Microgrid Capabilities

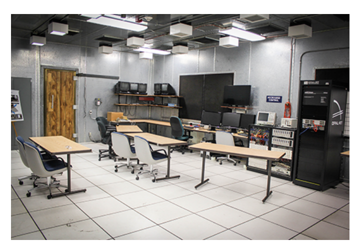
Low-Lab – one machine tie-down, overhead crane, chilled water supply

Spin Test Bunker – The facility also houses a high energy spin test bunker designed to safely contain a 20 psig internal overpressure. The 600 ft2 spin test bunker features 30 in. thick fiberglass reinforced concrete walls with 6 in. thick aluminum door, window, and roof closures. A stainless steel tie down structure is rated for 5 million pound vertical load and torque loads of up to 20 million lb-ft. A metal building located immediately adjacent to the spin test bunker was designed for installation and testing of gas turbines, with openings for intake air and integral exhaust ducting in the roof. This structure can also be used for local instrumentation and data acquisition for experiments being conducted in the spin test bunker. In the spin test bunker, however, full instrumentation wiring and optical fiber is routed to a faraday-shielded control room on this end of the main building.

Turbine Testing - A 21'x23' gas turbine test cell has been added to the high energy spin bunker to operate turbines as a prime power source for direct drive generators. The Turbine Test Cell includes a rigid mounting system that was installed with consideration given to the need to reconfigure a test setup based on a variety of necessary test equipment.

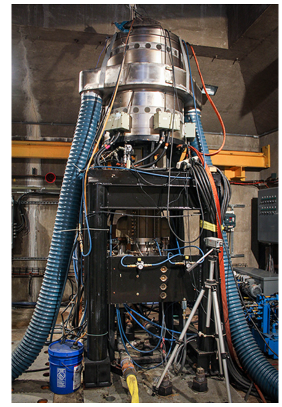
Pulsed Power Test Bed - Currently the pulsed power testbed is powered by an 18 MJ capacitor bank composed of eighteen 1 MJ bank modules. These modules can be independently charged and triggered to provide a tailored current pulse shape for grid stability testing in the presence of large pulse loads. This power bank supplies the High Energy Medium Caliber Launcher (HEMCL) capable of 2 MJ muzzle energy at an exit velocity in excess of 2 km/s. This test bed is also equipped with a projectile recovery tank designed to capture and stop a high velocity test package with minimal deceleration and little to no damage incurred.

Control Room – Safety is always of primary concern at CEM. Dedicated control rooms are present in both the low lab area within the main building, and adjacent to the pulsed power test area. Fiber networking connects test equipment to the control rooms for real-time monitoring of test events and electrical isolation.



Power Grid Equipment:
Motors/generators – (1) 2 MVA, 12,000 rpm
Resistive Loads - 1.3 MW Resistive load and 2 MW chopper
Rectifiers - 3.2 MVA (diode), 1.2 MVA (controlled), 1 MVA (Toshiba)
Inverters: 1 MVA (Toshiba), 2 MVA (ARCP)
Utility Power: two 480 Vac 3φ utility supplies
Transformers: 490 kVA, 1.2 MVA multi-tap

Microgrid Capabilities



Kahn Water Brake Dynamometer - The 5MW Kahn Series 100 hydraulic dynamometer are designed primarily for testing of high speed turboshaft engines at speeds up to 23,000 rpm and at power absorption levels of up to 7,000 hp. Power is absorbed by vortices generated by the perforated disk rotors and stators; the resulting drag applies a moment to the dynamometer housing which is measured with a strain gage torque reaction sensor. Absorbed power is modulated by controlling the amount of water in the dynamometer with the inlet and outlet control valves. The dynamometer is bi-directional and is capable of both vertical and horizontal orientation; this is critical for testing of vertical axis motor/generators for advanced energy storage flywheels. The electro-pneumatic inlet and outlet control valves control the flow of water to the dynamometer based on commands from the Kahn Series 545 digital dynamometer controller. The hydraulic dynamometer provides a controlled load for a prime mover such as a gas turbine or electric motor.

Digital Real-Time Simulator - The digital real-time simulator was developed by Opal RT to perform real-time simulations of power systems from very large-scale grid models to very fast power electronics. Opal RT offers several software packages designed for different power system levels simulations. Their ePHASORsim was designed for large-scale powers grid simulations with time steps greater than 10 ms and up to 30,000 nodes. HPERSIM is a large-scale power simulator with a little higher accuracy and short-er time steps. It was designed for time steps greater than 10 μs and up to 3000 nodes. eMEGAsim was designed for smaller grids such as microgrids with faster time transients. It's designed to simulate power systems and power electronic hardware with time steps simulations with time steps as low as 10 ns. These packages can be used in co-simulation environments to cover very fast time transients as well as very large scale grid models. Currently the Center for electromechanics has licenses for eMEGAsim and eFPGSsim. The real-time simulation hardware is compatible with the complete suite of Opal RT simulation solvers. Two hardware systems have been combined to perform microgrid level as well as power electronic real-time simulations and co-simulations. The eMEGAsim package currently resides on the Opal OP5600 hardware platform.

Power Electronic Building Block converters (PEBB) - The PEEB power converter concept is to create a single modular electronic power package that can be easily modified to create a variety of different power converter packages. These power converter types include AC to DC (passive and active rectification), DC to AC (inverter, DC to DC step up (boost), and DC to DC step down (Buck). The Center for Electromechanics employs 10 PEBB converter modules. These modules are made up of a Semikron Semistak RE power converter assembly. That feature an IGBT based Skiip 4 intelligent power module (IPM) in a three-phase half-bridge configuration.

Microgrid Capabilities

Power Switching, Filtering and Fault Introduction - To allow for switching and line filtering, there are 8 modular three phase 1600Amp isolation contactor and 130uH inductor sets to be utilized at the optimal point in the test circuit. A large capacitor bank has been added for additional filtering options. The capacitor bank consists of 100 capacitors, each rated for 500uF at 2000Volts. The capacitor bank can be divided into smaller sections for best performance as determined by the desired test parameters. With the capability of switching in different capacitive and inductive values, the test circuit and filtering are easy to modify to meet testing goals. Additional high current and high voltage breakers are utilized to introduce short circuit faults in the test circuits. The three phase breakers consist of two 3000Amp, 4000Volt units. The breakers combined with different test loads allow for short circuit fault tests from a few to hundreds of amps all depending on the circuit operating voltage and the selected fault load. Control software has been implemented on the control circuits to detect the short circuit faults and interrupt the current flow. Additional standalone circuits have been developed to detect and locate the system faults.

Hardware for performing DC series fault tests includes electrodes, linear motor, and containment system. DC series fault tests can be performed at different bus voltages as well as different current levels from a few to hundreds of amps. The ability to perform many different types and levels of tests illustrates the flexibility of the microgrid system at CEM.

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