



Connecting For Success...
ELECTRIC POWER DAYS 2017

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Caterpillar Custom Power Solutions

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Week 2: Philip McKeown / Stephen Banks
Michael Thompson

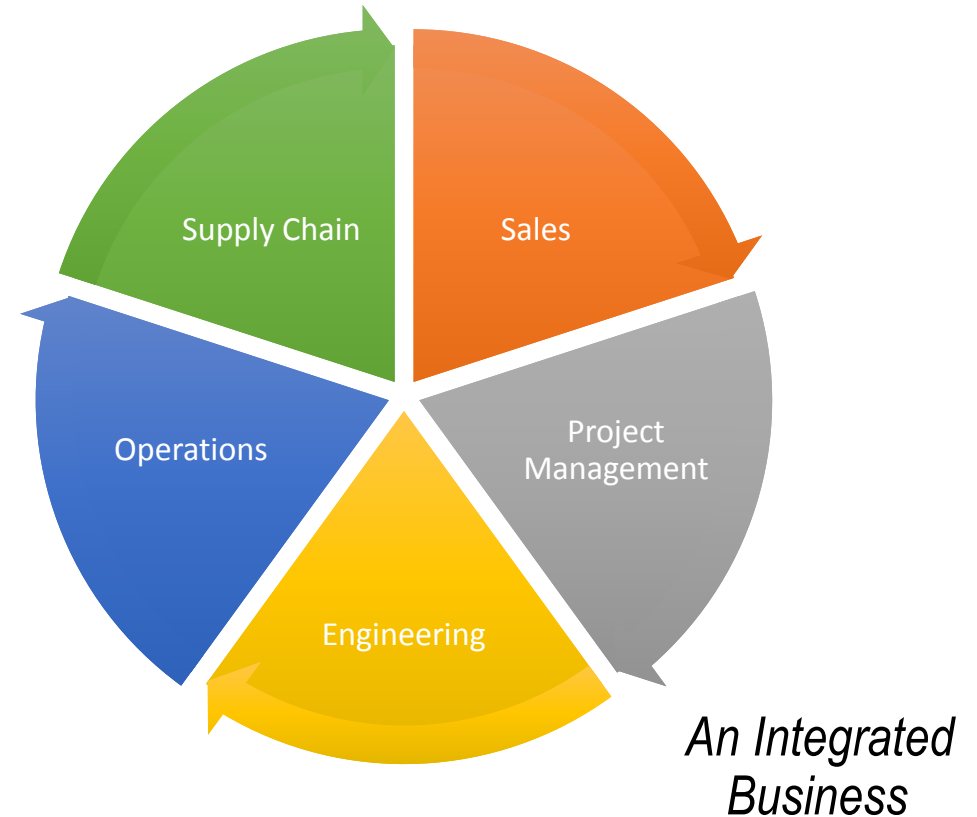
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Custom Power Solutions

Agenda

- Who are Custom Power Solutions?
- Why use Custom Power Solutions?
- What is considered a Solution/DTO?
- Custom Power Solutions Product
 - Mechanical / Electrical examples
 - PLCs
 - Validating / Testing Solutions product
 - Commissioning
- Questions

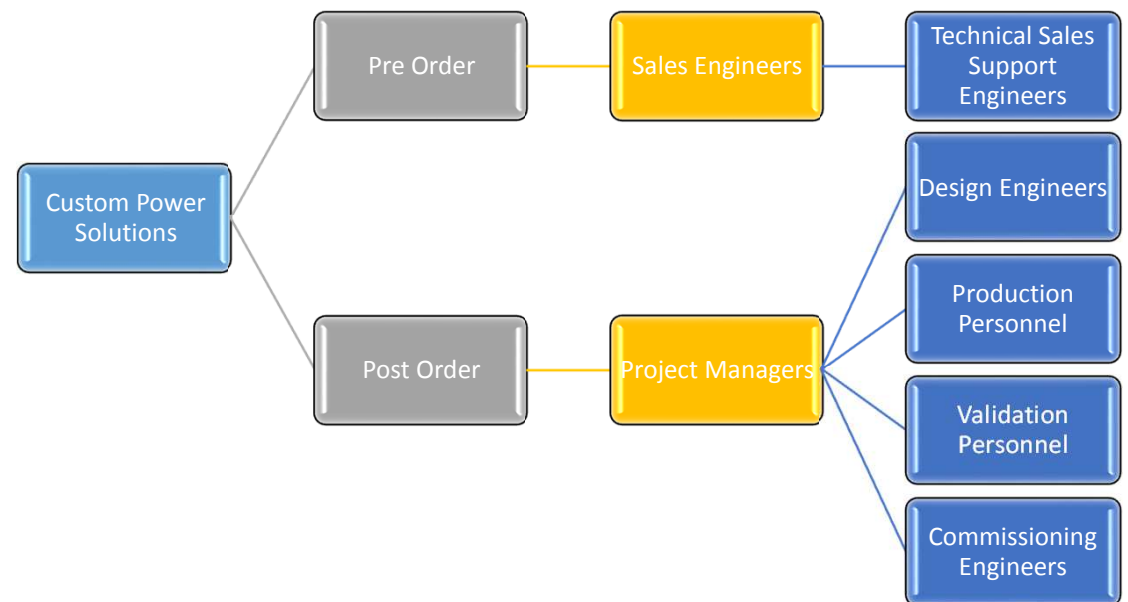


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Who are Custom Power Solutions?

- Highly qualified team of over 250 people globally within Large Electric Power (LEP)
 - Sales Engineers
 - Mechanical Engineers
 - Electrical Engineers
 - Project Managers
 - Production Personnel
 - Validation Personnel
 - Commissioning Engineers
- Team has almost 50 years experience in designing and building custom products



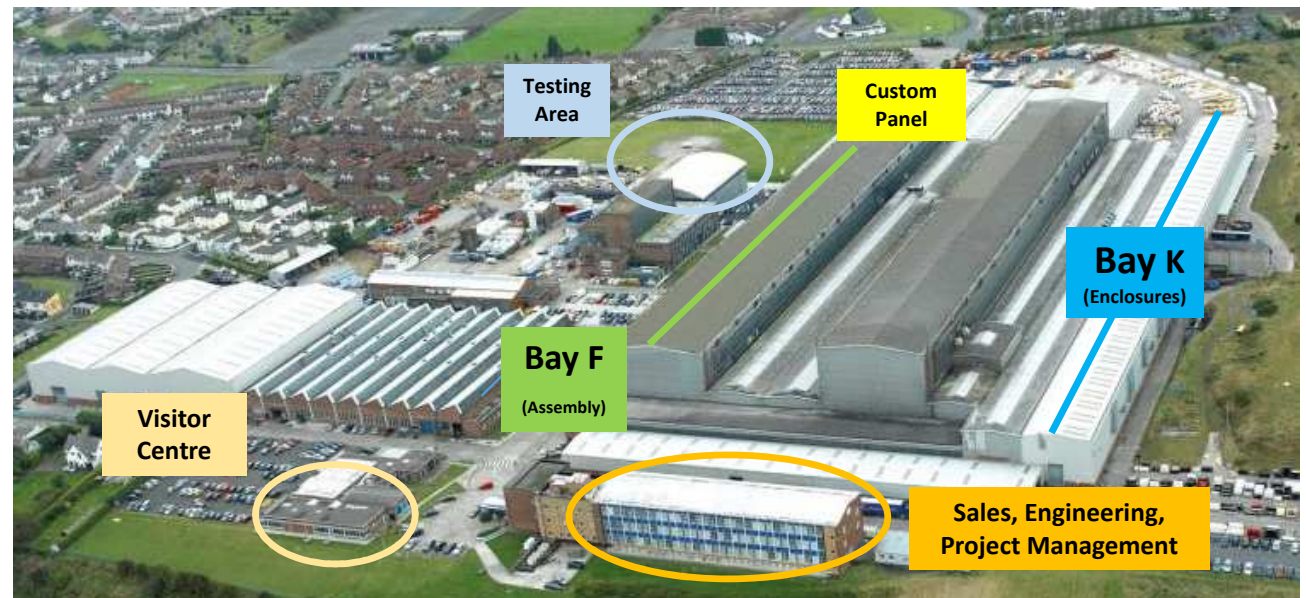
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Who are Custom Power Solutions? - Facilities

Dedicated Solutions factory and test facilities located in Larne, Northern Ireland

- Sales, Engineering, Project Management
- Enclosure manufacture (Bay K)
- Custom panel manufacture
- Solutions assembly (Bay F)
- Testing Area
- Customer Visitor Centre



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Who are Custom Power Solutions? – Sectors served

- Diesel Gensets – Low and Medium Voltage
- Acoustic enclosures
- Oil & Gas Packages e.g DNV offshore
- Dual-fuel Gensets
- Control Systems and Switchgear
- Balance of Plant
 - 3600/CM series auxiliary equipment
 - Building load management
- Customer Support

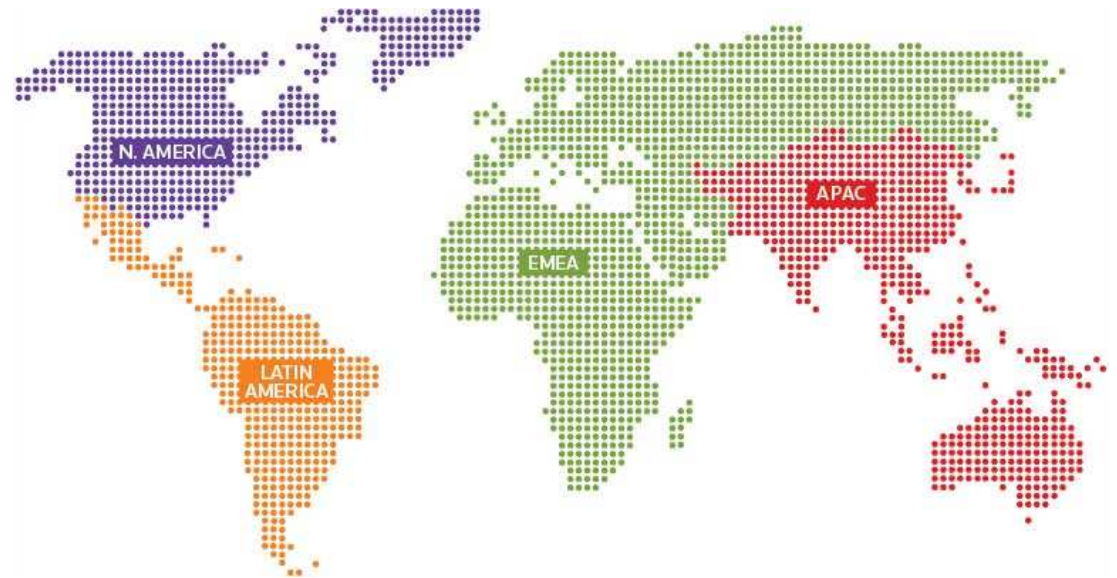


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Who are Custom Power Solutions?

- Global reach
 - Europe, Africa, Middle East (EAME)
 - Americas
 - North America (N. AMERICA)
 - Latin America (LATIN AMERICA)
 - Asia Pacific (APAC)
- 2012 to 2016 sales of over \$1,019 million USD
- 2017 projected sales of over \$239 millions USD



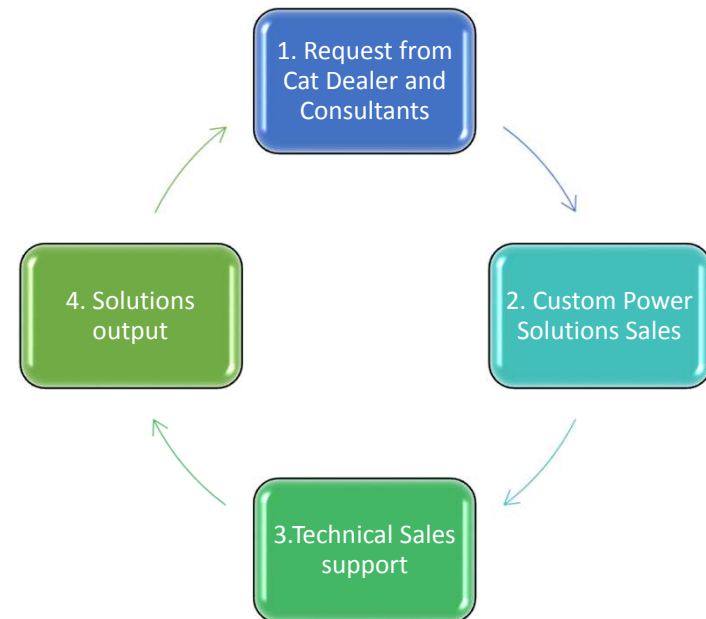
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Why use Custom Power Solutions?

Pre Sales

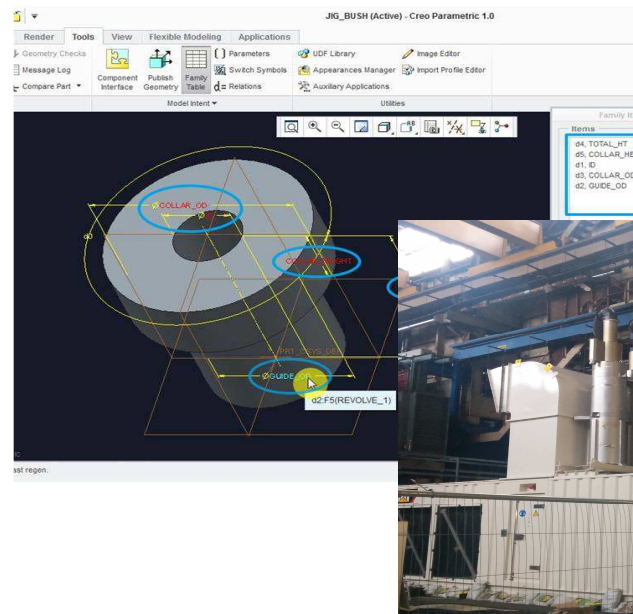
- Experience, expertise and advice
 - Local experience and guidance provided by Cat[®] Dealer
 - Pre sales technical support and advice available for Custom Products
 - Diverse portfolio of previous projects leveraged



Why use Custom Power Solutions?

Post Sales - Projects

- Dedicated Project management of your product/project from order received to delivery at site
 - Your resources can be utilized elsewhere
- Advanced engineering capabilities
 - 3D modelling
 - CFD analysis
 - FEA analysis
- Product testing and validation prior to dispatch
 - Confidence in on-site performance
- On-site commissioning support available through Custom Power Solutions



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Why use Custom Power Solutions?

On-Site

- On-site installation can be completed and/or coordinated by Local Cat Dealer
- Worldwide availability and coverage
 - Access to one of the most extensive and experienced Dealer Networks available globally
- Warranty provided by Caterpillar on the complete solution supplied
 - Piece of mind against any failures



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What is considered a Solution?

- Any product or service that is not available through the conventional Pricebooks is considered a solution

Mechanical examples:

- Complete 'turnkey' customer specific products
- Acoustic enclosures
- Special alternators/generators e.g IP44, IP55
- Dynamic gas blending
- Special cooling packages e.g remote radiators
- Balance of plant for other LEP products e.g 3600 series

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Gas package

- CG170-20 gas engine
- 2000kW, 11kV, continuous
- Ability to synchronise multiple units
- Overall noise level of 75dBA @ 1m
- Customer requested special BS4800 colour finish
- Cooling module manufactured with integration of pumps and pressure vessels
- Bespoke Cat modular control system
- Complete package assembled and witness tested at factory by final customer
 - Auxiliary equipment operational test
 - Load acceptance / steps



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Data centre package

- C175-20 diesel engine
- 3200kW, 4000kVA, stand-by
- LV output not available in standard Pricebook
- Average noise level of 76.5 dBA @ 1m
- Electric driven cooling group inside enclosure selected and provided as part of package
- Complete package assembled and witness tested at factory
 - Load steps
 - Extended load run –12hrs
 - Free field noise measurement in noise circle



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Modular plantroom package

- 2 off 3512B synchronising diesel engines
- Low ambient operation -35°C to +25°C
- Exhaust gas heat recovery system with bypass
- 3 enclosures combined together to form one overall plantroom
- 1 enclosure was a maintenance workshop area
- Complete package assembled and witness tested at factory
 - Heat recovery system proven using an additional remote cooling group
 - Free field noise measurement completed in noise circle
 - Proof fit before assembly at final site



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Alternator Upgrades

- C7.1 up to C175
- Up to 3100kVA standby alternator upgrade already completed
- New baseframe
- New coupling selection
- New control panel arrangement
- Possible air filter relocation (prevent hot air entering engine)



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Dynamic gas blending (DGB) upgrade

- Two Power nodes available
 - 3512B (1500kVA, Prime)
 - 3516B (2000kVA, Prime)
- Up to 70% substitution of diesel fuel while maintaining diesel performance
 - Improved load step vrs gas genset
- Reduced running cost
- Gas train compliant to local regulations
- DGB fuel cost estimator <https://dgb.cat.com>
- Unit factory tested using factory gas supply



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What is considered a Solution?

- Any product or service that is not available through the conventional Pricebook is considered a solution

Electrical examples:

- Caterpillar integrated solutions
- System level controls – PLC/SCADA
- Caterpillar manufactured modular switchgear
- Circuit breaker upgrade, ATI, Load bank etc
- Motor control/fuel transfer control integration
- Non EMCP genset controllers e.g Comap, Easygen

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Cat Generator Controllers

Controls

- Local & remote start / stop
- Cool down timer
- Local & remote emergency stop
- Programmable security levels
- Reduced power mode

Digital Display

- Voltage
- Current
- Frequency
- Engine RPM
- Oil pressure
- Coolant temperature
- 28 languages

Protections

- Over / Under voltage
- Over / Under frequency
- Phase sequence
- Low oil pressure
- High coolant temperature
- Low coolant level
- Fail to start

EMCP 4.4

EMCP 4.3

EMCP 4.2B

EMCP 4.2

EMCP 4.1



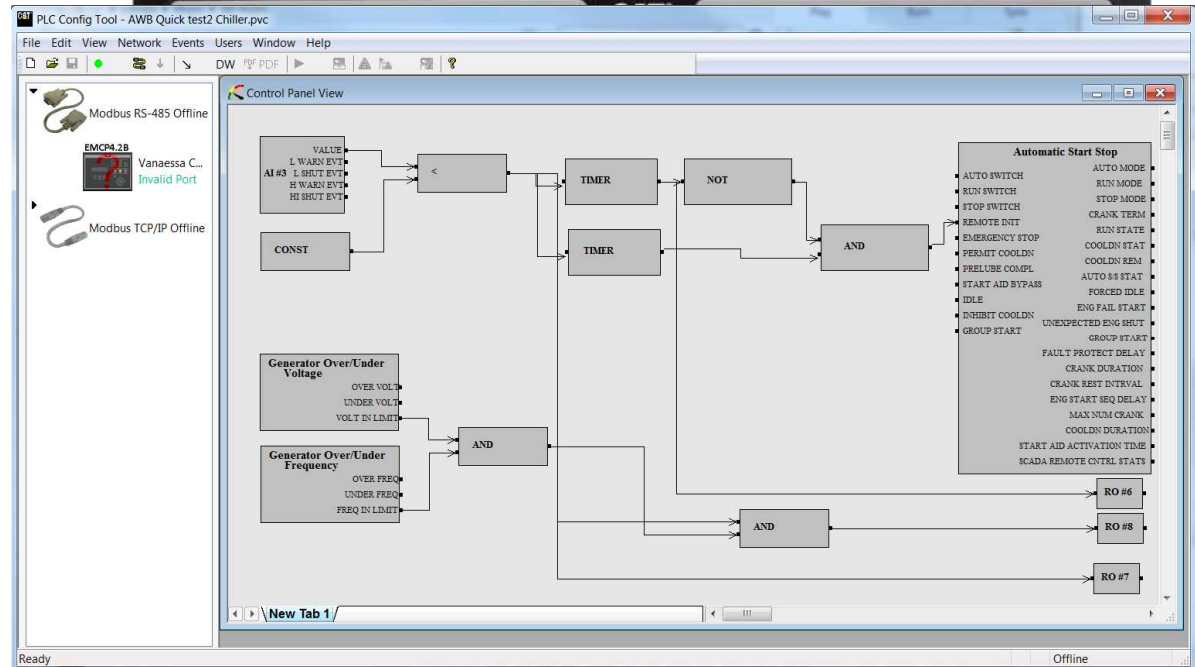
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EMCP 4.2B

Additional Features

- ATS Control
- Custom display screens
- Configurable set point security levels
- Configurable resistance maps for analogue inputs
- Trip KWh & KVarh counters
- Keypad inactivity screen
- PLC Logic



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Customisable

- Control panel/ Breaker relocation
- Breaker upgrade (Fixed/ Withdrawable/Fault level/ size)
- Additional breakers (Load bank)
- Diode failure modules
- Earth fault/ leakage
- Air flap valves
- Motorised louver control
- Dual/ air starter and dual/ air starter control
- Vibration sensors
- Differential protection
- Best battery diode panels
- Fuel metering panels

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Alternative Generator Controllers

Why use an alternative?

- Integrate with existing installation
- Greater flexibility
- Utility synchronising & load sharing
- Multiple breaker control
- Colour display
- Customer preference



Woodward



ComAp



DEIF



DeepSea

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Alternative Controller Integration

- EMCP controller replaced by alternative
- Control panel can be segregated, modular floor standing, modular set mounted or oversized
- Complete system designed by Caterpillar engineers.
- Manufactured in Caterpillar facility to Caterpillar standards.
- In house tested by Caterpillar test engineers
- Covered by Caterpillar warranty

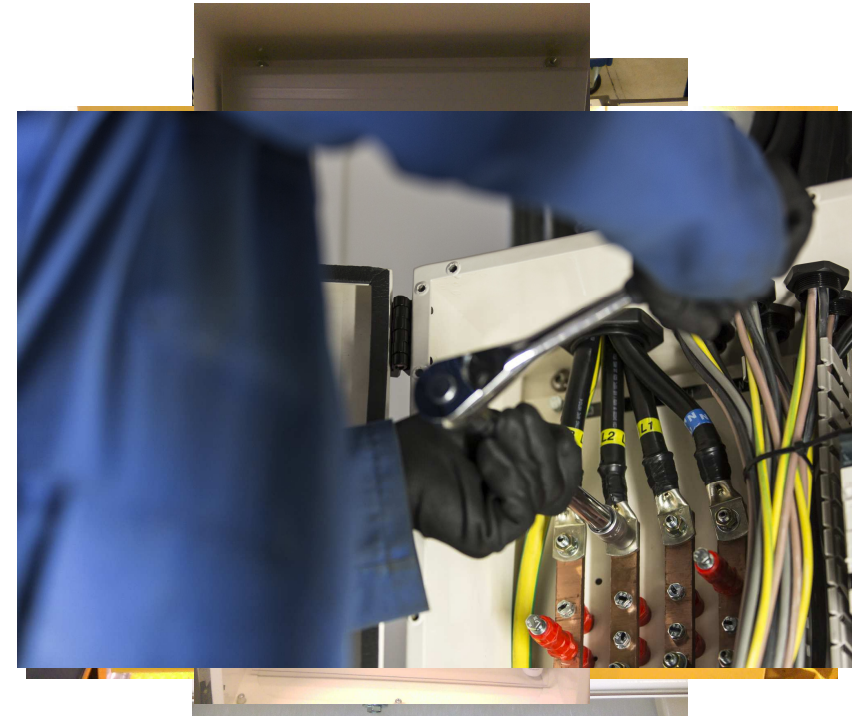


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Motor control centre & Fuel transfer control integration

- Can be set mounted, mounted in container or supplied loose
- Cooling system control & protection
- Electric driven set mounted radiators
- Electric driven remote radiators
- Cooling pumps
- Solenoid/ motorised valve control
- Pump/ duplex pump control
- Pipe leak/ tank rupture detection
- Local and remote alarm annunciation



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Additional circuit breaker

- Mains and generator circuit breakers set mounted
- Both breakers controlled by Genset controller
- Panel mounted mode select and test on / off load switches

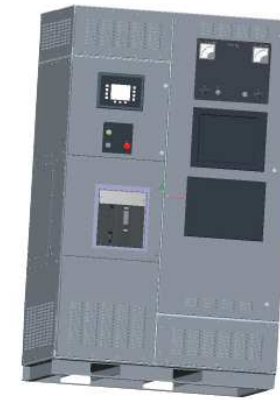


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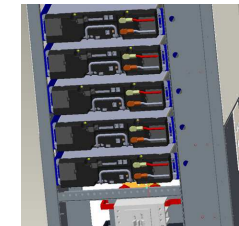
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Modular Switchgear and Control Systems

- Caterpillar integrated switchgear solutions.
- Multiple utility sources/multiple generator paralleling applications PLC's standard code.
- MV switchgear and alternator solutions. Typical supplies 11/12kV - 200/630A
- MV can be packaged complete with installed MV cabling.
- The complete integrated package can be factory witness tested, thus benefiting the customer with a turnkey optimised solution when delivered to site.



- Malaga Demonstration panel (In Village)
- 2000A breaker c/w New Woodward XT controller.
- PLC/Scada Master
- Modular scalability – e.g Rear Control section.
- Microgrid – 19" battery rack example.



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Modular LV Switchboards

- Modular LV switchboards designed and manufactured by Caterpillar
- Conforms to IEC 61439-2
- IP22 with option for IP54 protection
- Segregation Form 2a (single section) with option for Form 4b
- Floor standing ACBs from 1600A to 5000A
- Short circuit fault rating 65KA/1s I_{CW} with option for 100KA/1s I_{CW}
- Fixed, withdrawable, manual or motorized option
- Extended height control sections for generator controllers, protection relays etc.



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Modular Breaker Range

Description	Option	MSX1600	MSX2000	MSX2500	MSX3200	MSX4000	MSX5000
Breaker Models		ABB EMax2 E2 1600A	ABB EMax2 E2 2000A	ABB EMax2 E2 2500A	ABB EMax2 E4 3200A	ABB EMax2 E4 4000A	ABB EMax2 E6 5000A
Poles	3 Pole	Standard					
	4 Pole	Option					
Fixed/ Withdrawable	Fixed	Standard					
	Withdrawable	Option					
Control	Manual	Standard					
	Motorised	Option					
Ingress Progression	IP23	Standard					
	IP54	Option					
Internal Segregation	Form 2a	Standard					
	Form 4b	Option					
Ventilation	Natural	Standard					
	Forced	Option					
Rated Current ¹	@ 35°C	1600A	2000A	2500A	3200A	3700A ²	5000A ³
Short Circuit Fault Rating (I _{cn})	66 kA, 1 sec	Standard					
	100 kA, 1 sec ⁴	N/A			Option		
Dimensions ⁵	Height ⁶	1800 mm				2250 mm	
	Width	600 mm			750 mm		1200 mm
	Depth	900 mm					
Plinth	100 mm Plinth	Standard					
Lifting	Fork Lift Pockets	Standard					
	Swivel Lifting Eye (M10)	Option					

Look up Cat.com

- Document LEHE1031-02 (available in village)



Notes:

1. Rated current stated for standard configuration. Actual rating will be affected by combination of factors including ambient, internal segregation and ingress protection.
 2. 4000A rating available with forced ventilation option.
 3. 4000A rating available in E6 ACB range as natural ventilation option.
 4. E2 frame breaker not available in 100 kA rating. If 100 kA required, use E4 frame breaker and adjust overload as required.
 5. Other sizes are available based on a 150 mm grid.
 6. Height stated without removable plinth.
- Some options are available via Solutions / DTO only.

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System Level Controls – PLC / SCADA

Why use PLC based control systems?

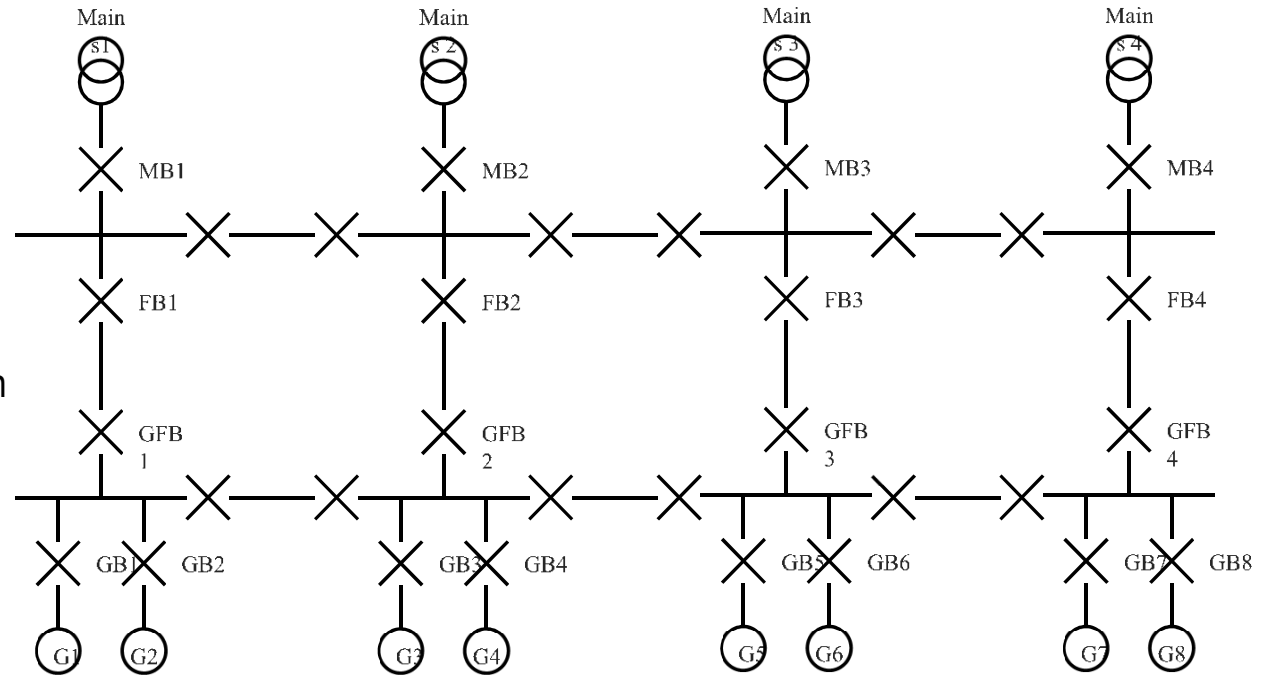
- Complex control philosophies
- Modular system, easily scalable
- System integration
- Remote access – monitoring and control

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Applications

- Multiple utility / Generator group control
- Bus coupler control
- Long term / short term utility paralleling
- AMF applications
- Building load management / load optimisation
- Predictive load steps
- Balance of plant
- Configurable base code



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PLC Options

- Single PLC
 - Flexible
 - Scalable
- Dual 'Cold' standby PLC
 - Increased reliability
 - Typical 250ms to 1 sec switchover
- Dual 'Hot' standby PLC
 - Industry leading reliability
 - Bumpless switchover
 - Suitable up to SIL2 applications



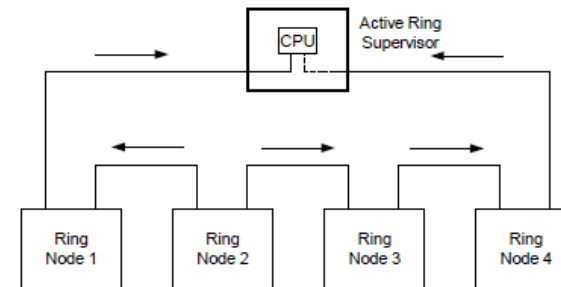
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Interfacing and Networking

- Input / Output (I/O)
 - Local I/O
 - Distributed I/O
 - Redundant I/O
- Network
 - Ethernet Network
 - Flexible implementation
 - Star/ Line topology – Simple low cost installation
 - Ring topology – Increased system resilience
 - Range
 - 100 meters between devices for copper twisted pair wiring
 - Up to 2000 meters using fibre cabling

- Communication Protocols
 - Ethernet/IP
 - Modbus
 - Canbus
 - Profibus
 - Devicenet
 - Controlnet
 - Bacnet



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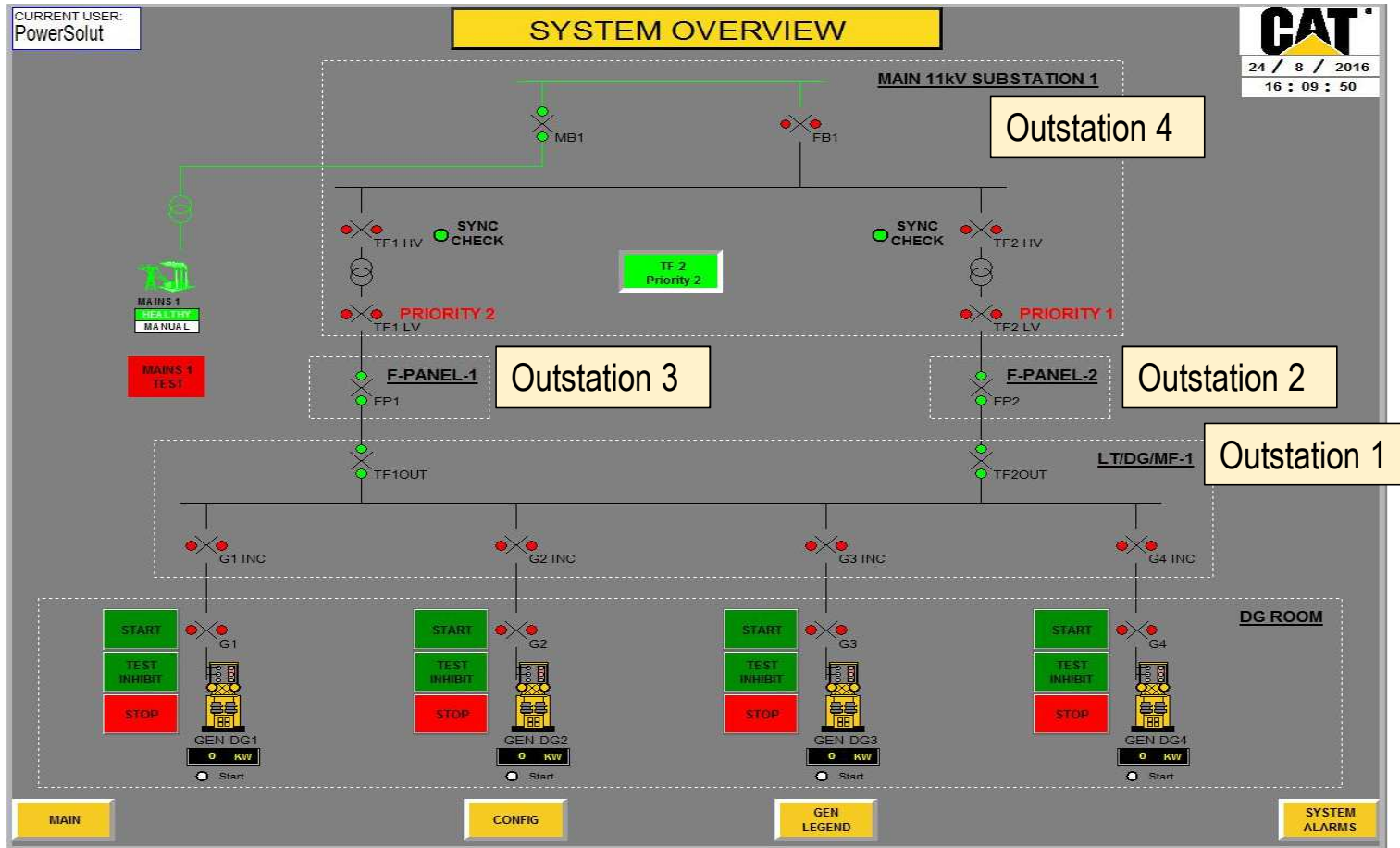
SCADA / HMI

- SCADA Display
 - Local / remote displays
 - Single interface for system overview and control
 - Project specific screens
 - Generator / auxiliary equipment screens
 - Data logging
 - Alarm / event logging
 - Password protection



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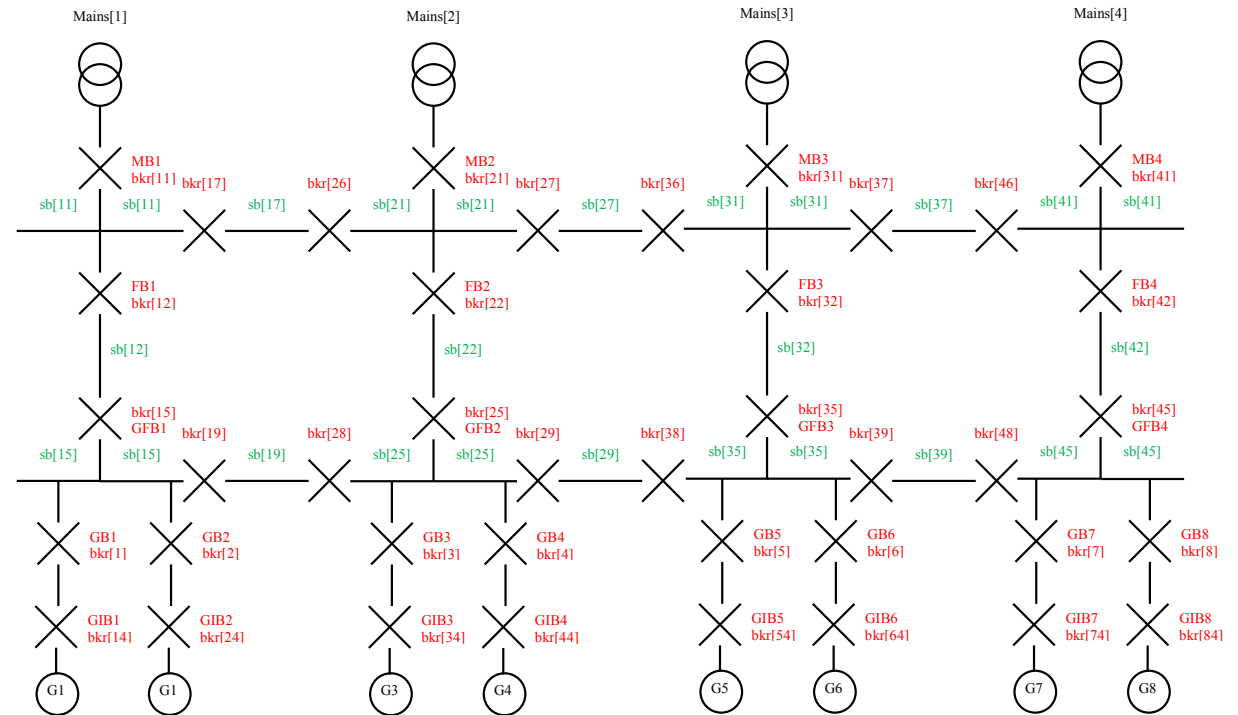
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- PLC code can be tested before installation
- Changes & new scenarios can be quickly and safely proven



CURRENT USER:
Supervisor

MAIN

2 / 5 / 2017
13 : 52 : 09



MASTER PLC STATUS

SYSTEM OVERVIEW

LOGIN

LOGOUT

PASSWORD

TOGGLE COLOUR

GENSET G1

GENSET G2

GENSET TG3

GENSET TG4

VENTILATION FANS

ETHERNET A

ETHERNET B

RESET DLR A
DIAGNOSTIC

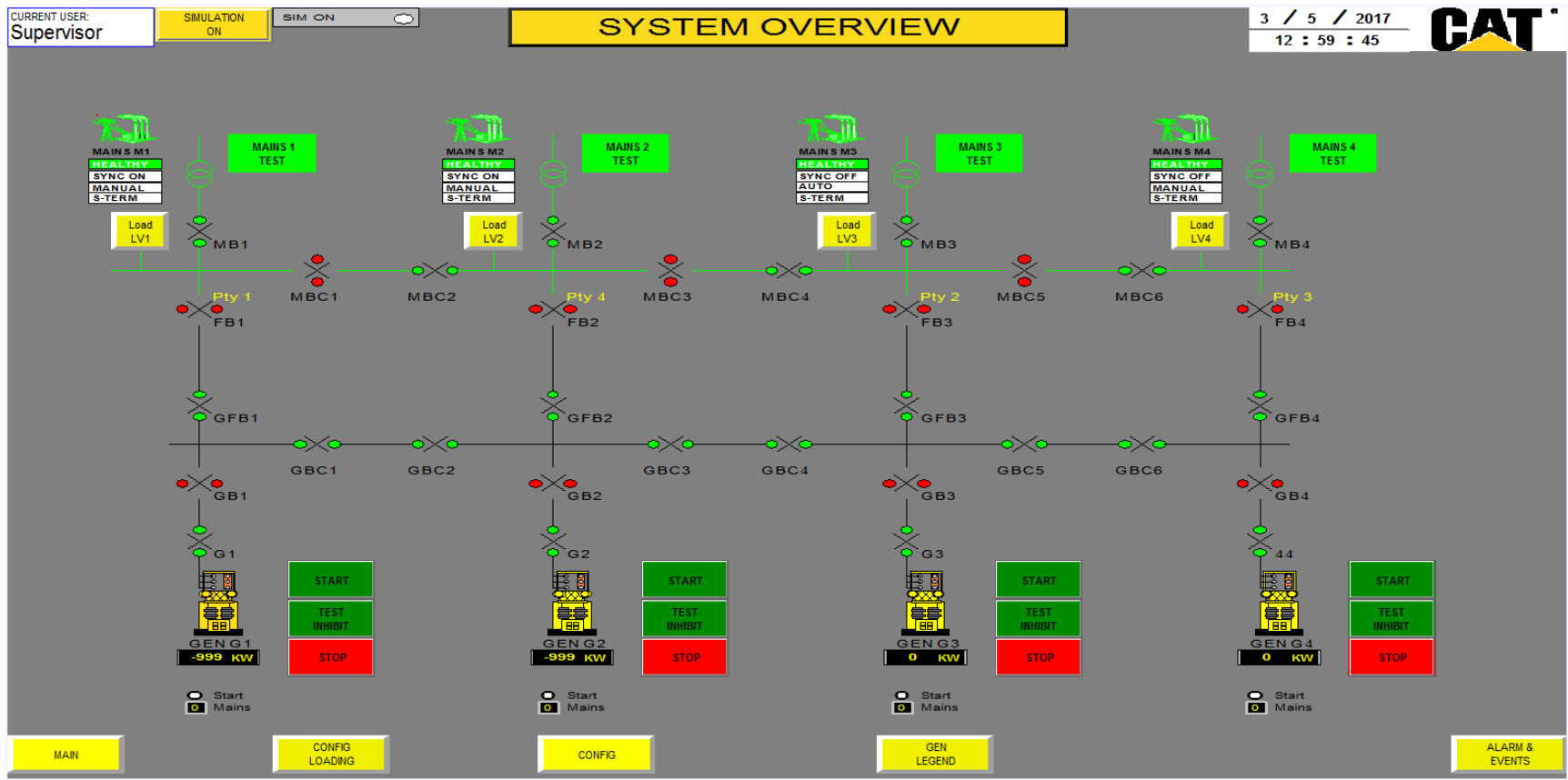
RESET DLR B
DIAGNOSTIC

SYSTEM
OVERVIEW

ALARM &
EVENTS

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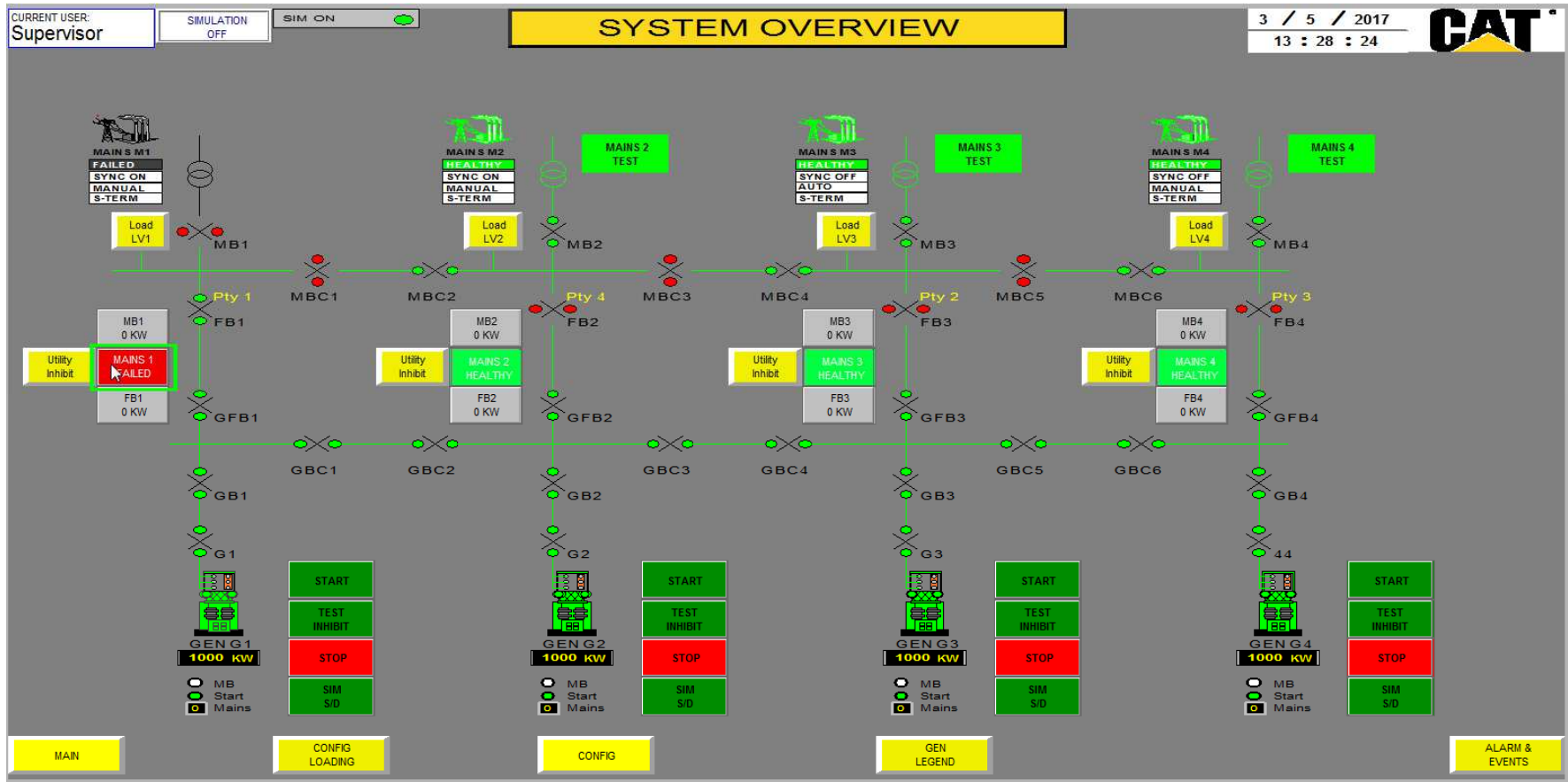
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○ ENABLED

ENABLE

2 / 5 / 2017
14 : 36 : 45

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MB1

MAINS
BREAKER
1

11

RESET

OPEN

AUTO

MANUAL

CURRENT USER:
Supervisor

BACK

CURRENT STATUS

○ OPEN

● CLOSED

○ TRIPPED

○ SIGNAL FAULT

○ UNAVAILABLE

○ FAIL TO OPEN

○ FAIL TO CLOSE

○ EARTH SELECTED

○ EARTHED

○ IN LOCAL

○ WATCHDOG

○ DIFFERENTIAL

○ WITHDRAWN

Breaker Name Change
(10 characters including
spaces per line)

MAINS

BREAKER

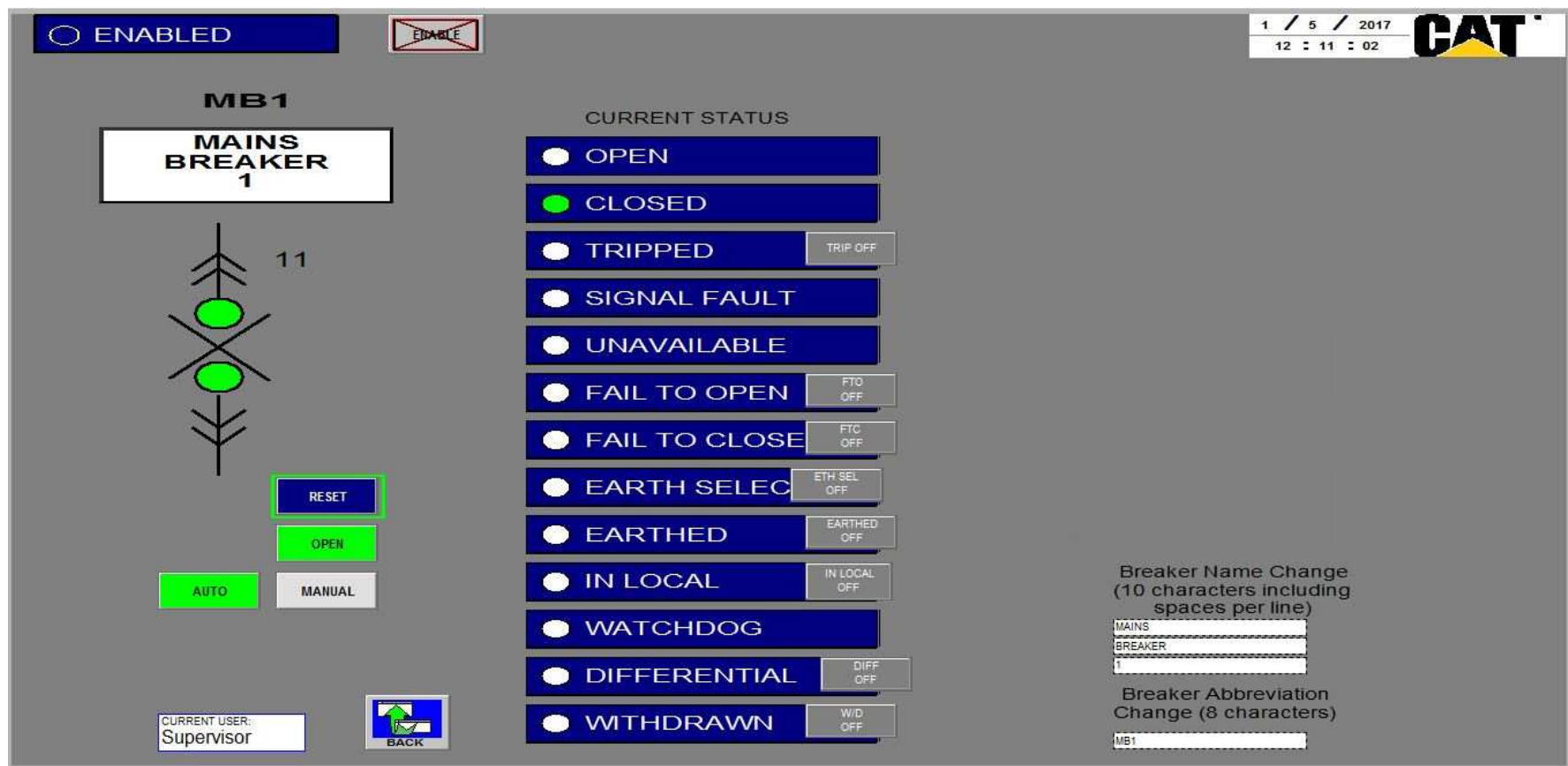
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Breaker Abbreviation
Change (8 characters)

MB1

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Validation

New package designs undergo rigorous validation testing including –

- Cooling package performance
- Noise measurements
- Airflow testing
- Vibration testing
- Water ingress testing
- Safety & serviceability
- Control philosophy testing



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Witness Testing

- World class test facility
- Customized tests
- 10 open set test cells & containerised test area
- 12MW resistive, 3MVAR inductive, 750KVAR capacitive load bank capacity
- Europe's largest Hemi anechoic chamber
- Large packages tested in free field conditions on noise circle
- High ambient test cells, up to 50°C



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Commissioning

- Access to one of the most extensive and experienced Dealer networks available
- Complete commissioning by Custom power Solutions commissioning engineers is available
- All Custom Power products supported
 - Diesel, gas, MV generators
 - PLC systems
 - Switchgear

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Conclusion

- Custom Power Solutions can provide the following:
 - Solutions designed, built and tested in a caterpillar facility, by Caterpillar engineers to Caterpillar standards
 - Flexible solutions
 - Integration with 3rd party equipment
 - Full system test at factory
 - Sales/ project management/ commissioning
 - Caterpillar warranty

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Questions?

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