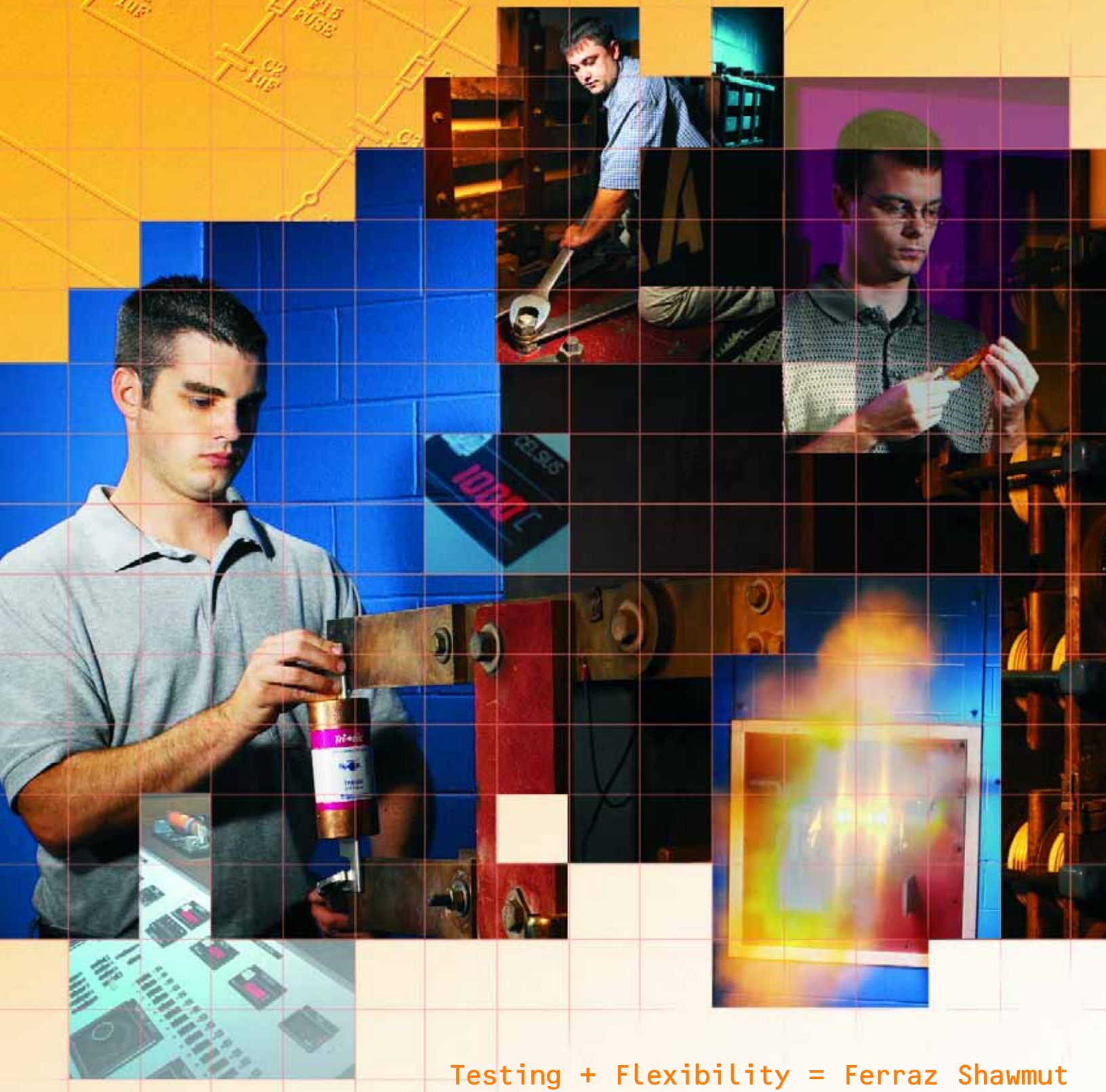
High Power Test Lab



Testing + Flexibility = Ferraz Shawmut

GROUPE CARBONE LORRAINE

Ferraz Shawmut

Your circuit protection resource.

Our focus on efficiency makes the Ferraz Shawmut test facilities extremely productive and affordable for all your testing needs. Our customers turn to us to avoid the inconveniences of long lead-times for test dates, and to gain the advantages of rapid setup and change over times (e.g., circuit-switching in five minutes vs. one hr.) allowing us to provide you more "shots" per day. We appreciate that our customers expect flexibility, and we make every effort to accommodate their unique testing requirements.

Ferraz Shawmut offers our customers global test capabilities for testing products in North America (Newburyport, MA) or in Europe (Saint Bonnet, France). Our labs are ready and able to meet all your test requirements from UL or CSA approval testing in North America to IEC testing in Europe.

This is why innovative and successful companies who manufacture equipment like AC and DCDrives, Soft starters, UPS's, lighting controls, circuit breakers, MCC, industrial controls, cables, surge suppression devices and many other electrical products select Ferraz Shawmut and our global test capabilities as their partner when it comes to critical design and approval testing. They value our on-site engineering trouble-shooting expertise and consultation services.

Our facilities in North America and Europe have the capability to test from the smallest components to the large complete system such as motor control centers and power distribution panel boards. Our lab will provide precise graphical representation of even the lowest levels of current, voltage and time.

To keep you and ourselves competitive, we are continually reviewing and updating our data acquisition technologies, lab design, and test procedures. Turn to the Ferraz Shawmut high power test labs for expert, effective, accurate, and affordable high power electrical testing.

Test Control

All testing is controlled and can be observed in the safety of a separate, isolated control room. The test cells and operators are segregated for safety, and operators control all test functions via state-of-the-art digital or fiber optic links to the test station cells.

Short circuit test data is conveniently collected via the control room in a variety of ways:

Acquired by six Digital Storage Scopes through:
- Coaxial shielded double-cable
- Fiber Optic isolation transmitters and receivers

High fault currents and voltages are linearly stepped-down, or transduced to low level signals that can be measured by the scopes by using:
- Resistive shunts
- Current transformers
- Isolation transformers

All signal analysis equipment is calibrated with a tolerance of +/– 1%.

Test Cells/Device Connection

The test area is comprised of a 3-cell configuration.

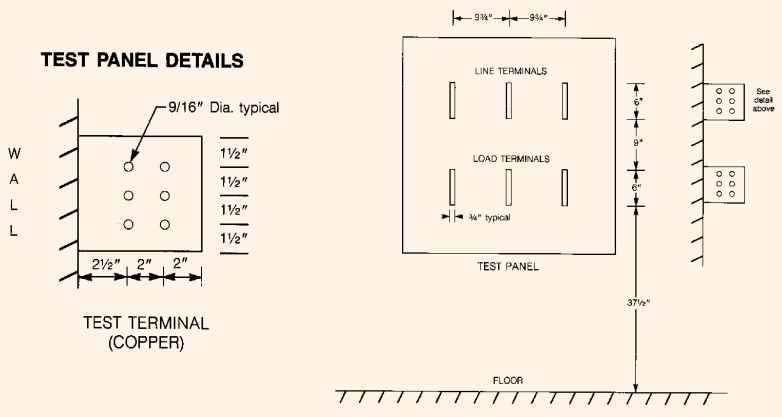
Cell 1: Primarily used for single-phase testing – fuses, single-pole breaker, mov's, cable connectors, etc.

Cell 2: All 3-phase testing is completed in this location – 3-phase switch-gear, motor controllers, transformers, circuit-breaker etc.

Cell 3: This is our medium-voltage cell (max. – 38,000 volts)

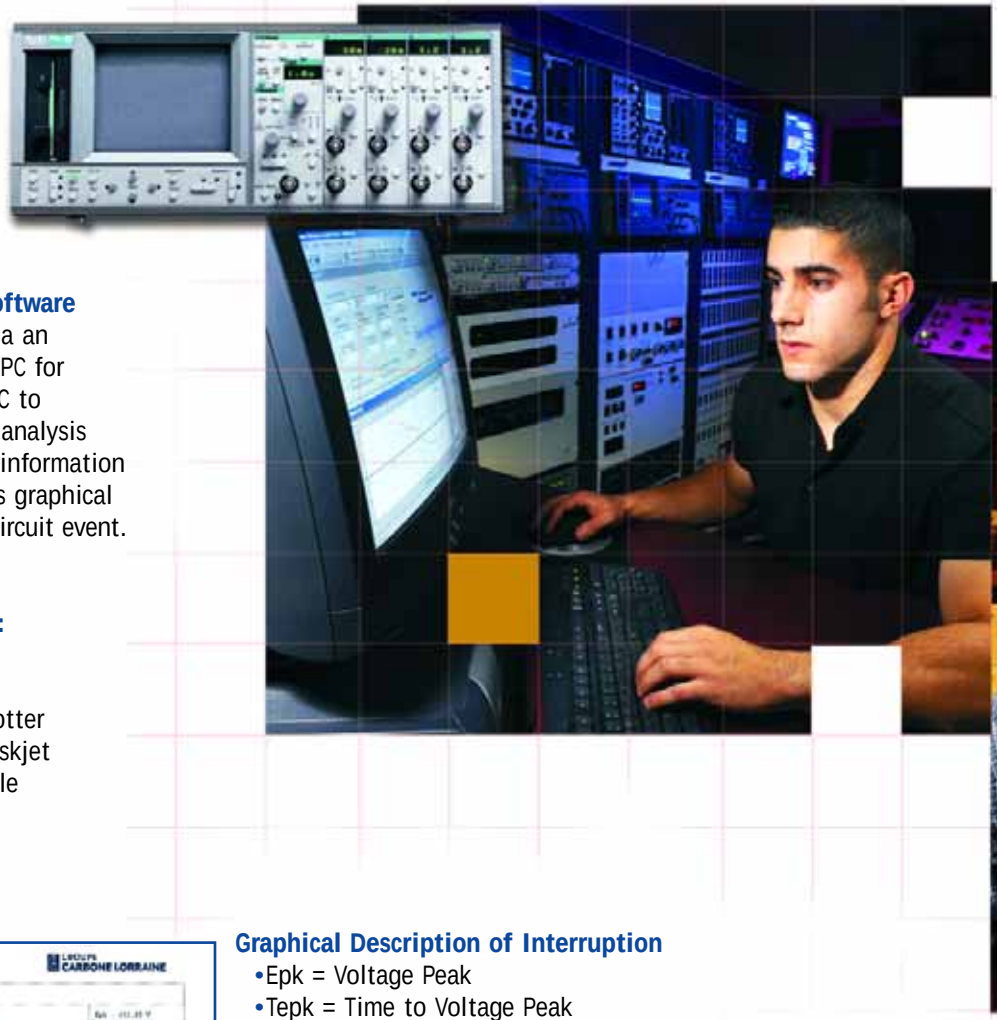
All devices under test are connected directly to the associated cell's copper bus-bar.

@Connection specs are noted below –



Nicolet 430 Digital Storage Oscilloscopes

- 32,000 bits-per-sweep
- 12 bit/10Mhz Digitizer
- Master/Slave Capabilities
- Variable Input Filters
- Single/Live Modes
- Stores to 3 1/2" Disk
- Sampling from 100e-9 and Up
- Six Individual Scopes Available

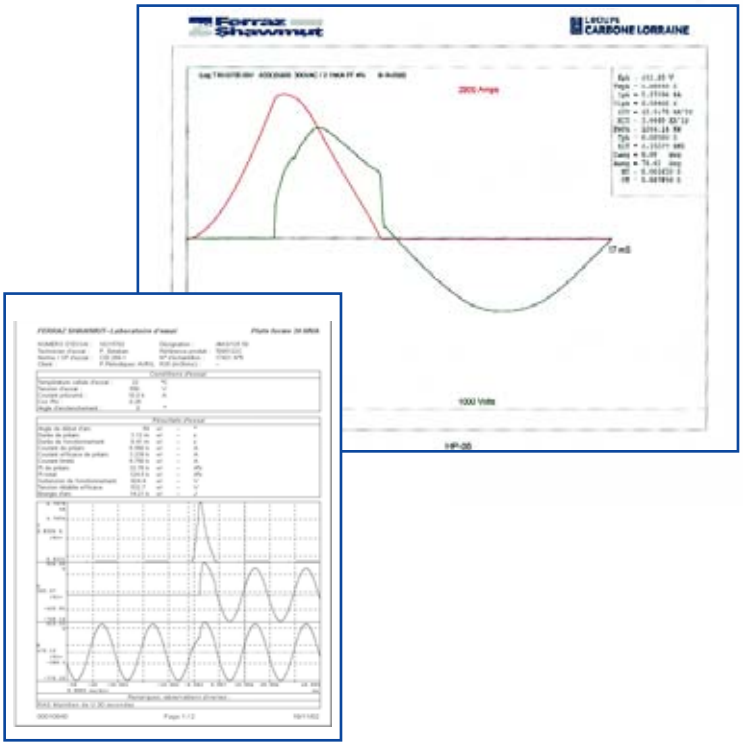


Ferraz Shawmut Waveform Analysis Software

Digital oscilloscopes are connected via an IEEE.488 bus, and interface with the PC for analysis Test Lab engineers use the PC to control all scope functions Waveform analysis software program reads the digitized information from scopes, into the PC, and outputs graphical and text information about the short circuit event.

Data Output presentation options are:

- Display on PC screen
- Output displayed and graphed to Plotter
- Output displayed and graphed to Deskjet
- Output displayed and saved to PC File

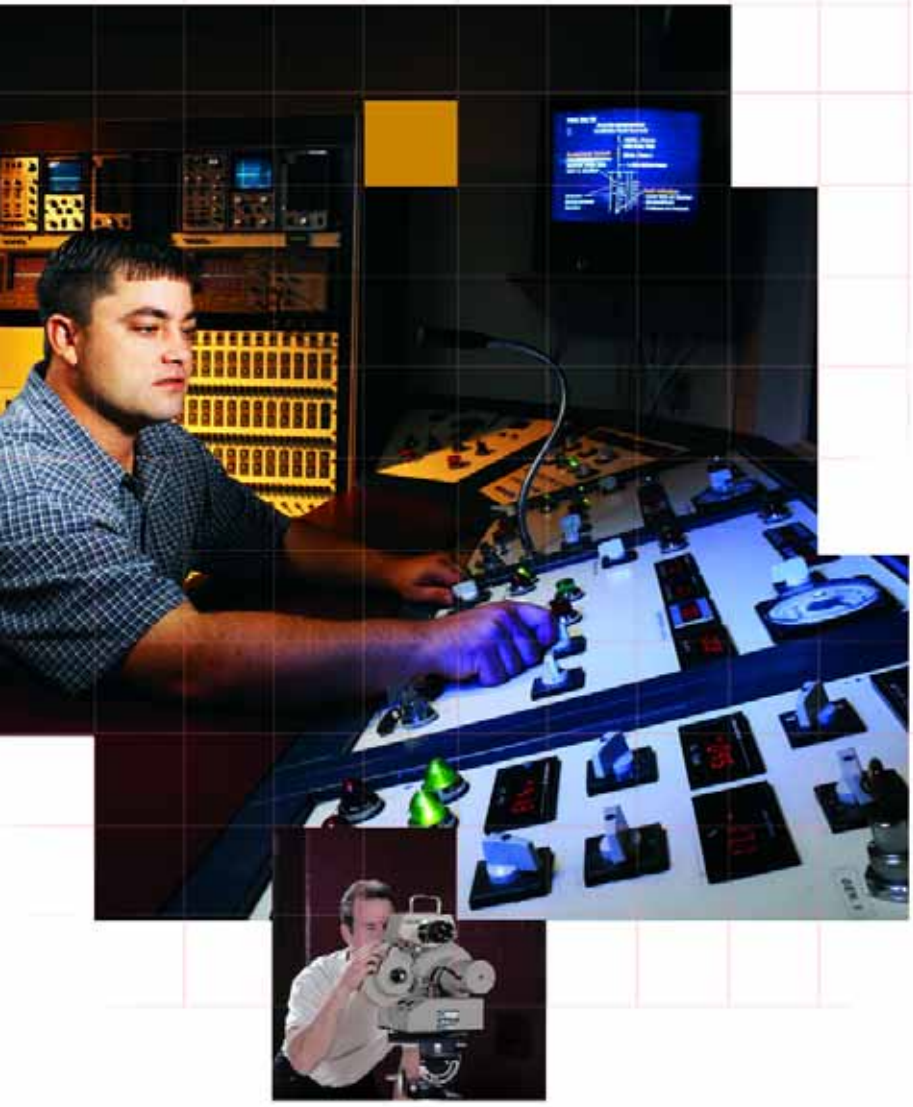


Graphical Description of Interruption

- Epk = Voltage Peak
- Tepk = Time to Voltage Peak
- Ipk = Current Peak
- Tipk = Time to Current Peak
- IIT = Energy Value of Current Envelope
- MIT = Energy Value prior to melt
- PwPk = Peak Power
- Tpk = Time of Peak Power
- EIT = Voltage-Current-Time ratio
- Aang = Arc Angle
- Cang = Closing Angle
- MT = Melt Time
- CT = Clearing Time

Red Trace = Current/Green Trace = Voltage

System Power & Circuit Configuration



Power (North America)
Our test station uses two 3600 RPM synchronous alternators used in parallel to produce the high currents for short-circuit testing. Each alternator is driven by a 4160 volt, 536 hp electric motor.

Power (Europe)
Our test lab has three different power sources. Station one is a continuous current and voltage cell supplied by a utility line. Station two uses a 3 MVA motor generator set and Station three uses a single 400 MVA synchronous motor generator set to develop your short circuit current needs.

Load
Currents from the generators are fed to Ferraz Shawmut's custom-made load banks consisting of high power resistors and concrete reinforced inductors. The load banks are quickly adjustable to allow short circuit current regulation from 1 – 100,000 amperes with a full range of power factors for AC circuits and time constants for DC circuits .

Output
A wide variety of test voltages can be produced, allowing a corresponding range of short circuit test-currents. To acquire desired test voltages, test lab engineers monitor and adjust generator excitation current via remote control.

DC Rectifier
Direct Current test circuits are energized by a high-speed, bounce-free synchronized closing switches. DC capabilities include currents + 100,000 amps and below, at a variety of voltage ratings.

Transient Impulse Testing

The High-Power Test Lab now has impulse testing capabilities. The recently installed custom-made impulse generator can produce a 1.2/50us voltage wave across an open circuit. It also produces a 8/20us unidirectional current wave, with a magnitude range of up to 100,000 amps. The waveforms manufactured by the impulse generator comply with U.L. 1449, IEEE C62.41, and IEC standards.

Acquisition Equipment
- Tektronix 420A 200MHz Oscilloscope with 200MHz bandwidth, 100MS/s sample rate, floppy disc storage (graphical hardcopy and Excel format) and computer interface capabilities
- Tektronix P6015A 1000:1 High-Voltage Probes
- 100MHz 1000:1 Pearson Current Transformer
- Differential Voltage Reading: custom designed for minimal induced voltage errors

Formal test report and video of test program is available upon request. The test lab is capable of producing customer-specific voltage and current waveforms.

Additional Capabilities
Other capabilities of the test lab include high-speed filming of testing, low-voltage preheating, hypot and Megger testing.

High-Power Labs

North America and Europe

North America (Newburyport, MA)

Maximum Test Capabilities

Single Phase/Three Phase

125 VAC
0 – 45,000 Amps 12% Power Factor
250 VAC
0 – 100,000 Amps 12% Power Factor
277 VAC
0 – 100,000 Amps 9% Power Factor
480 VAC
0 – 100,000 Amps 9% Power Factor
500 VAC
0 – 100,000 Amps 9% Power Factor
600 VAC
0 – 100,000 Amps 7% Power Factor
700 VAC
0 – 50,000 Amps 5% Power Factor
1000 VAC
0 – 75,000 Amps 5% Power Factor
All Power Factors are available

Direct Current

130 VDC
0 – 50,000 Amps 13mS Time Constant
300 VDC
0 – 100,000 Amps 10mS Time Constant
600 VDC
0 – 100,000 Amps10 mS Time Constant
700 VDC
0 – 100,000 Amps 10 mS Time Constant
1000 VDC
0 – 85,000 Amps 8mS Time Constant
1250 VDC
0 – 140,000 Amps 3mS Time Constant

Circuit Values AC/DC

Primary	**Max.**	**Min.**
Inductance:	.0029h	.0000242h
Resistance:	.38 ohms	.000002 ohm
Secondary	**Max.**	**Min.**
Inductance:	.079h	.00018h
Resistance:	78 ohms	.035 ohms

Bypass Pri/Sec
Values approach zero

Specific Circuit Values Can Be Fabricated To Meet Customer Needs

System Description

Generators: 10 MVA continuous-rated alternator (short-circuit rated 68 MVA) generating 2400 volts @ 60hz

BUI: HK type circuit-breaker to interrupt test voltage after preset

HI: Continuous-duty primary inductors from 0 to 1.12 ohms

RI: Continuous-duty primary resistor from 0 to .6 ohms

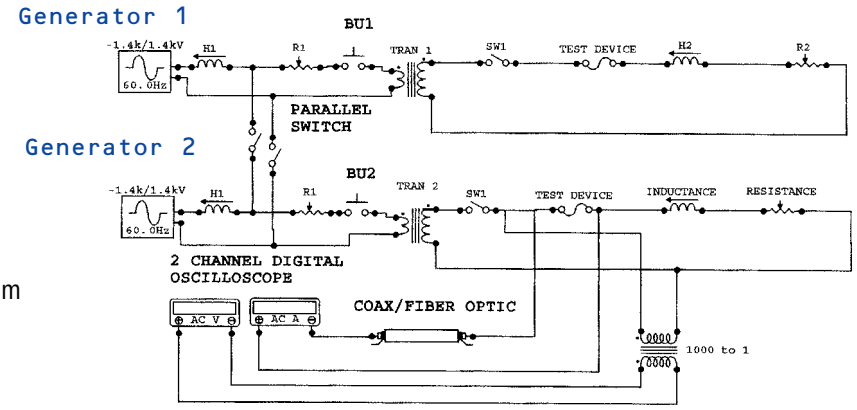
Transformers: 10MVA continuous-rated (68 MVA short-circuit)transformer with tap and voltage selection

SWI: Specially designed 100KA Making Switch – the closing angle may be controlled +/- 1 degree of a possible 180 degrees

H2: Continuous-duty secondary inductors from 0 to 1k ohms per phase

R2: Continuous-duty secondary resistor from 0 to 1k ohms

Data Acquisition: G.E. current-transformers and resistive shunts transmit interruption to digital oscilloscopes via coaxial cable or fiber optics



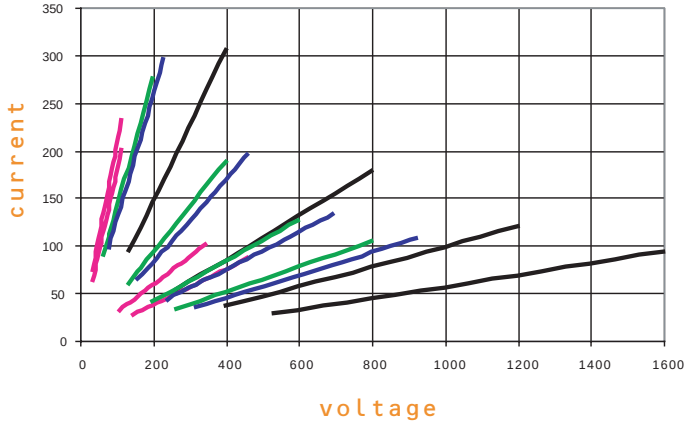
Europe (Saint Bonnet, France)

Maximum Test Capabilities

Station 1 3 MVA Utility line cell (Continuous current and voltages)
Single phase and Three phase test current up to 8000 amps RMS at up to 800 volts AC

Station 2 20 MVA Generator driven cell (up to 6 cycles)
Single phase and Three phase test currents up to 35,000 amps RMS at voltages from 80 volts to 1200 volts AC.

Station 3 400MVA Generator driven cell
Single phase only with test currents up to 350,000 amps RMS at voltages from 100 volts to 45,000 volts AC



Low Power Test Lab Capabilities

Clearing Test
0 – 6000 Amps continuous

Cycling Test
- Simulates starting and stopping of a system
- 0 – 3000 Amps for a given cycling rate – not a continuous rating

Temperature Test
Custom system used to monitor and store temperature data over a required time – system utilizes Labtec software to analyze and chart the rates of change.
- Thermal couples transmit data to analyzing software
- Voltage drop is continuously monitored by the Labtec system to produce time/voltage charts

Verification
At test completion, all temperature values and time of clearing will be verified using U.L., MSHA, CSA, and EIC standards. The Low-Power Lab utilizes variable transformers to produce currents which restrict voltage levels to less than 10VAC

To schedule test time, contact the Test Lab Manager via e mail, telephone, or in writing, at:

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When a test date has been arranged, the client will be sent an Engineering Test Agreement which must be filled out and returned prior to the test date. This agreement verifies the test date, and sets forth contract conditions for the client and the lab. Liability and responsibility are explained in the test agreement.

Requirements
- Client Purchase Order
- All witnesses to test must conform to Test Lab Visitor's Safety Policy
- Clients must read and sign Visitor's Safety Policy
- Test Lab recommends that the client have an engineer present during actual testing to ensure compliance to any special requirements

Testing
- Summary sheet of test lab charges is available on request and will be sent with the Engineering Test Agreement
- Testing is normally run in accordance with recognized standards such as UL, CSA, MSHA, and EIC
- All testing is treated with the strictest confidential awareness

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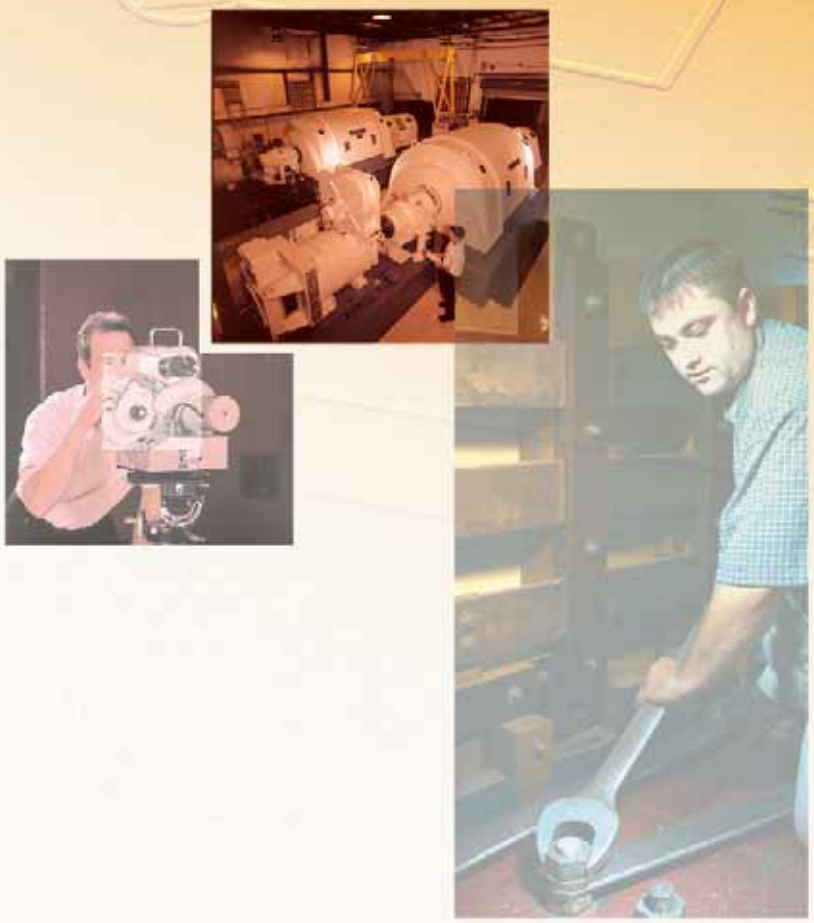

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