IEEE Central Tennessee

PARALLELING SWITCHGEAR

ONBOARD VS TRADITIONAL
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Objective for today's meeting:

To examine the latest technology in paralleling controls and discuss the pros and cons of each.
Overview

1. Why Parallel
2. Traditional Paralleling
3. On-Board Paralleling
4. Paralleling Best Practices
Why Parallel
Why Parallel

Paralleling

• Synchronous operation of two or more generator sets connected together on a common bus in order to provide power to common loads.
Why Parallel?

RELIABILITY:
- Continue operation if one Genset fails.
  - One large Genset failure/being serviced - entire facility is at risk.
- Utilize all available sources.
  - Many facilities have Gensets scattered from building to building without being paralleled.
  - If the Genset for life safety/Critical loads fails, cannot utilize other Gensets on campus.

REDUNDANCY:
- Redundancy required for most mission critical facilities.
  - Remove/Reduce single sources of failure.
  - Required for Tier 2+ data centers.
Why Parallel?

Legend:
ATS - Automatic Transfer Switch
EM - Emergency Load
EG - Emergency or Standby Engine Generator Set
PL - Peak Shaving Loads
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Why Parallel?

**FLEXIBILITY:**
- Using multiple units in parallel offers greater flexibility than a single unit (smaller units on a roof).
- Can share load or run on intervals.
  (which prolongs engine life and reduces maintenance costs)

**EXPANDABILITY:**
- Consider future needs and leave room for expansion.

**EASE OF MAINTENANCE AND SERVICIBILITY:**
- Can service/maintain one Genset while second Genset remains in standby.
Paralleling Switchgear Types

- Low Voltage (600V class)/Medium Voltage (5kV-15kV class) switchgear.
- Indoor (NEMA1) / Outdoor (NEMA 3R).
- Other (DO/FM Breakers, Closed Transition, Differential Protection).
Nine (9) Common Configurations
On-board vs Traditional Paralleling Switchgear

On-board Paralleling

Traditional Paralleling
Traditional Switchgear
Paralleling Control: 1 per genset

Control Equipment

Master Control: 1 per system

Distribution Equipment

Breaker
Traditional paralleling
Traditional paralleling

Engineered to Order
UL891 Switchboard
» Up to 600V
» Up to 8000 Amp Bus

UL1558 Switchgear
» Up to 600V
» Up to 10000 Amp Bus

UL Listed Medium Voltage
» Up to 27 kV
» 1200 to 4000 Amp Bus
Traditional paralleling

**BENEFITS**
- All controls for Gensets, breakers, utilities, protections in one place.
- When sequence of operations is more complex.
- Can accommodate custom configurations or solutions.
- More than a one utility paralleling.

**DRAWBACKS**
- Maybe single source of failure due to control wiring.
- Larger footprint.
- More $. 

![Diagram of traditional paralleling system]
On-Board Paralleling
On-Board Paralleling

- Move the Genset paralleling from switchboard/switchgear to on-board the Genset
- Electrically operated breakers can be mounted on the Gensets or in the switchgear/switchboard.
- Master control panel enables user to monitor system. Master also allows for load add/shed and Genset management
On-Board Paralleling Components

• On-Board Paralleling Control
  – First on logic
  – Synchronizer
  – Load / unload
  – Protective relays

• Distribution Switchboards
  – Common Bus
  – Breakers

• Master Control Panel
  – Generator management
  – Load management
  – Metering
  – History
Let’s explore a Sequence of Operation to see how the integrated pieces work together:

- When the Utility fails, the transfer switches signal the master of the outage. The master immediately communicates to each on-board genset controller to start up.

- The Genset on-board Paralleling Controllers communicate to each other and proceed with their first on logic to get the first unit online as quick as possible.

- First on logic and Random Access paralleling continues as the On-board control synchronizes and parallels all available gensets to the paralleling switchboard.
On-Board Paralleling

Sequence of Operation (Continued...)

• When the first generator set comes online, the Priority one ATS immediately transfers position to emergency

• As more generators come online, the (MCP) master control panel sees them and Add Loads per the pre-programmed priority for each ATS.

• After all generators are online and the system has stabilized, the MCP will monitor the total capacity using Generator Management to determine if the system can be optimized.

• Generator management is based on KW demand of the load. The set points are adjustable.
On-Board Paralleling

Sequence of Operation (Continued...)

- The MCP is constantly monitoring to ensure the system is stable. In the event of an overload, the system will Load Shed per the pre-programmed settings in Load Management.

- Upon return of Utility, the transfer switches signal the MCP which then removes the remote start contacts.

- The load is transferred back to Utility and the generators go into cool down, waiting vigilantly for the next outage.

- This can also all be done manually from either the MCP or Genset mounted Controllers.
On-Board Paralleling

Benefits of on-board paralleling
• Smaller footprint (No Genset control sections)
• Lower cost
• Smaller impact if interconnect wiring fails
• User interface safer. When master control is separated from switchgear.
• Simpler design – fewer points of failure
• Shorter lead time to manufacture

Drawbacks of On-Board
• Difficult to customize
• Could be difficult to integrate components
Paralleling Best Practices
Best Practices

- With onboard paralleling the EO Genset breakers can be mounted on the Genset or in the switchgear.
- Both examples are NEC okay. But both are not equally safe!
Best Practices

- Draw-out vs fixed mounted breakers
- Why isolate the Gensets from Utility
Best Practices

Avoiding single points of failure

- Single bus vs multiple bus.
- Battery failure/ best battery – Gensets batt. or paralleling station batt.
- Fuel supply with one pump.
Best Practices

SIZING PARALLELED GENSETS FOR LIFE SAFETY AND CRITICAL LOADS
• Smallest Genset must be large enough to start all priority one(1) life safety and critical loads.
• To meet NFPA110 type 10 for life safety, must be able to start in 10 seconds.
• Make sure the smallest Genset paralleled can start all priority 1 loads.

PARALLELING NATURAL GAS GENSETS:
• Most jurisdictions require an on site fuel source. i.e. diesel or LP.
• Natural gas Gensets do not react to single step loads and don’t start as fast as diesel.
• One option is to use diesel for priority one(1) loads.
Thank You!

Questions?

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