Agenda

- Emergency Backup Components
- Maintenance Programs
- Load Banking
- NFPA Standards
- Fluid Testing & Analysis
- Maintenance-Beyond the Basics
Emergency Backup Components

- Automatic Transfer Switch
- Generator
- Engine
- Lubrication System
- Cooling System
- Fluid System
- DC Electrical System
- Exhaust System
Transfer Switch Components

**Transfer Switch:**
A transfer switch is an electrical device for switching loads between alternate power sources. An automatic transfer switch monitors the condition of the sources and connects the load to the alternate source if the preferred source fails.
Sequence of Operations

- Utility Fails
- Generator Starts – Load Transfers
- Utility Returns – Transfers Back
- Engine Cools Down
- Generator Shuts Off
TIME DELAYS

- Time Delay Engine Start (TDES)
  - 0-6 SECONDS
- Time Delay Normal to Emergency (TDNE)
  - 0.0 TO 60 seconds
- Time Delay Emergency to Normal (TDEN)
  - 1 TO 60 MINUTES – “My generator is still Running!”
Maintenance of ATS

- Automatic Transfer Switch (ATS)
  - Physical Inspection
  - Performance Test
    - (Engine Start Test / Minimum Option)
  - Utility Failure Simulation
    - (Full System Test / Best Option)
Arc Flash is the result of a rapid release of energy due to an arcing fault between a phase bus bar and another phase bus bar, neutral or a ground. During an arc fault the air is the conductor.
ARC FLASH and OSHA

- Compliance with OSHA involves adherence to a six-point plan:
  - A facility must provide, and be able to demonstrate, a safety program with defined responsibilities.
  - Calculations for the degree of arc flash hazard.
  - Correct personal protective equipment (PPE) for workers.
  - Training for workers on the hazards of arc flash.
  - Appropriate tools for safe working.
  - Warning labels on equipment. Note that the labels are provided by the equipment owners, not the manufacturers.
RISK FACTOR of ARC FLASH

- Property Damage
- Injury to Personnel
- Loss of Life
Diesel generators are the workhorse of the power generator industry. Most diesel generators are designed for a more permanent installation. They are longer lasting and more robust in construction but more expensive to repair.
Maintenance Points

- AC Generator
  - Physical Condition
  - Instrumentation
  - Performance Test
    - Building Load
    - No Load
Maintenance Points

- Engine
  - Lube System
  - Cooling System
  - Air System
  - Fuel System
  - Electrical System
  - Instrumentation
  - Protection System
  - Exhaust System
What does my engine oil actually do?

Primarily it stops all the metal surfaces in your engine from grinding together and tearing themselves apart from friction.

Change oil and filters every 200-250 hours or annually. Oil breaks down over time due to high temperatures and infrequent maintenance.
Lubrication - Areas of Concern

- External Oil leaks
- Oil level on dipstick
  - Low Importance, larger engines can consume up to 12 quarts in a 10 hour period.
  - High Importance,
    - Coolant in oil
    - Fuel in oil
Cooling System

- Major Components
  - Engine Block
  - Water Pump
  - Radiator
  - Thermostat
  - Block heater
  - Belts
  - Hoses
  - Fan
Coolant - Areas of Concern

- External coolant leaks
- Belt condition-cracked or loose
- Block heater – on constantly or leaking
- Hoses – leaking, soft, brittle, bulging
- Radiator – Leaking, plugged, broken fan shroud
Plugged External Core
Leaking Radiator Seam
Prevent Radiator Damage By:

- USE PROPER COOLANTS with INHIBITORS IF NOT THE RESULT WILL BE:
  - Clogged Internal Radiator Cores
  - Pitted cylinder Liners (Engine)
Fuel System - Areas of Concern

- Fuel System
  - Check for leaks.
    - Floor of enclosure
    - Side, front, rear of engine
    - Piping seeping
  - Day Tank
    - Check for leaks
    - Motor operations
  - Fuel tank level
    - 1/2 or more
  - Cracked or hardened fuel lines.
DC Electrical - Areas of Concern

- Battery Charger - voltage and amperage
- Condition of batteries - Change every 24-36mths
- Wiring - connections
- D/C Alternator – Belts, connections
Security System - Areas of Concern

- Engine Controller
  - Check alarm status - Low fuel, oil, voltage
  - Check engine instrumentation
  - Check A/C generator instrumentation
    - No amp load if generator is not transferred
Air System - Areas of Concern

- Air System
  - Dirty air filters
    - Check indicators
    - Air filter replacement recommended every five years.
  - Check hoses, clamps, piping
  - Check charge air cooler hoses, clamps, piping
    - Piping comes from turbo to radiator to intake of engine.
Exhaust System – Areas of Concern

- Silencer – rust, leaks, broken brackets
- Rain cap – opens and closes properly
- Piping, tailpipe – leaks, broken brackets
- Turbo- leaking exhaust or oil
- Crank Case Breathers-oil over generator
Wet Stacking

- What is it?
  - **Wet stacking** is a condition in diesel engines in which not all the fuel is burned and passes on into the exhaust side of the turbocharger and on into the exhaust system.

- What it causes?
  - Wet stacking not only reduces the operating performance of the gensets, it also creates a significant fire hazard.
  - What causes it?
  - the diesel engine is running at only a small percentage of its capacity 40-70%
Wet Stacking
Load Bank Testing

- What is a Load Bank?
  - Simulates utility failure without taking building off grid
- Why are they needed? (benefits)
  - Satisfy requirements of NFPA 110
  - Remove carbon build-up
  - Reseats the piston rings reducing crankcase vapors and pressure
  - Tests adequate room ventilation and cooling system efficiency.
Load Bank Testing

→ Tests the power system without interruption to the critical loads.
→ Assures performance at full load capacity.
→ Determines engine and generator problems before expensive failures.
Load Bank Testing
NFPA 110 Generator Classifications

- **Level 1**
  - Failure of the equipment to perform could result in the loss of human life or serious injuries.

- **Level 2**
  - Failure of the equipment to perform is less critical to human life and safety and where the authority having jurisdiction shall permit a higher degree of flexibility than that provided by a Level 1 system.
NFPA 110 Recommendations

- ALL LEVEL 1 AND LEVEL 2 GENERATORS NEED TO BE LOAD BANKED FOR 4 HOURS EVERY 3RD YEAR
  - 80% OF NAME PLATE RATING FOR 4 HOURS
NFPA Compliance Inspectors

- State Health Inspectors – Level 1
- State Fire Marshal – Level 1 and 2
NFPA 110 Recommendations

- Exercise monthly for 30 minutes
  - Loading that maintains a minimum exhaust gas temperature as recommended by manufacturer.
  - Under operating conditions and not less than 30% of nameplate rating.
  - If above can not be achieved then run until oil pressure and water temperature have stabilized but less than 30 minutes.
Beyond the Basics

- Laboratory-Fluid Analysis
- Change coolant every 3-5 years
- Change air filters every 5-7 years
- Change batteries every 3 years (NFPA 110)
- Thermographic Predictive Maintenance (recommended by NFPA)
Fluid Analysis Programs

- **Types**
  - Oil
  - Coolant
  - Fuel

- **Benefits**
  - Determine engine and generator problems before expensive failures.
Analysis Program Benefits

- Oil Analysis
  - Tracks history
  - Indicates wear metals and contents in PPM
  - Indicates fuel dilution
  - Indicates glycol dilution
  - Recommends corrective measures to be taken
Analysis Program Benefits

- Coolant Analysis
  - Tracks history
  - Indicates freezing point of coolant
  - Indicates wear metals and contents in PPM
  - Indicates conductivity ability of coolant
  - Indicates Nitrite levels
  - Recommends corrective measures to be taken
Analysis Program Benefits

- Fuel Analysis
  - Tracks history
  - Indicates stability
  - Indicates bacteria count - #1 cause of engine break down
  - Indicates Cetane content
  - Recommends corrective measures to be taken
Bacteria in the Diesel

- Diesel is an organic fuel.
- Bacteria infect systems and form bio-films on steel surfaces. Accelerated corrosion occurs wherever the bio-film settles.
- Microscopic in size, they can develop into a mat easily visible to the naked eye very quickly. A single cell, weighing only one millionth of a gram can grow to a biomass of 10 kilograms in just 12 hours, resulting in a biomass several centimeters thick across the fuel/water interface.
- Once contaminated diesel enters the fuel system, it is very difficult to eradicate.
Thermographic Predictive Maintenance

- Before an electrical component burns up, it heats up.
- Infrared Thermographs finds the problems early in the failure cycle. Early detection allows maintenance personnel to take corrective action before a component fails, minimizing damage to the component, reducing repair costs, eliminating production losses, preventing safety hazards and saving energy.
The Benefits of Thermal Imaging

- Determines if the components and system have been properly installed and are not damaged
- Reduces downtime
- Reduces risk of equipment failure
- Increases safety
- Improves insurability
- Improves system performance
- Determines whether components and systems operate properly and meet the design intent
- Saves money
Detecting the Unseen
Actual image from Ohio State University Project
Data Center Thermal Mapping
Questions?