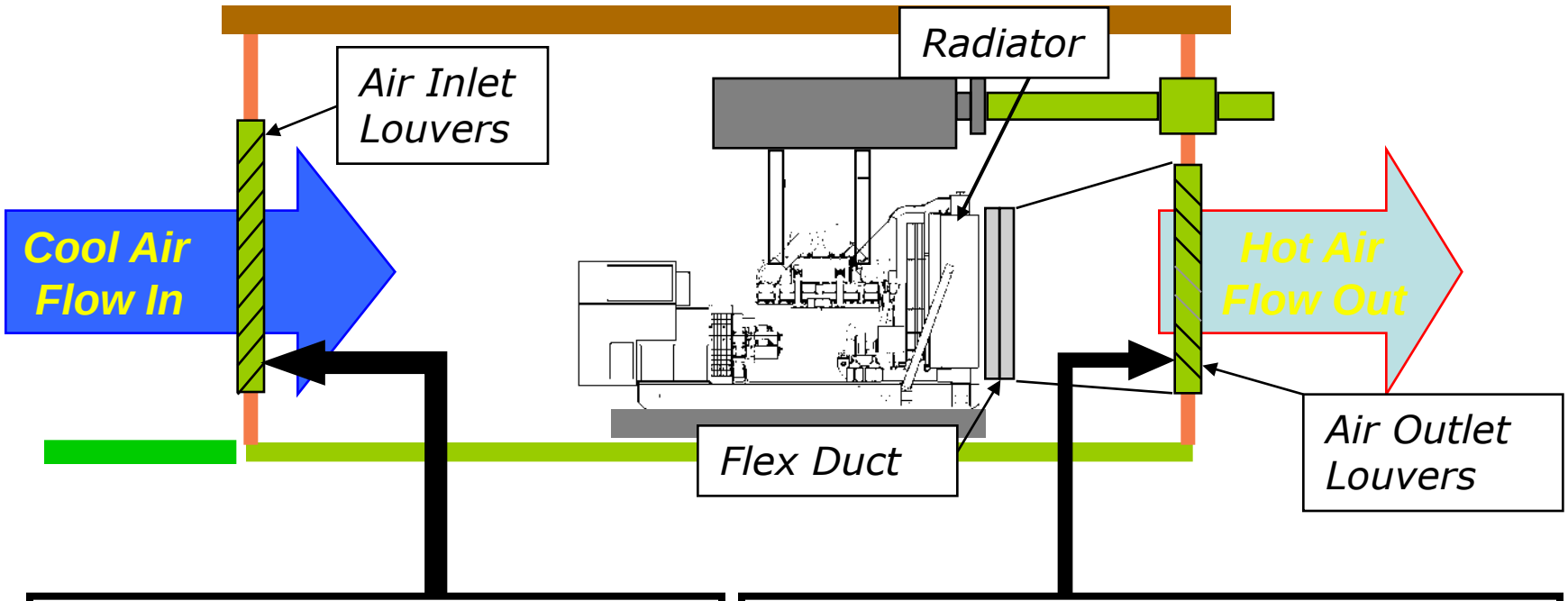


Ventilation System



- Sufficient air flow to remove heat from room or enclosure
- Requires testing in controlled environment to verify design (NFPA110 requirement)
- Radiator fan moves air through system
  - No leaks, bypasses, recirculation

Gensets With Mounted Radiators

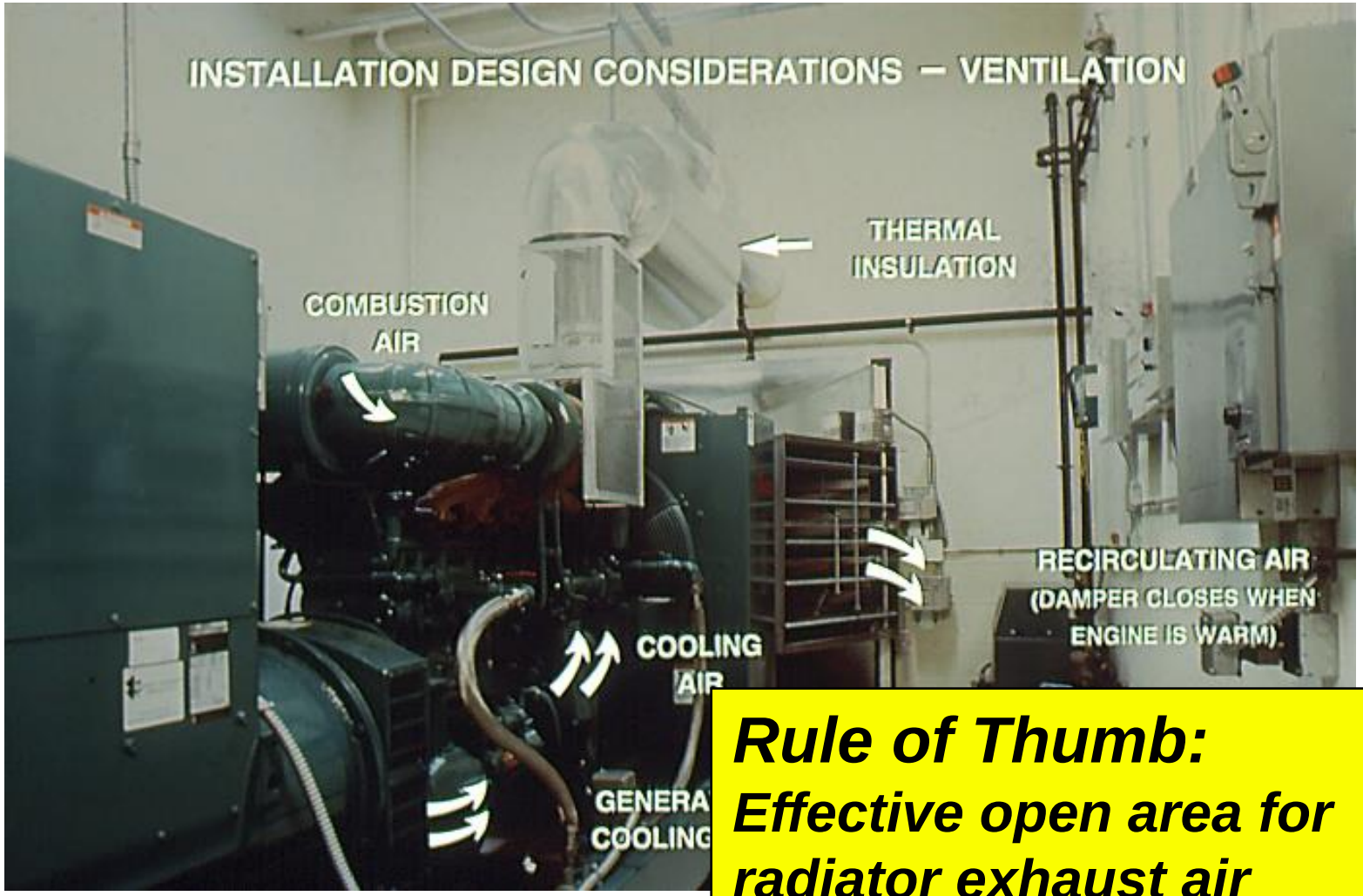


Intake should be sized (**at minimum**) to have an effective open area of **1.5 times** the size of the radiator core.

If louvers are to be used, the restriction must be accounted for.

Discharge should be sized (**at minimum**) to have an effective open area **equal to** the size of the radiator core.

Similarly to the intake side, if louvers are used, oversizing of the discharge will be required.



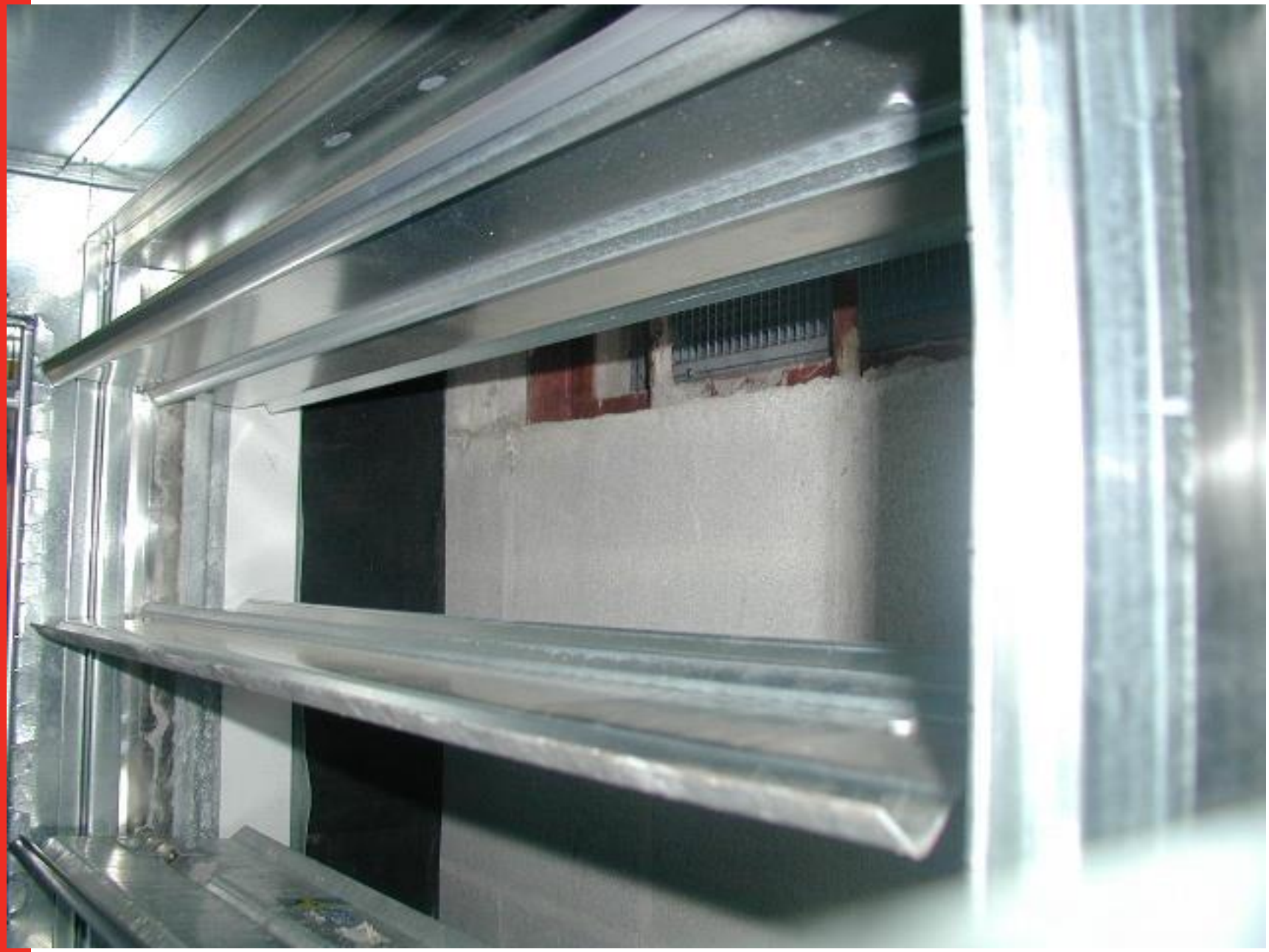
Rule of Thumb:
Effective open area for radiator exhaust air should be roughly equal to radiator area.

Equipment/Room Ventilation

- Best to Have Flow Across Genset.
- Check Doors for Opening, Noting Room is in Slight Vacuum

Rule of Thumb:
Effective open area of inlet to room must be 1 1/2 times the radiator area.


Power
Generation

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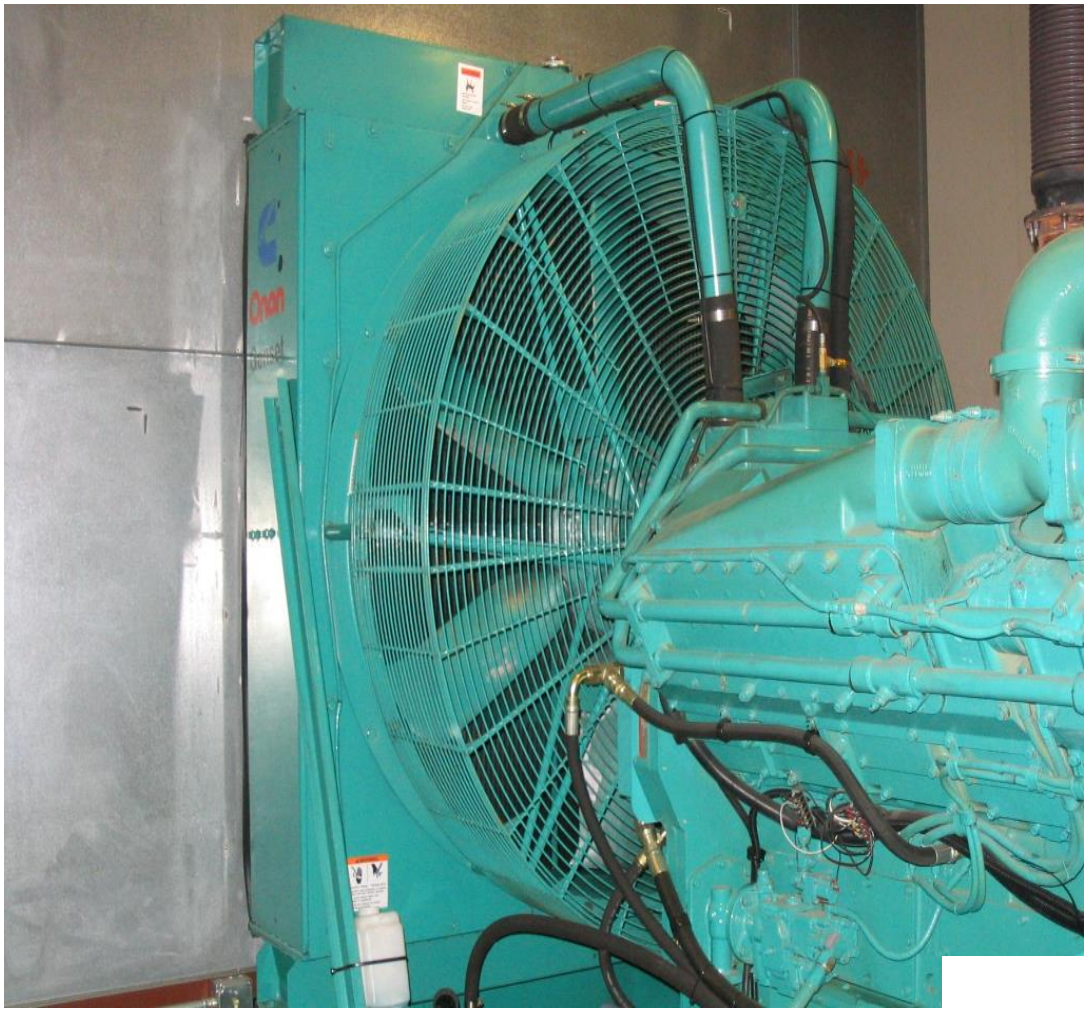
DANGER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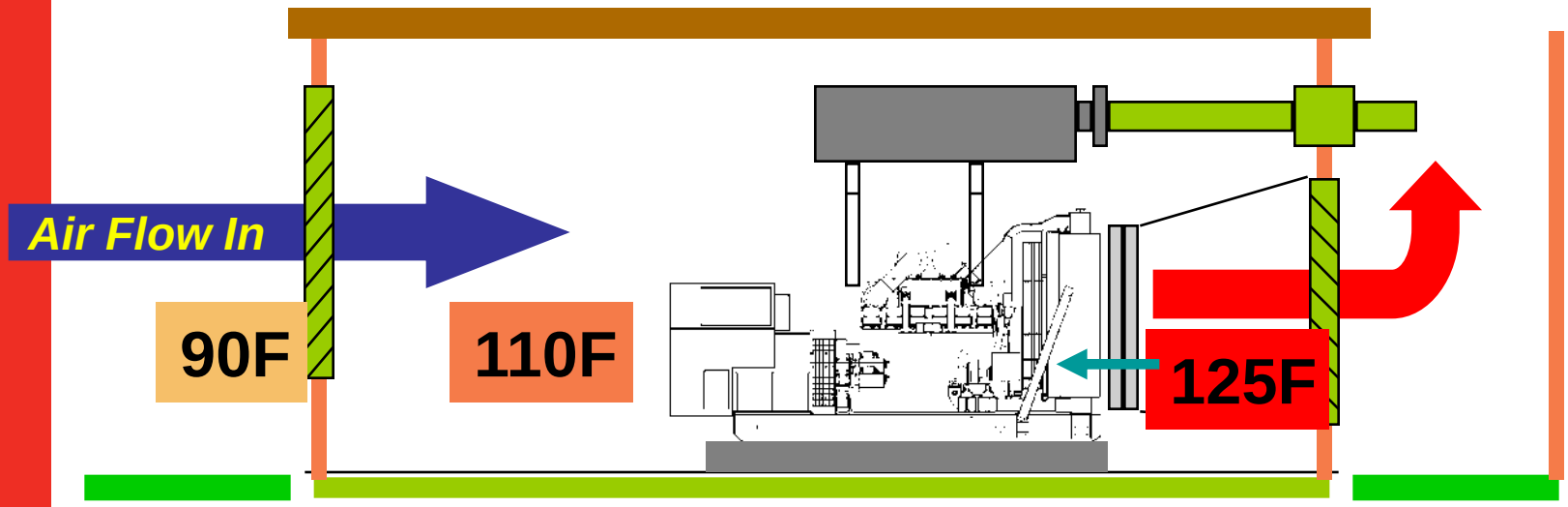
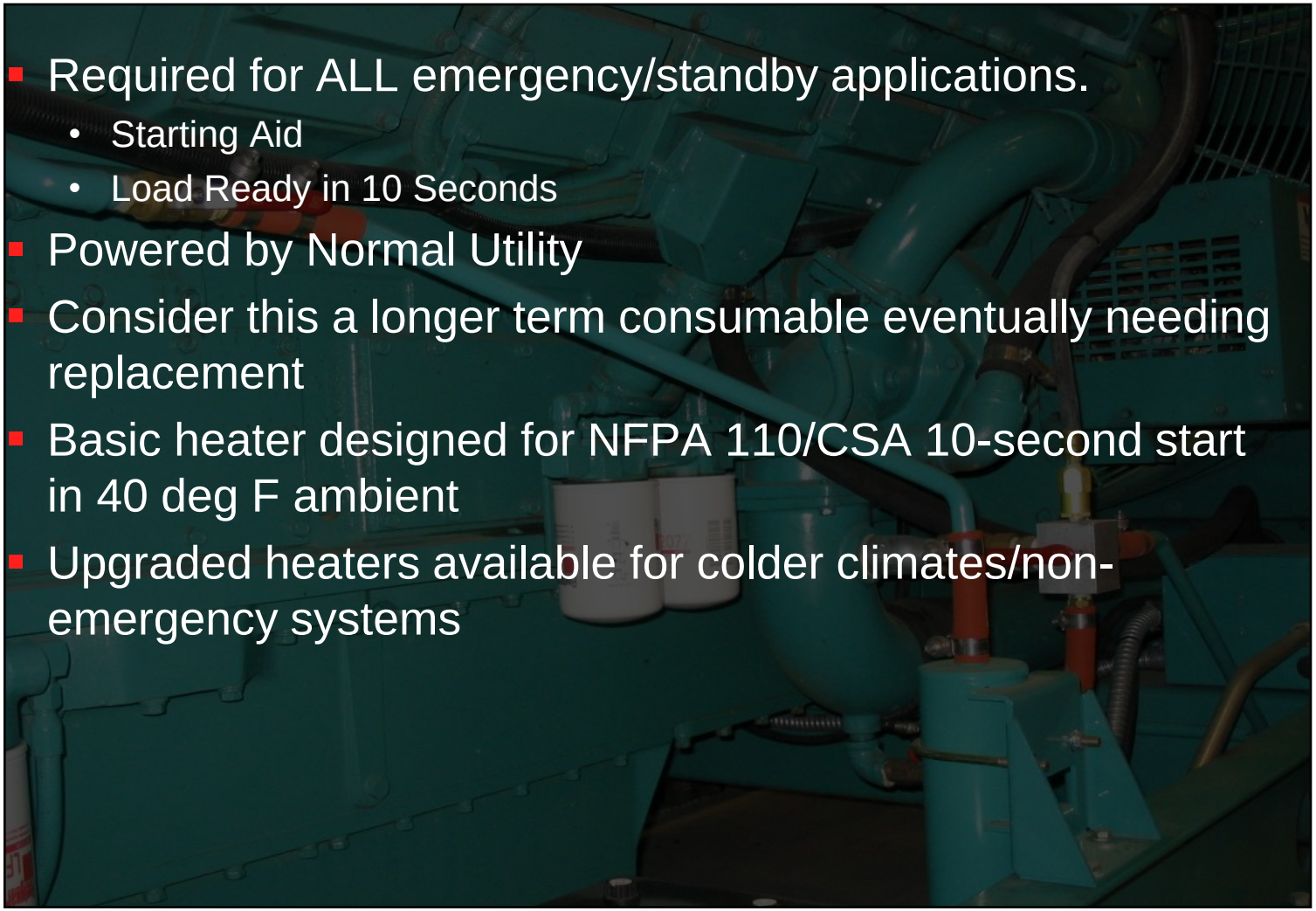
Exhaust Recirculation

Cooling System



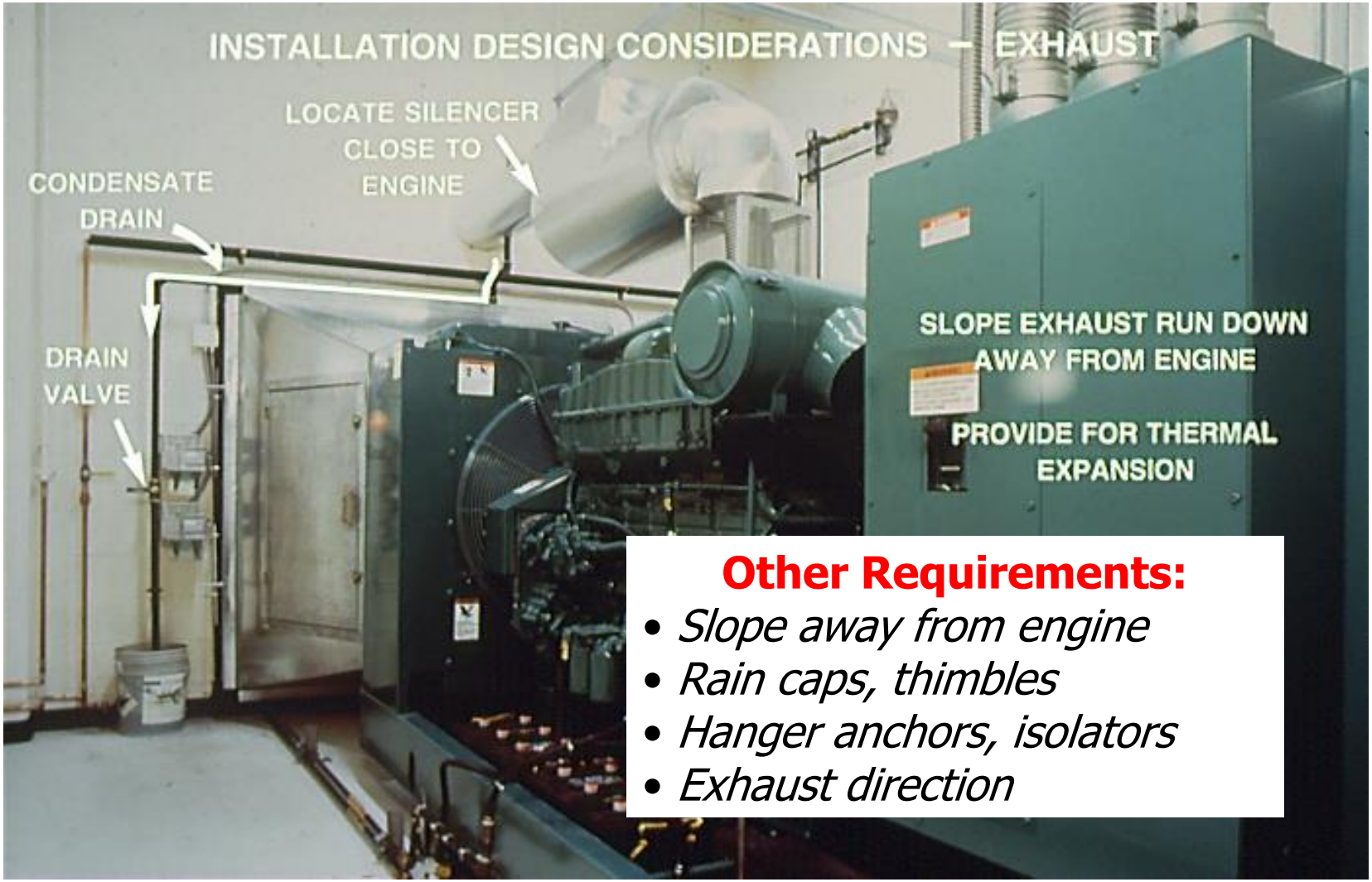
- Make sure radiator is sized for it's ambient
  - Genset cooling system design requires testing to verify performance--mfr. data is not always accurate.
- Result of poor design is inability to carry full load at high ambient temperature conditions.
  - Look for temperature rise inside enclosure/room vs. outdoor

Cooling Systems: Jacket Water Heaters



- Required for ALL emergency/standby applications.
  - Starting Aid
  - Load Ready in 10 Seconds
- Powered by Normal Utility
- Consider this a longer term consumable eventually needing replacement
- Basic heater designed for NFPA 110/CSA 10-second start in 40 deg F ambient
- Upgraded heaters available for colder climates/non-emergency systems

Exhaust System Considerations



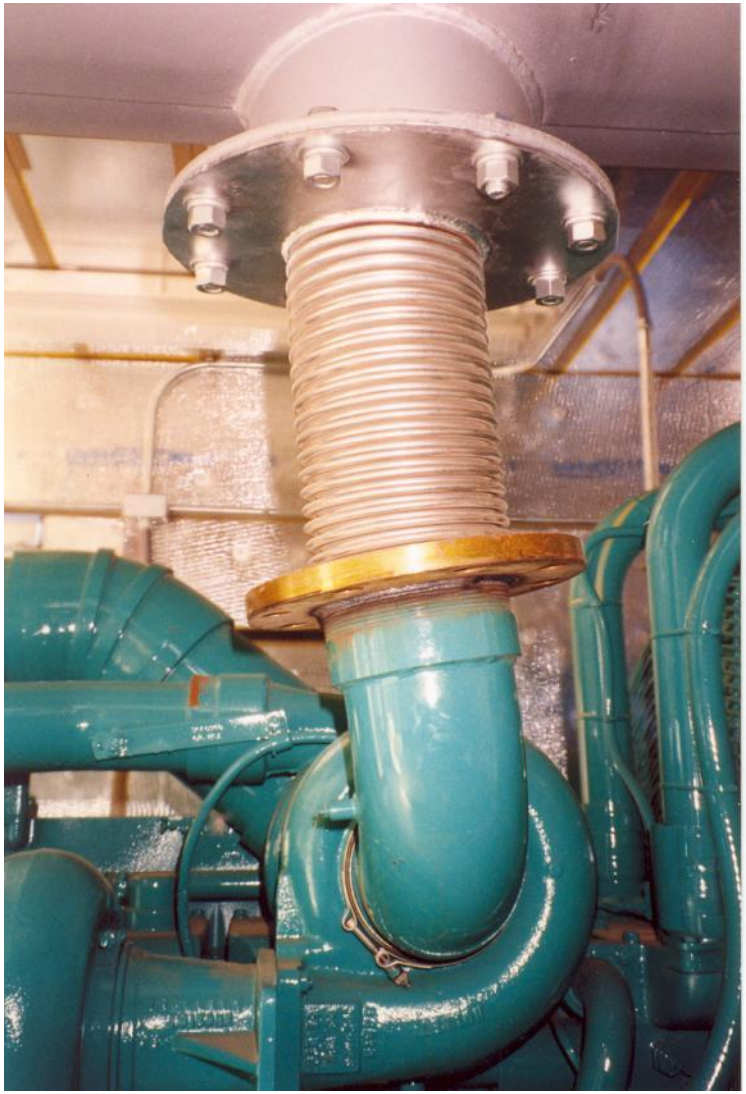
Other Requirements:

- *Slope away from engine*
- *Rain caps, thimbles*
- *Hanger anchors, isolators*
- *Exhaust direction*

Exhaust Systems

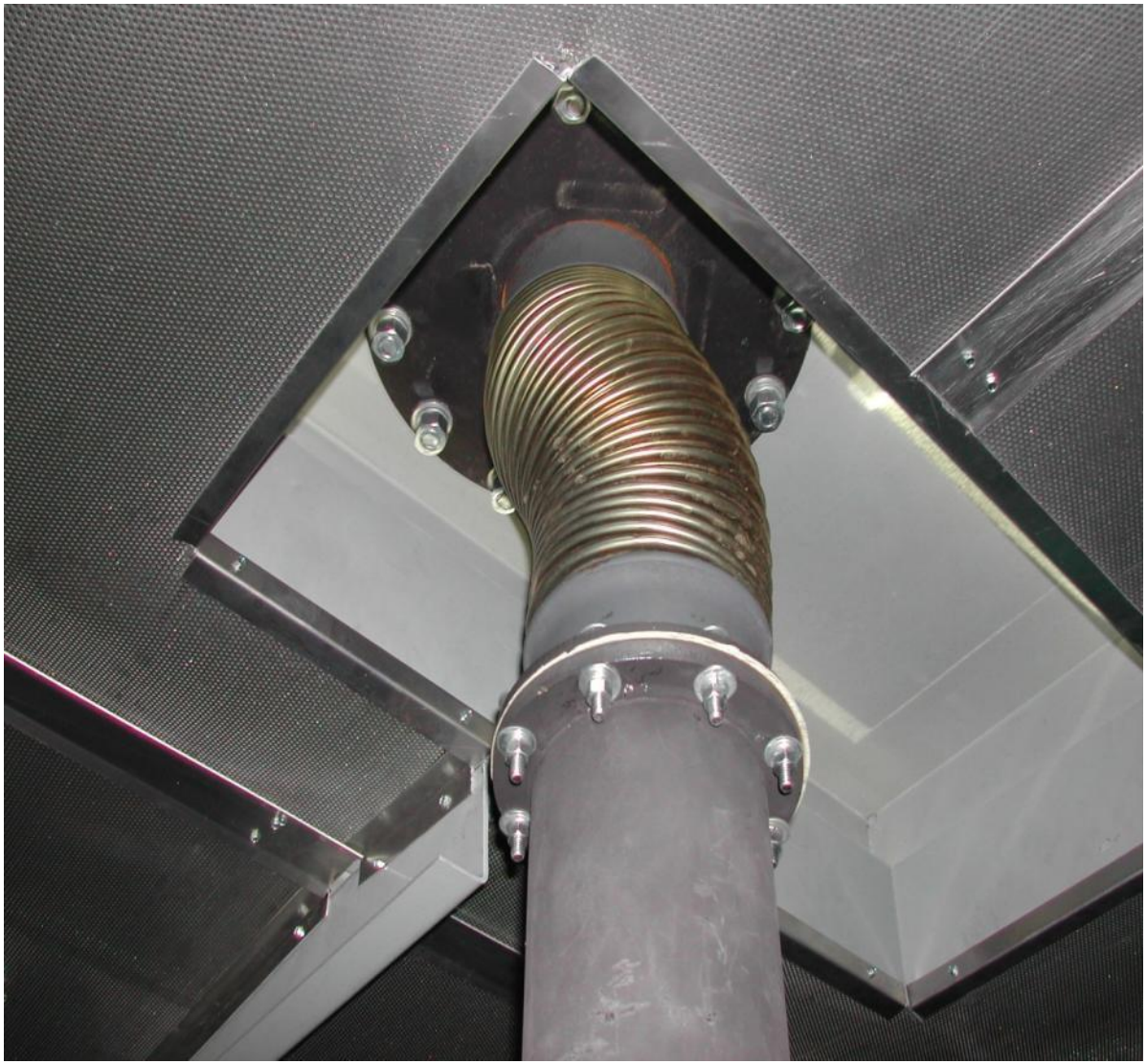
- Noise level as installed
  - Enclosure sound attenuation alone, or exhaust attenuation alone won't positively solve your problem.
  - Best results can be verified with prototype testing.
  - Without measuring the noise with a genset operating INSIDE the enclosure, an assembler has no idea what impact vibration noise will have on the overall sound level.
- There is a wide range of performance for any "industry standard" muffler type.
- Vibration on the surface of the enclosure increases the noise coming from the panels, diminishing the overall benefit.

How about this one?



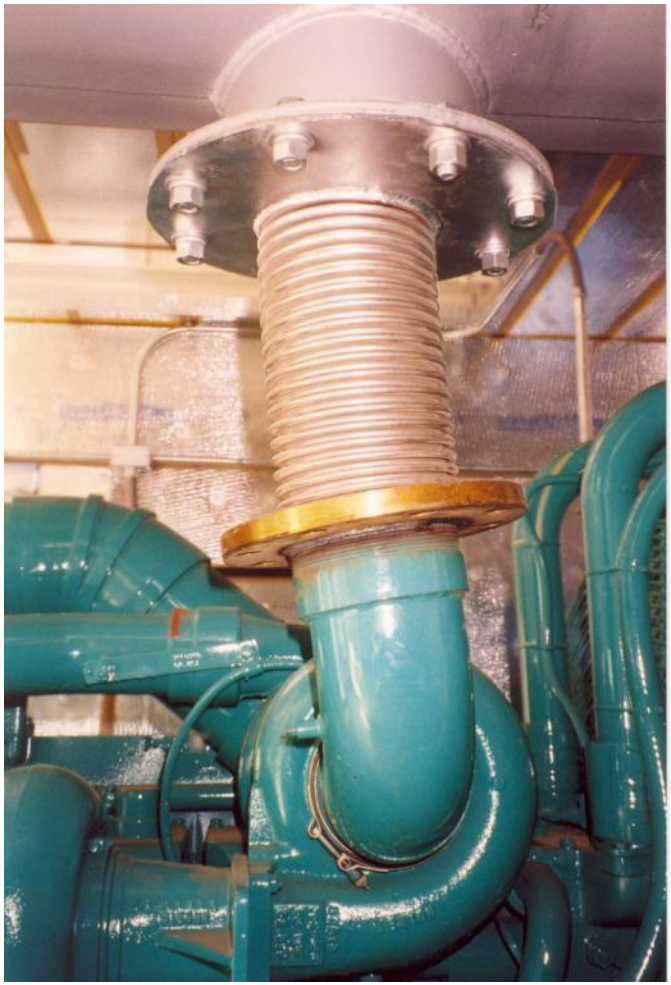
Installation Review #7 : Exhaust Systems

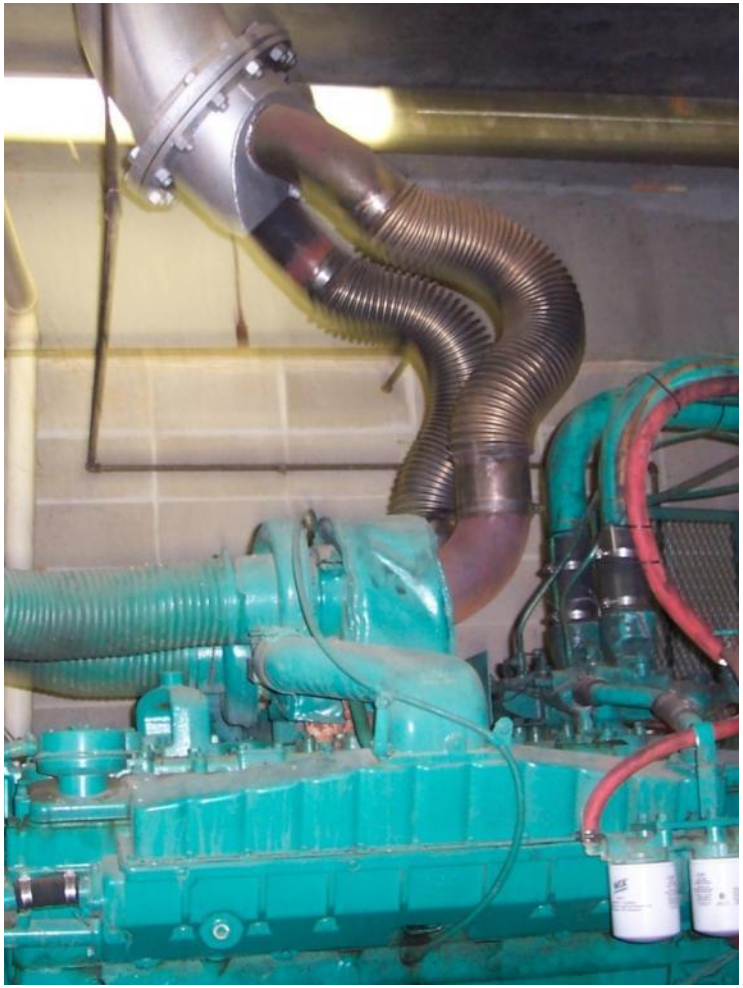
This flex tubing lasted 10 minutes.



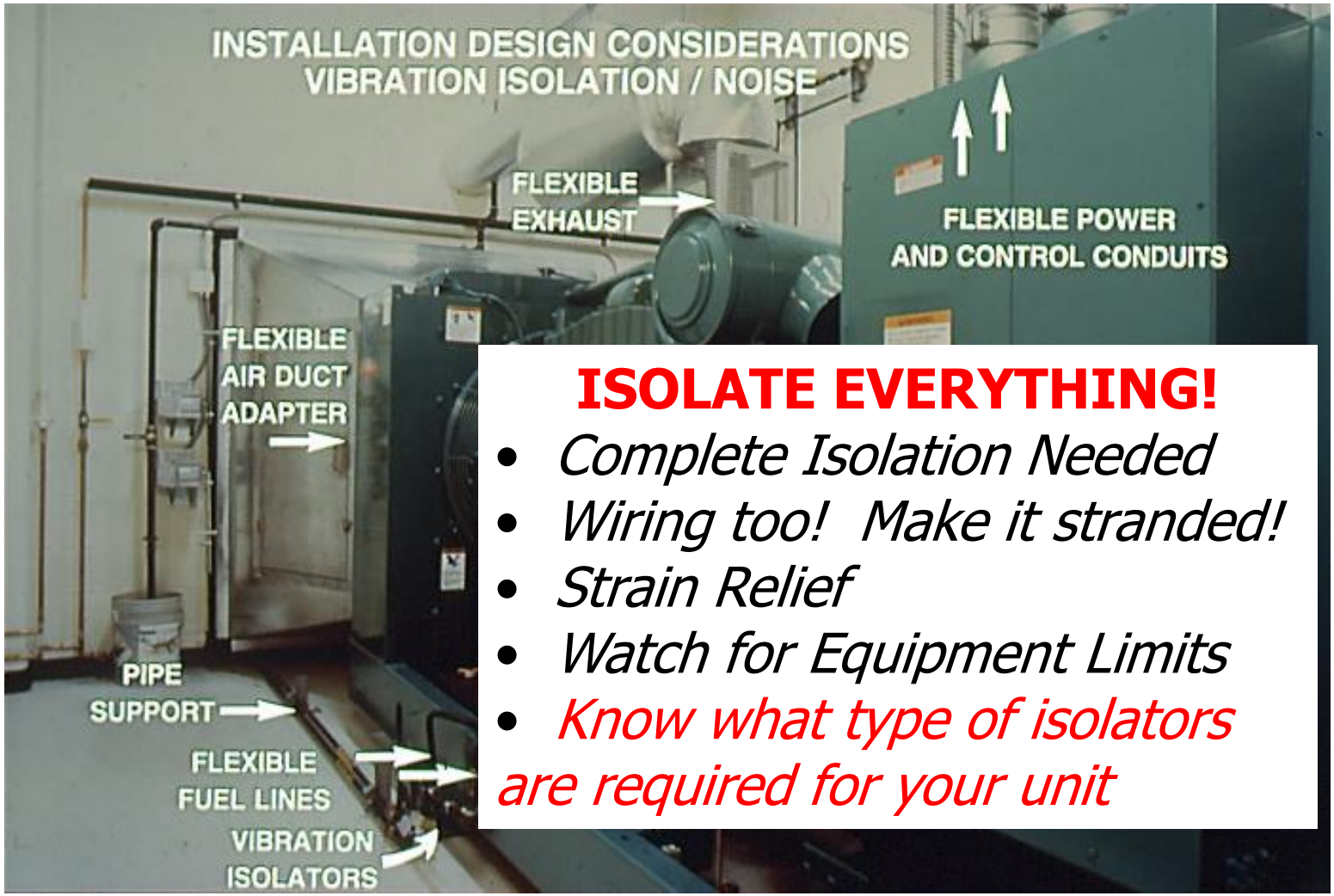

Onan QuietSite II

Installation Review #8 : Exhaust Flex





Vibration Isolation

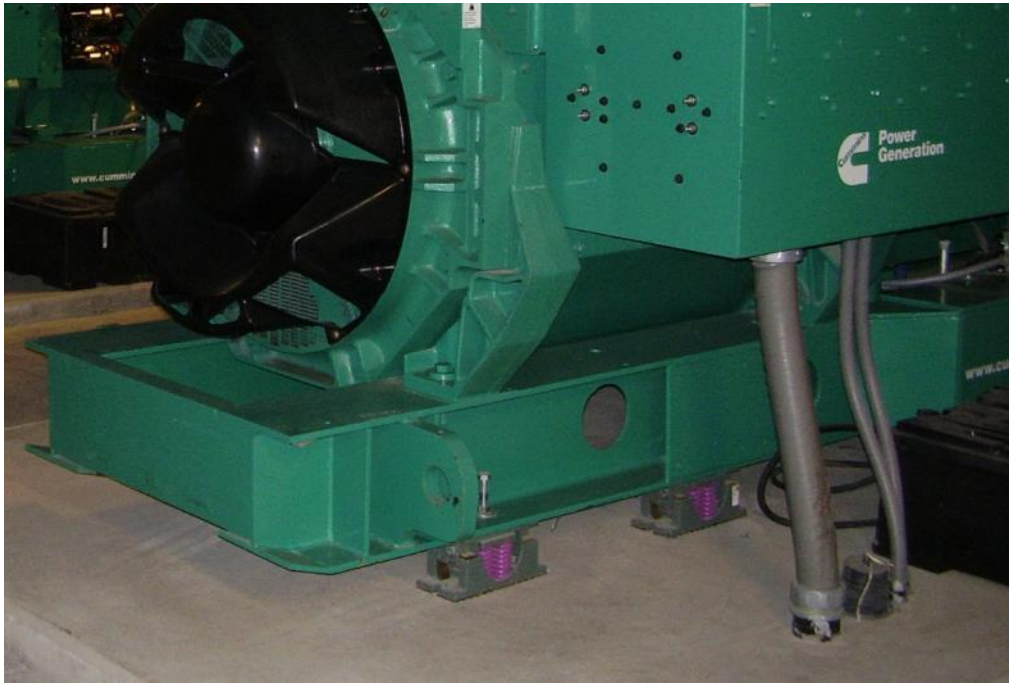


ISOLATE EVERYTHING!

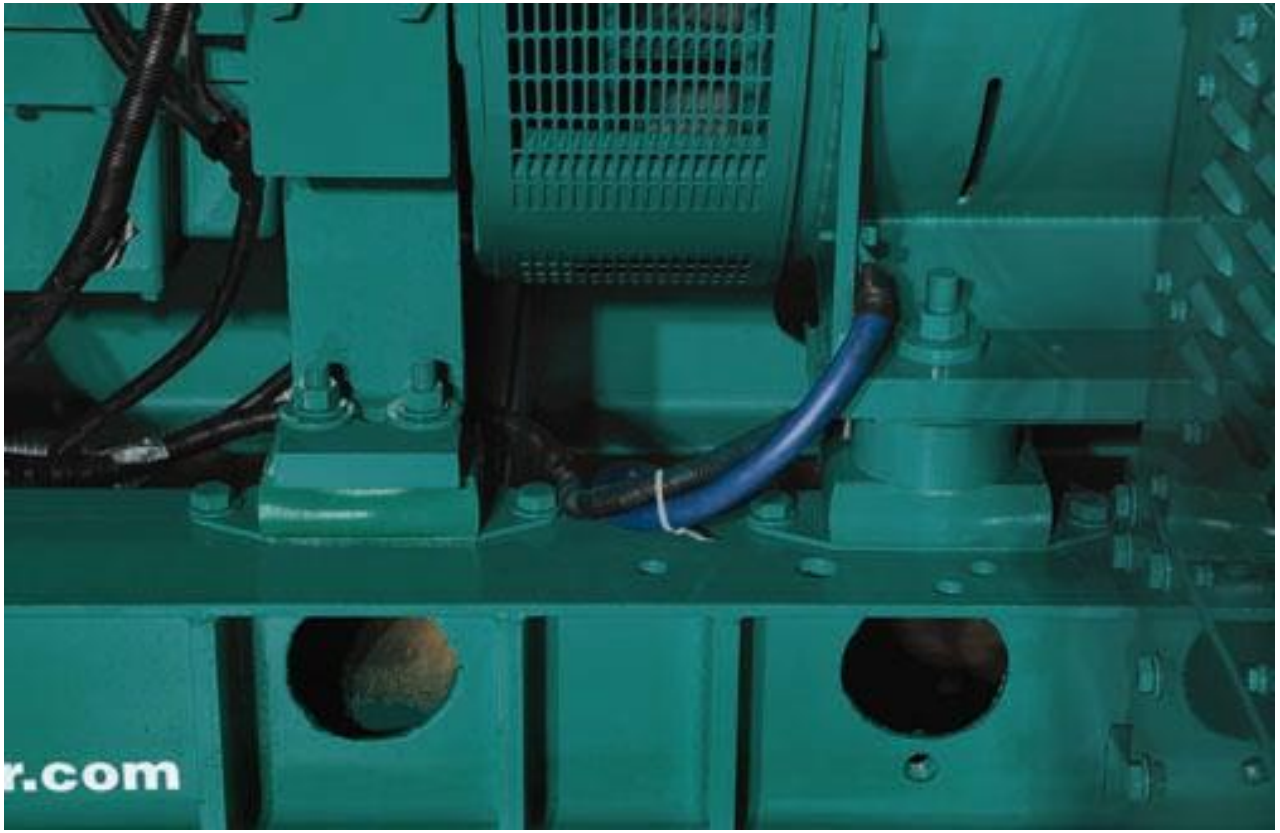
- *Complete Isolation Needed*
- *Wiring too! Make it stranded!*
- *Strain Relief*
- *Watch for Equipment Limits*
- *Know what type of isolators are required for your unit*

Genset Vibration Isolators – Under Skid

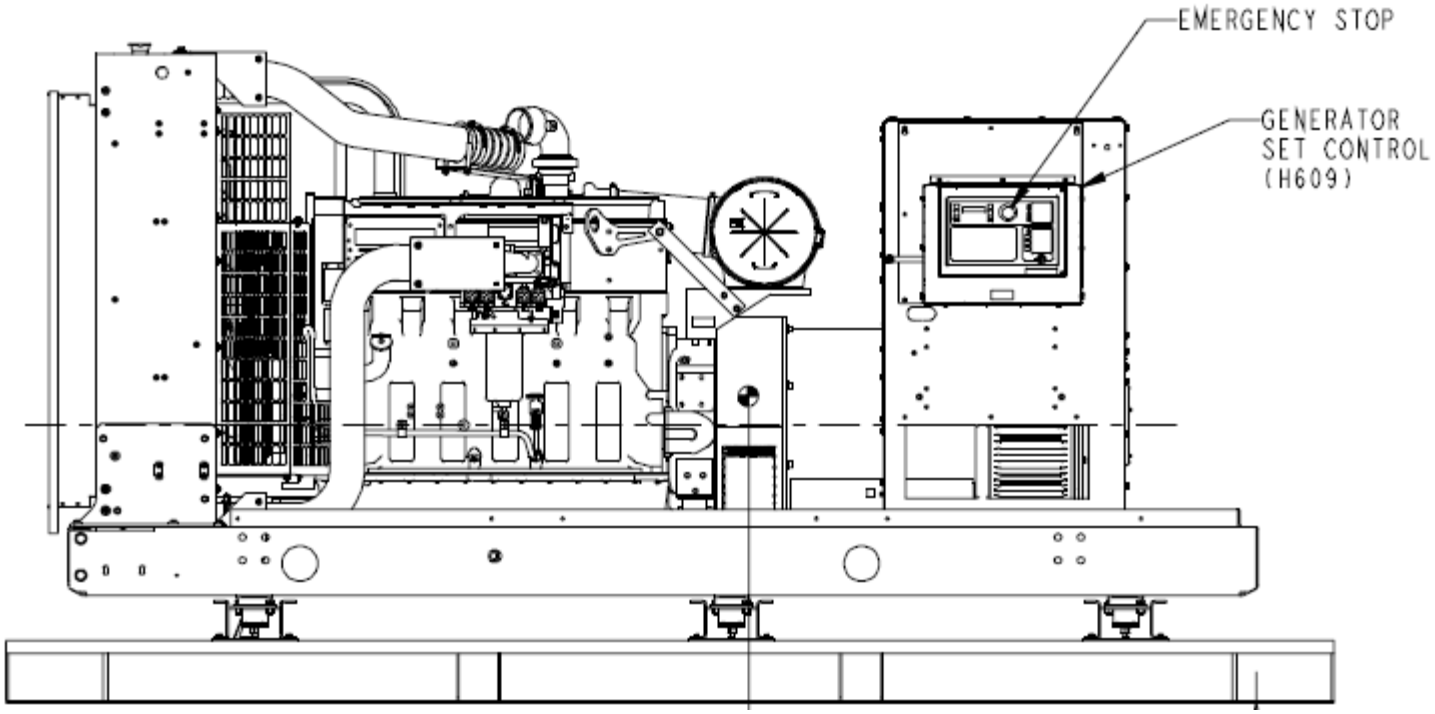
- Genset is rigidly mounted to frame
- Must provide vibration isolators below skid



Genset Vibration Isolators – In Skid

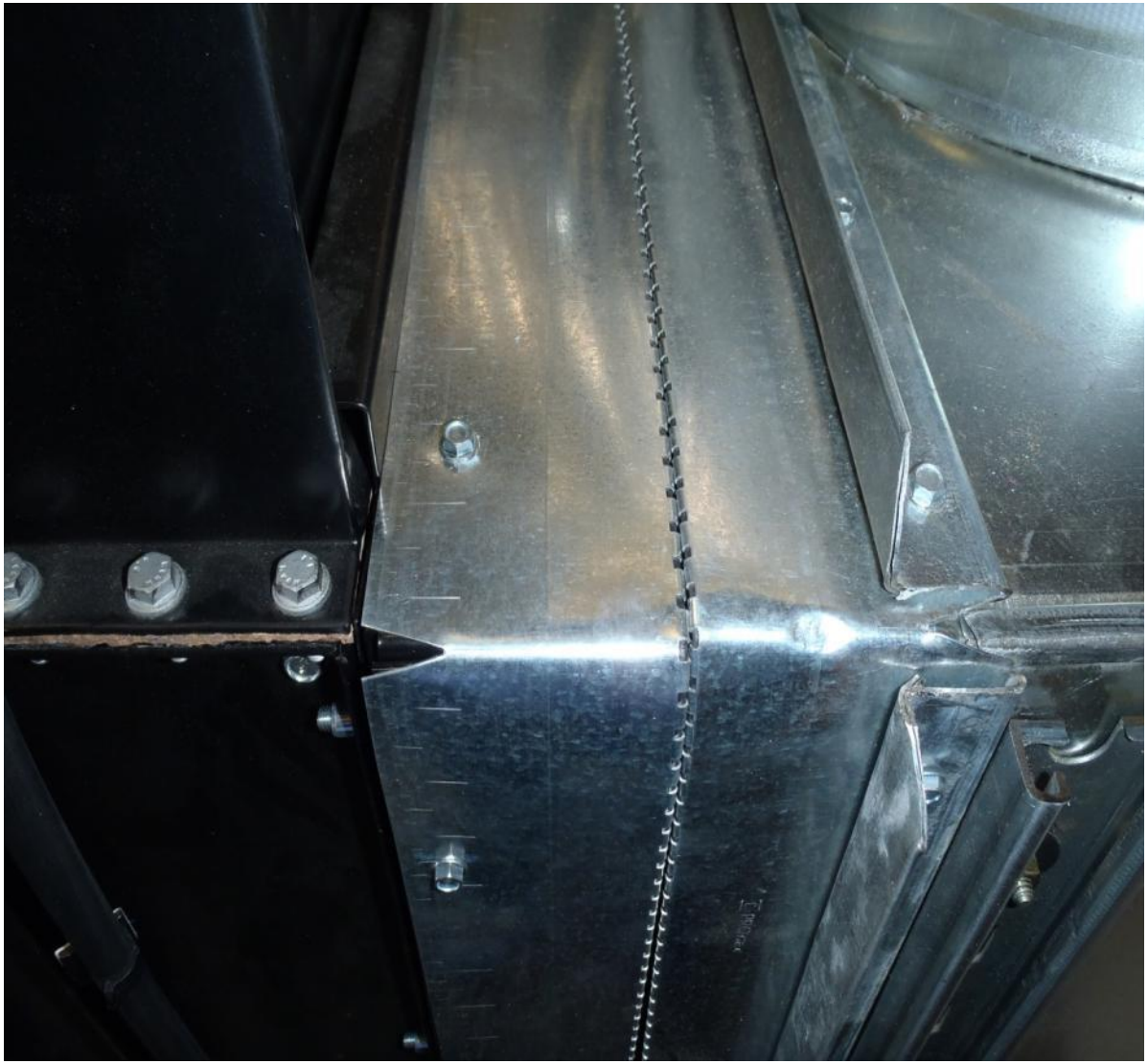


Genset Vibrations Isolators – Tank Mounted Units



Installation Review #9 : Conduit Tolerance

Why bother with ductwork?



Fuel Systems

Why Gas?

- Fewer fuel storage concerns
- May not be suitable for emergency without on-site fuel
- Easier cold starting
- Service requirements, particularly for large NG sets

Why Diesel?

- Not as dependent on outside fuel source
- Fast starting with proper fuels
- Long life
- Usually better transient performance
- Usually better frequency stability

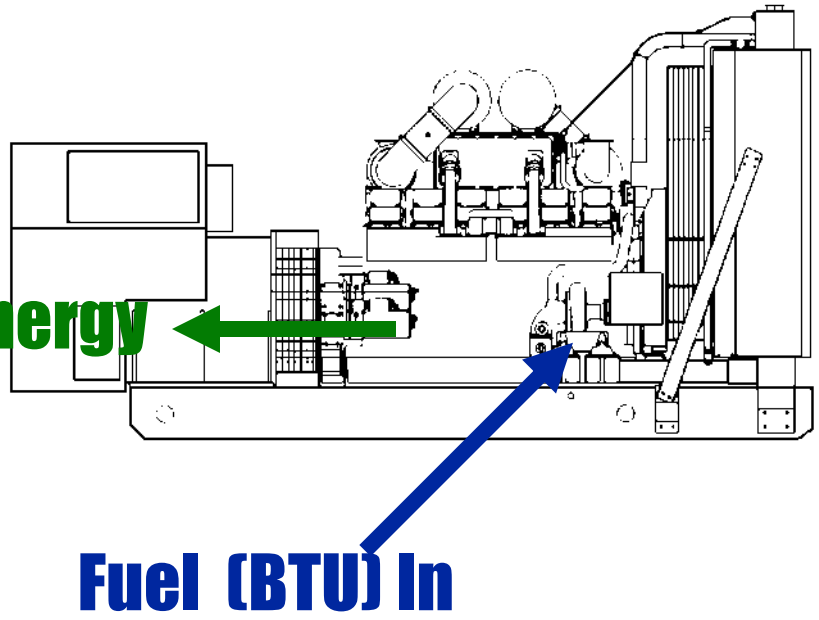
Rules of Thumb: Fuel Energy

- Diesel: 140,000 BTU's/Gallon
- Natural Gas: 1000 BTU's/Ft ^{3}
  (HHV vs. LHV)
- LP Vapor: 2500 BTU's/Ft ^{3}
- LP Liquid: 36.5 Ft ^{3}/Gallon
- *For continuous duty applications, cost/BTU of fuel may be an evaluation point.*

Diesel Fuel Systems

- Reliable fuel supply depends on:
  - no air in fuel
  - fuel temperature
  - proper volume delivered to engine
  - fuel quality
- System Design Greatly Affected by Local Codes and Interpretation
- System Design Should Meet NFPA 37

Estimating Diesel Fuel Consumption



- (kW)*(57) ⇨ BTU/Min
- Assume 140,000 Btu/Gal diesel fuel, and 35% overall efficiency

Rule of Thumb:
Multiply the standby KW times .07…
that's the fuel consumption (gph)

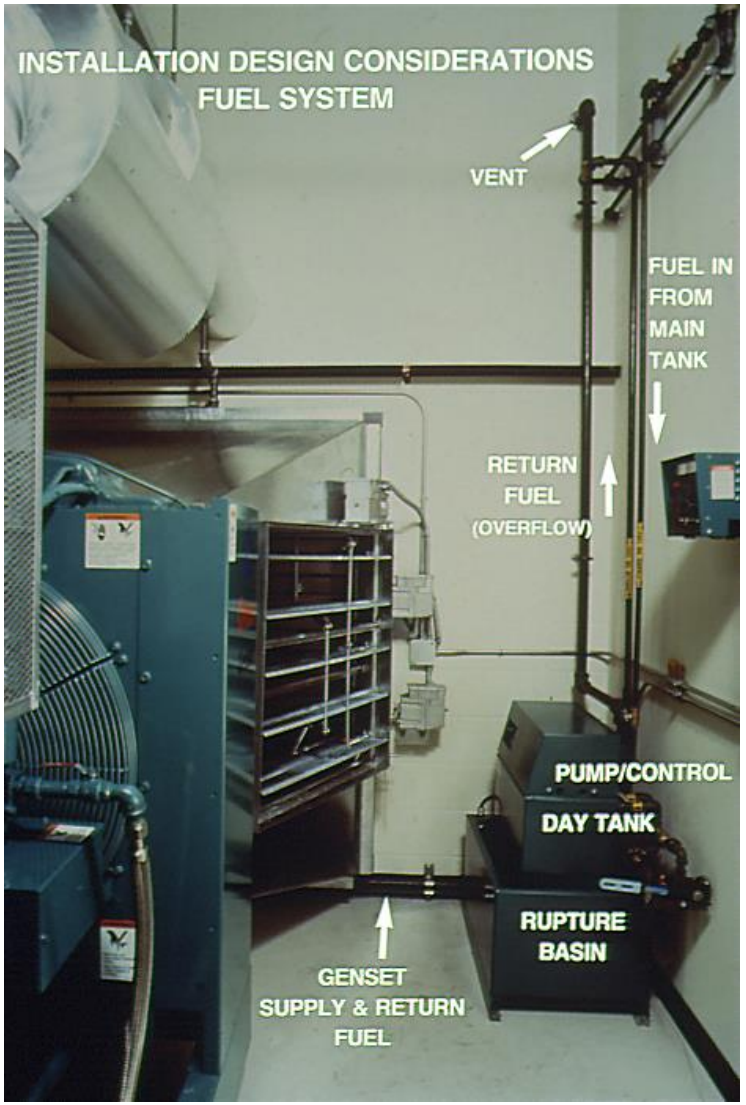
What Size Fuel Tank?

- Decision based on:
  - GenSet Fuel Consumption
  - Application Type
  - Expected Duration of Outage
  - Priority and time to Re-Fuel
- Recommendations
  - Roll-over fuel 2 times per year
  - If this is not possible, plan for Fuel Maintenance


FUEL

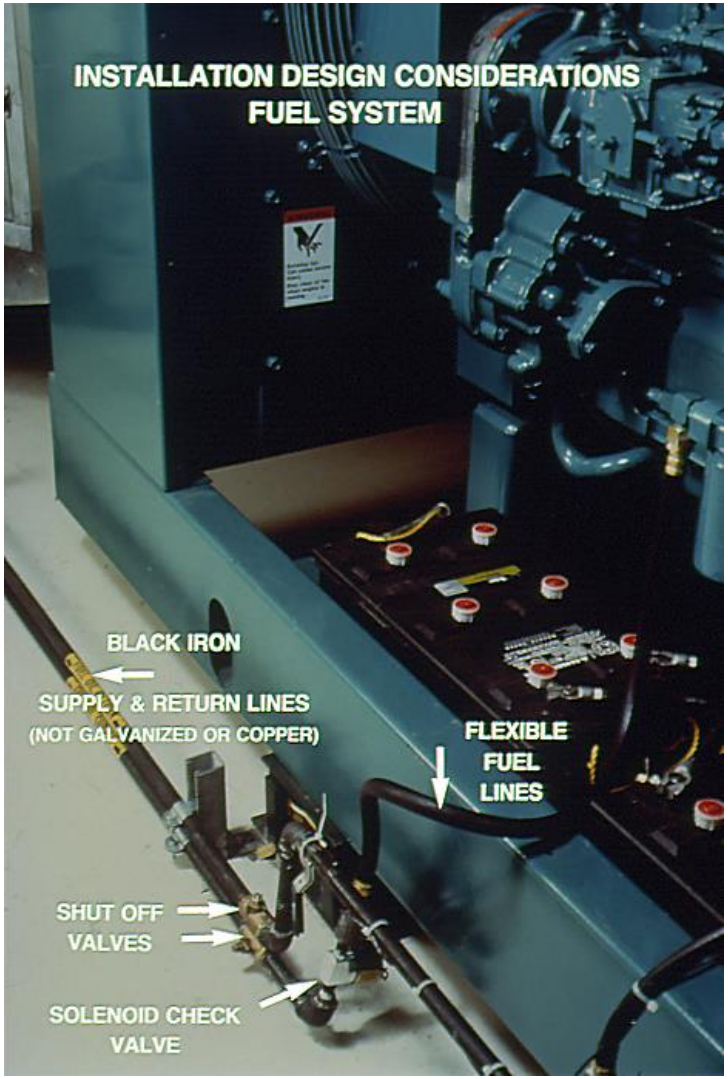
Typical Fuel System Notes

- Requires Supply and Return Lines for Both Day Tank & Engine
- Lines all “Down Hill”
- Vent Required
- Filling Provisions?
- Rupture Basin?
- Fire Suppression Requirements?
- Fuel heating?



Requirements for Fuel Systems

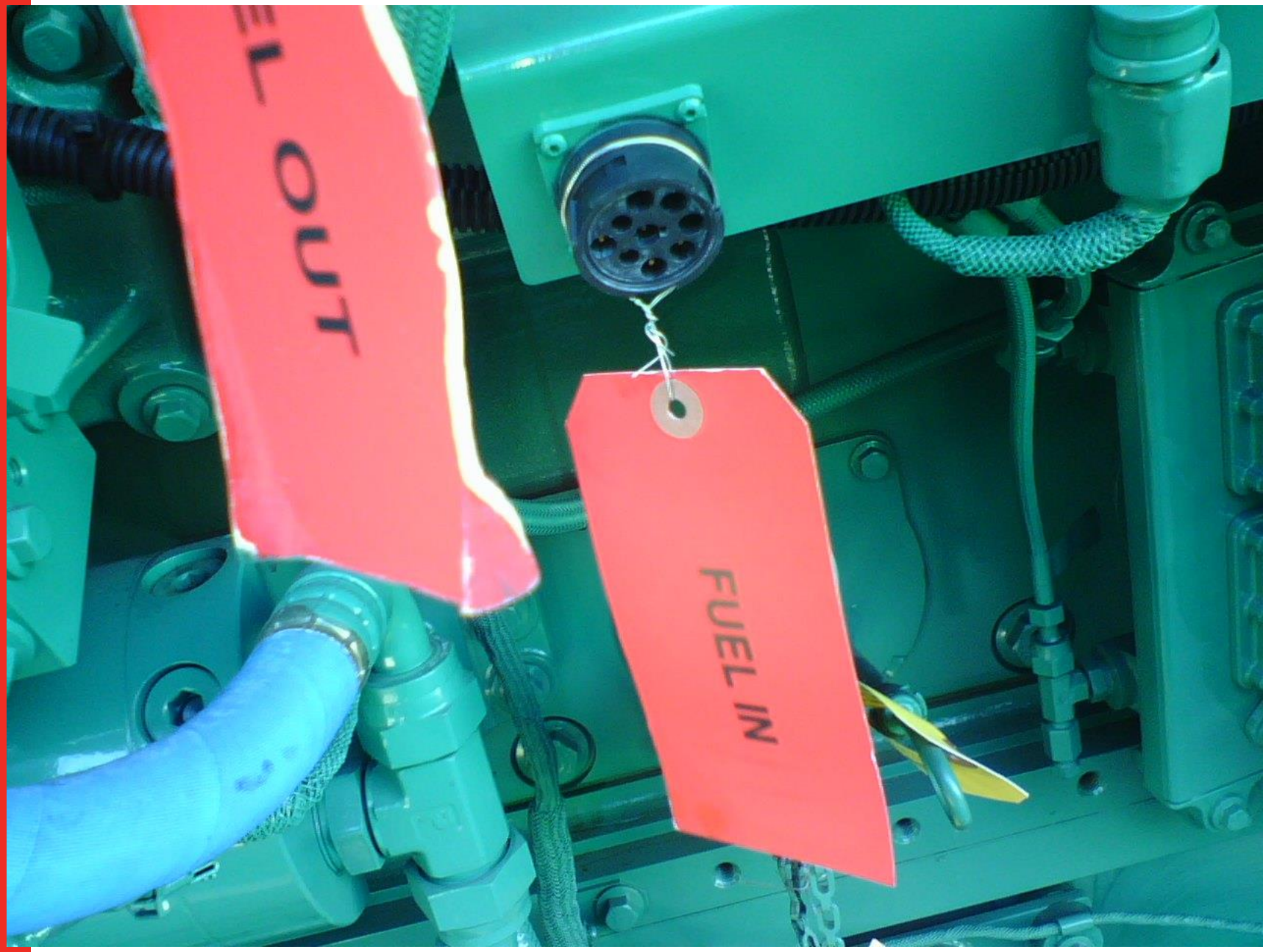
- Engine Capabilities
  - liftability
  - flow
  - return
  - cooling
- Piping Type - Black Iron
- Size Lines for FLOW, Not Consumption
- Isolation, Check Valves
- Flex Lines



Fuel Tank Type & Location

- When do I need a day (transfer) tank?
  - Bottom of main tank more than 6 feet below engine
  - Main tank more than 4-14 feet above fuel return
  - Fuel Codes Limit Fuel in Room
  - Dynamic Head More Than Pump Can Pull
    - too many bends and turns in lines
  - Return Line too High

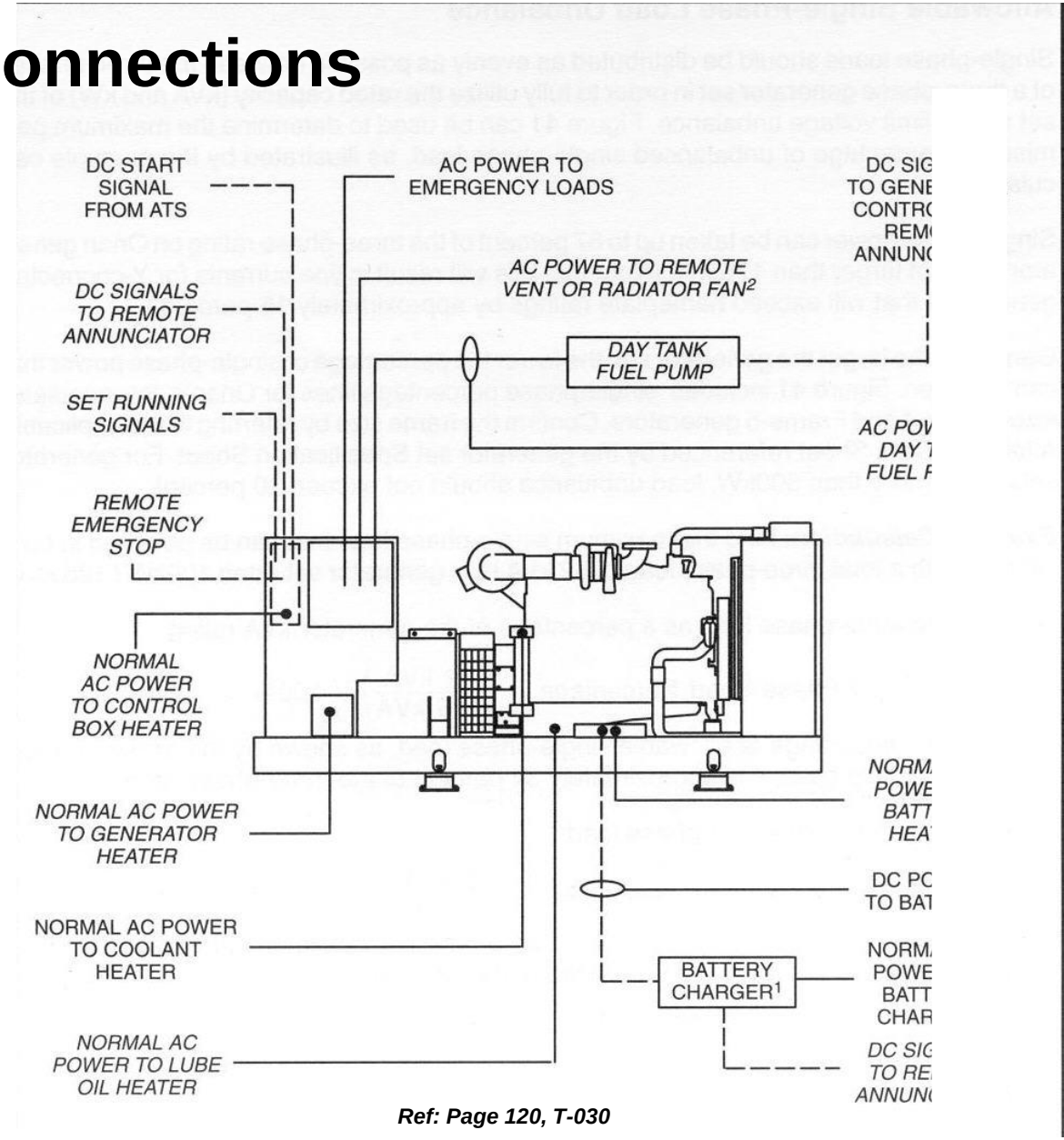
Day Tanks are Usually a Good Idea.


EL OUT
FUEL IN

A few words about practicality…

Electrical Interconnections

- Each installation different
- Ampacity of Supply Circuit is GenSet Specific
- Note Some Circuits Fed by GenSet, others by Utility

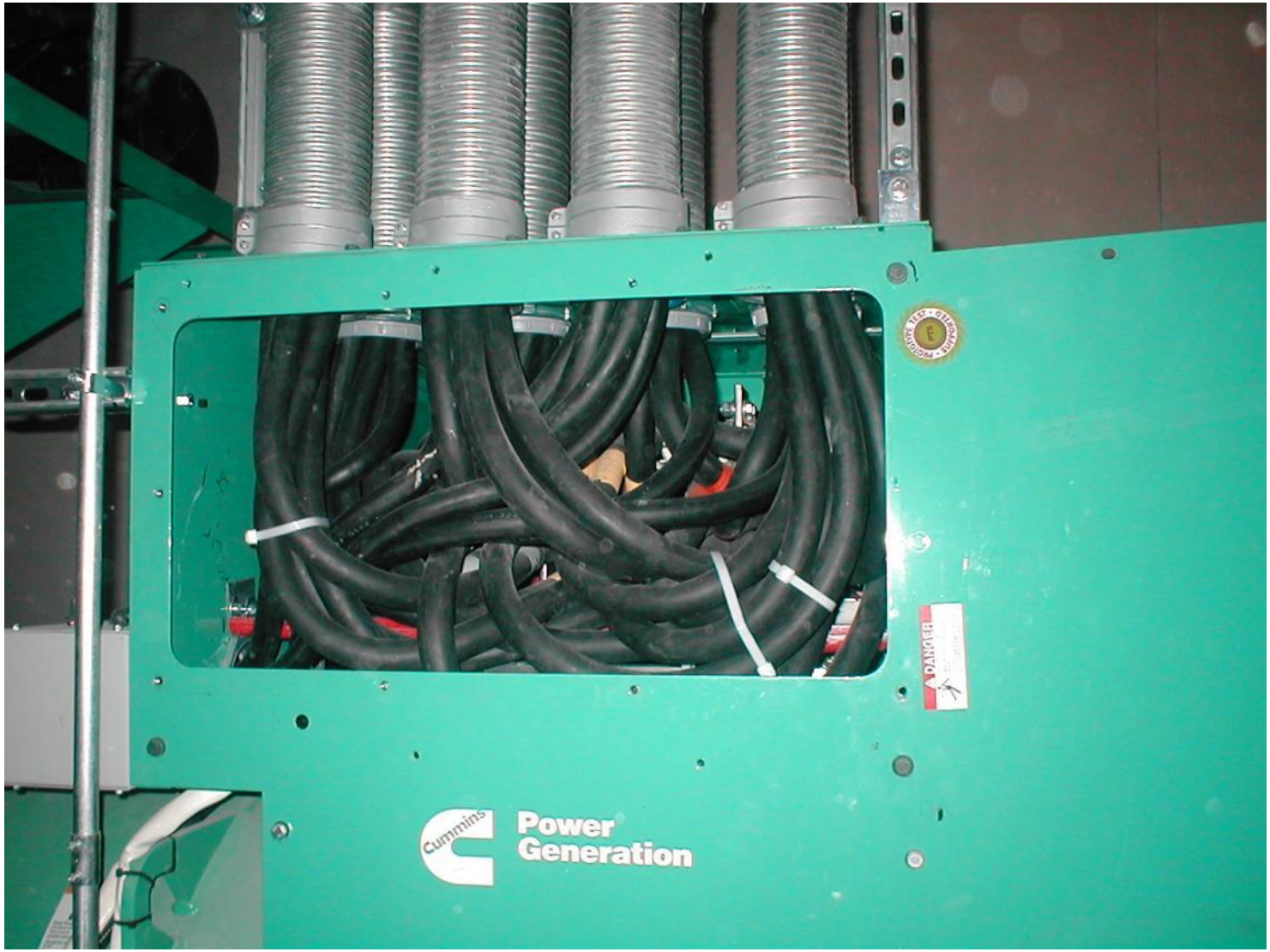


Ref: Page 120, T-030

Electrical Design Notes

Don’t Forget:

- Vibration Isolation
  - Piping supported by building, NOT genset
- Utility (or ATS) power supplies for heaters, vent fans, chargers
- Genset supply for dampers, fuel pumps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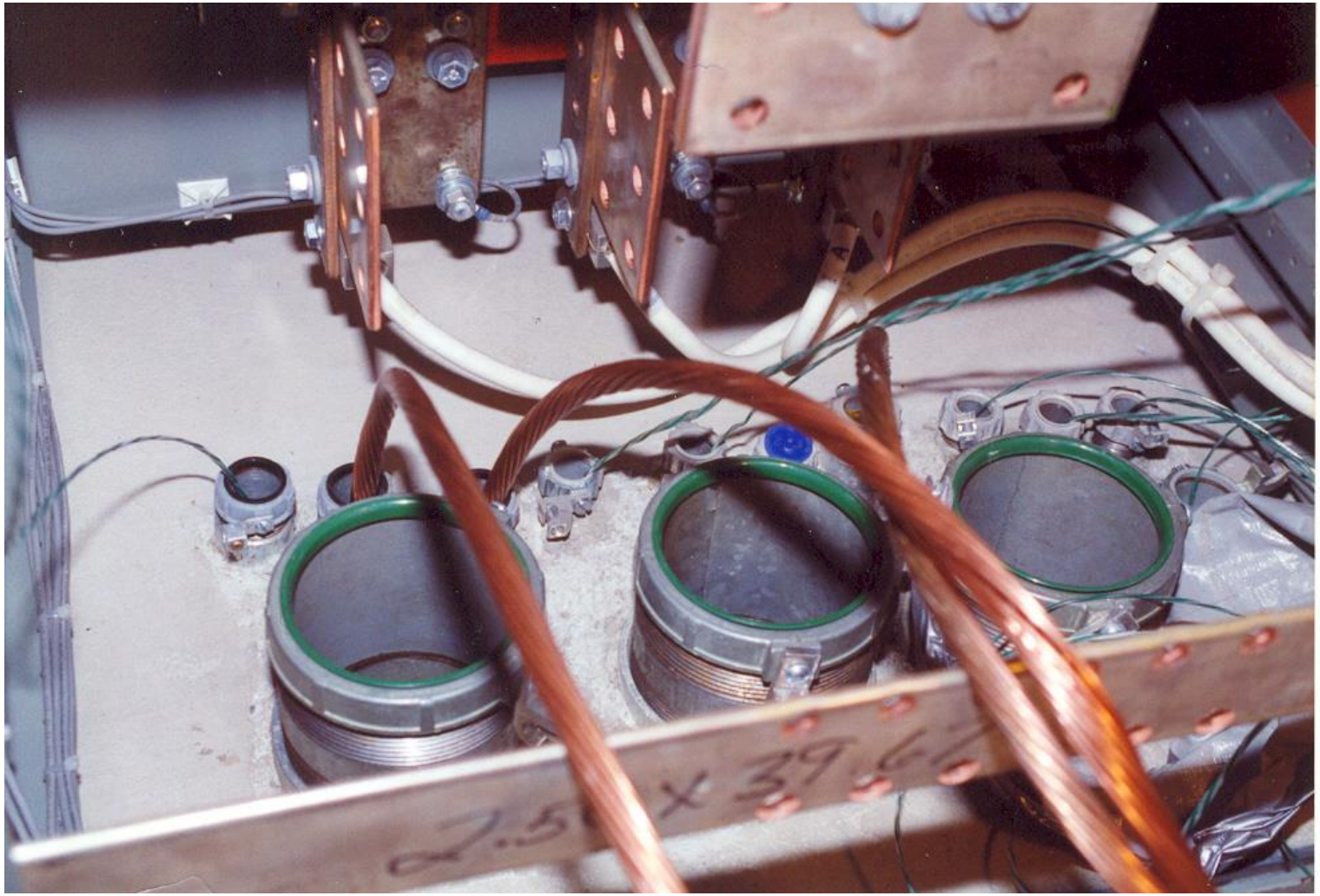
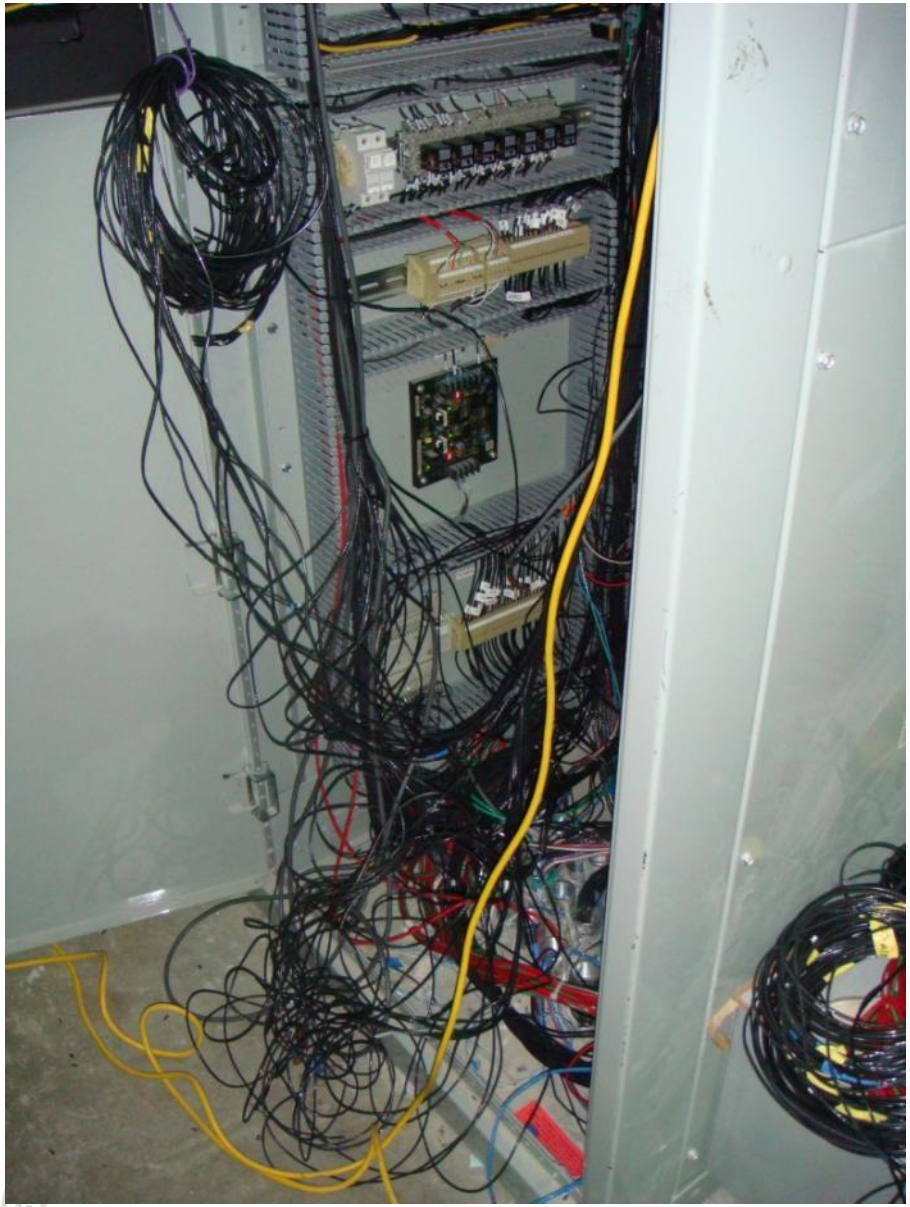
Easy one for electrical guys...

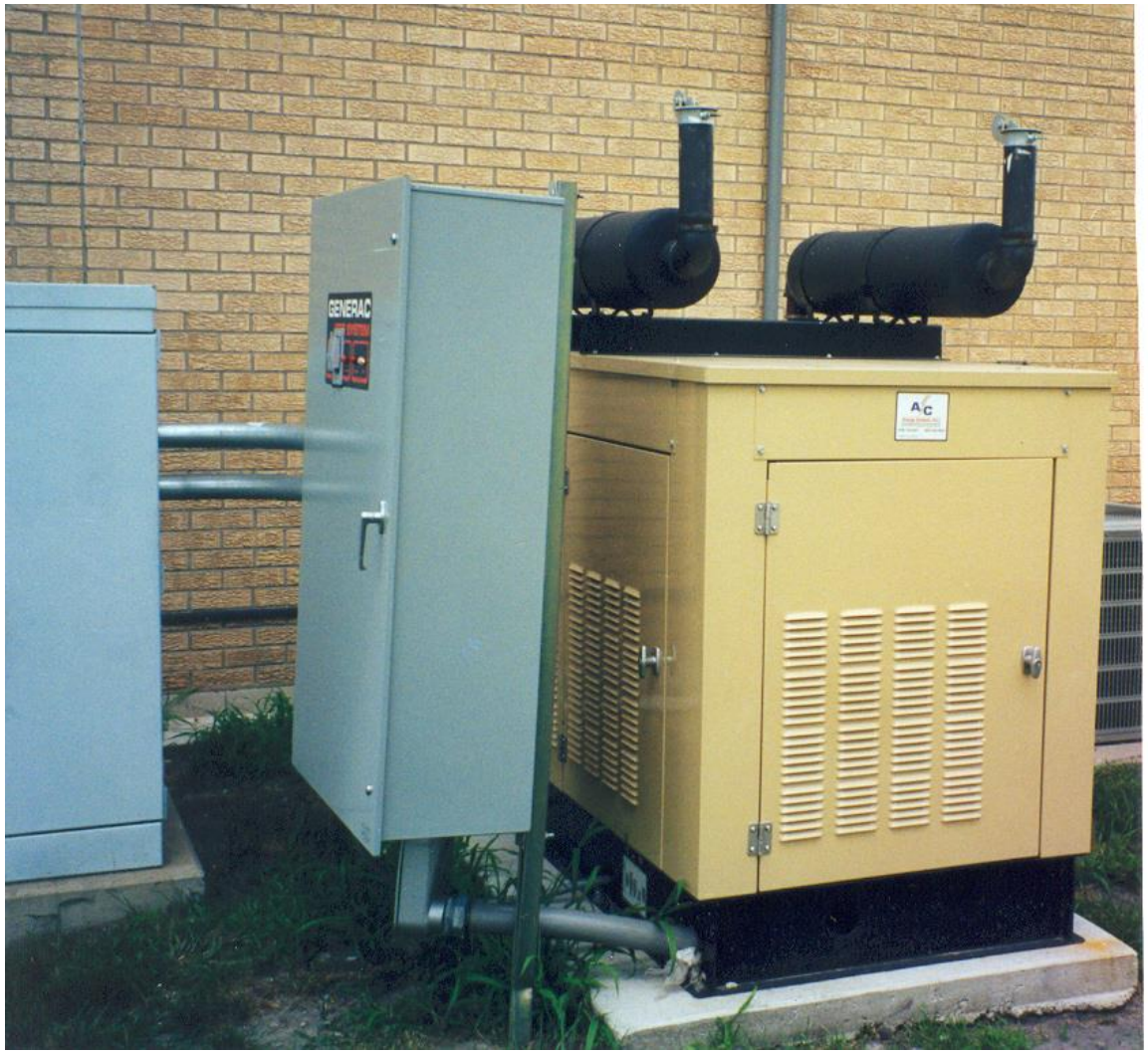


I was just speechless.




HOT

Final Exam



Commissioning

- Installation Review
  - “5 big groups”
  - Check List
- Initial Starting and Adjustment
- Site Test
  - usually resistive load
  - test with real loads
  - power failure test

Electrical Design Notes

Rule of Thumb:
***Green generators work better than any other color*.**

Questions?

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A brief introduction for the electrical at heart.