AC Dielectric Test Systems

PHENIX TECHNOLOGIES

Phenix Technologies offers a complete line of the most advanced AC Dielectric Test Systems with voltage and power ratings to meet your testing requirements.

CABLE | CIRCUIT BREAKER | GENERATOR | GIS SWITCHGEAR | INSULATION MATERIALS | MOTOR | PROTECTIVE EQUIPMENT | RECLOSER | TRANSFORMER

Specifications are subject to change without notice.

Brochure No. **60404**

AC Dielectric Test Systems

Phenix Technologies AC Dielectric Test Systems are designed to perform high voltage AC tests by measuring dielectric breakdown and dielectric strength of electrical equipment and insulating materials at commercial power frequencies. Our systems function in compliance with IEC 60060, IEEE 4, IEC 60270 and other recognized national and international industry testing standards.

Products requiring dielectric testing include:

- Rotating Machines
- Cable Joints/Splices
- Power Cables
- Switchgear (Air, Gas, Oil)
- Bushings
- Transformers, Shunt Reactors
- Instrument Transformers
- Fuses
- Lightning Arrestors
- Insulation Materials (Oil, Paper)
- Connectors
- Power Capacitors
- HV Components
- Coils
- Insulators
- Circuit Breakers
- Transmission Line Hardware
- Personal Protective Equipment (Rubber Goods) for Live Work

Phenix Technologies offers a variety of physical configurations suitable for many installation requirements and options to add significant testing capabilities. Our test systems are equipped with state-of-the-art programmable logic controllers with PC-based software to provide remote control, data acquisition, and automation capabilities for refined results.

Design Categories

Phenix Technologies AC Dielectric Test Systems are produced in two general design categories:
Conventional or Compensated

Conventional type designs are recommended for lower power requirements in which compensation is uneconomical or when the test object contains a large resistive component. The transformer and the regulator are rated for 100% of the test set's output power. It is the most versatile system and will test virtually any type of load.

In a **Compensated** design, the main power in the regulator is reduced with respect to the output power. Most commonly this is achieved through use of a low voltage reactor connected across the primary windings of the high voltage transformer. Primary compensation is typically variable in steps and can offer a near-perfect compensation.

Recognized Worldwide for Leadership and Innovation in Technology

Phenix Technologies has supplied AC Dielectric Test Systems for over 40 years. As a worldwide leader in high voltage, high current, and high power testing equipment, we have earned a reputation for high quality and custom-built equipment to meet our customer's exact requirements. Phenix is ISO 9001:2008 compliant which ensures high quality processes in both engineering and production to give our customers superior product reliability and years of service.

Phenix Technologies offers:

- Stand-alone, modular, caster-, truck-, trailer-, or skid-mounted systems
- Safety features to protect personnel and equipment
- Calibration Certificate traceable to NIST issued with every unit
- Detailed operator's manual
- Long-term customer support from fully experienced and knowledgeable staff

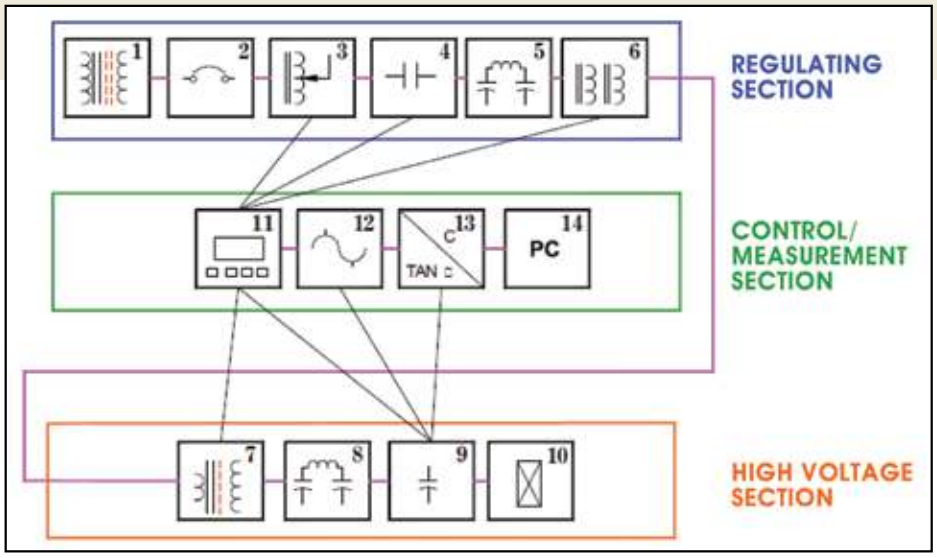
Safety and Design Features

Phenix designs in substantial safety features to protect personnel and equipment from potential injury, loss, or damage. To protect against flashovers or short circuits, our units have an adjustable electronic overload circuit. The circuit has a total response time of less than 30 milliseconds. The test sets have an input circuit breaker and backup overload protection in the primary input of the high voltage transformer. All test sets have additional standard protections including:

- Main power circuit breaker on regulator cabinet
- Operator key start
- Zero start interlock
- Emergency off mushroom pushbutton
- Slow and fast acting overload protection
- Surge protection on all meters and relays
- Overvoltage and overcurrent controls
- External interlock protection
- Controls in metal cabinet with provision for separate ground lead
- Overload circuit adjustable from 10% to 110% of rated current; includes indication with reset

Typical System Components

The AC Dielectric Test System consists of three main components: the controls, the power regulator, and the high voltage transformer. Our standard control package incorporates a state-of-the-art intuitive control system with a touch screen. The power regulator is based on our line of rugged and reliable variable auto transformers. The high voltage transformer is constructed of copper windings surrounded by a high quality steel core. The resulting system is a high quality design that provides many years of reliable service.



Note: Some components in above system diagram are options.

AC Dielectric System Diagram:

1 – Double Shielded Isolation Transformer
2 – Circuit Breaker
3 – Voltage Regulator
4 – HV-ON/OFF Contactor
5 – Low Voltage Filter
6 – Primary Compensation Reactors
7 – High Voltage Transformer
8 – High Voltage Filter
9 – Standard/Coupling Capacitor
10 – Test Object
11 – Controls
12 – Partial Discharge Detector
13 – C/Tan Delta Bridge
14 – Personal Computer

Controls and Metering

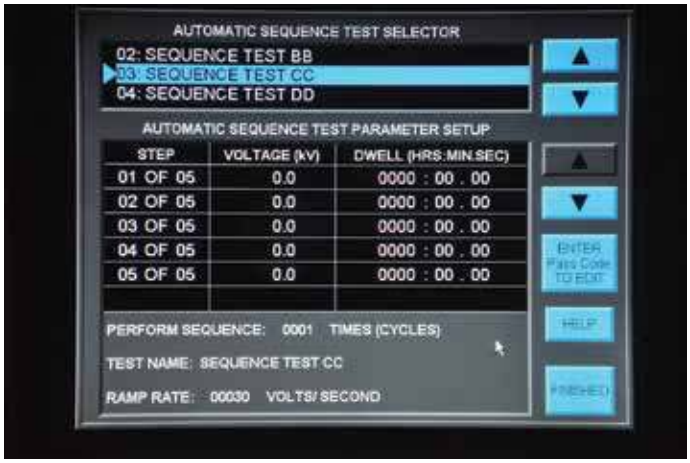
Phenix Technologies uses the latest development in computer-assisted controls. Our configuration creates ease in setup and simplicity in testing. The test system features a full-color touch screen liquid crystal display and Ethernet port to select automation modes through a remote personal computer interface. Functions and metering include:

- Auto Ranging Voltmeter
- Bar graph displays % kV
- Auto Ranging Current Meter
- Bar Graph displays % A
- Peak Memory Voltmeter
- Failure Memory Voltmeter
- Peak Memory Current Meter
- Auto Voltage
- Dwell Timer
- Auto Step
- Auto Sequence
- Over Voltage
- Over Current
- Duration Timer
- Motorized Regulator
- Motorized Tap Selector
- Variable Ramp Rate
- Burn Mode (optional)

Also included are calibration and service modes. All adjustments needed for yearly recalibration are simply made by adjusting a few numbers in the software. The service mode assists and simplifies maintenance, and helps in the diagnosis of failed components in the rare cases that may be necessary.

Normal Control Mode (Local) Screen

Set Up Test Screen



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Software

Phenix Technologies PC based software provides innovative features through a user friendly interface. The operator enters specific test parameters, or recalls previous test "recipes" for easy test duplication. Test results can be displayed, stored to a database, or printed.

Test Results

Test results can be viewed in table or chart format and show real-time voltages, current, step, dwell, and duration data. Report generating options allow for a concise or detailed print-out of data.

Test History

The software collects all saved test results in a database for easy recall and review. Search, sort, and printing of previous test results can be performed.

Test Profiles

Create new test profiles or "recipes" by selecting a custom test, cycle test, or step test and then choosing a tap value. A screen opens to enter test criteria desired, and the test profile is saved, and may be run or downloaded. Quickly recall previous profiles by test type, description, or ID value.

Instrumentation

A high precision measuring system is designed to enable accurate measurement of voltages and currents. The metered information is displayed on the Operator Interface Panel. The values displayed on the Operator Interface Panel are performed as a function of the programmable logic controller (PLC). The following metering measurements are displayed:

AC Voltage is measured by means of peak responding circuitry and is displayed in its peak/$\sqrt{2}$ value.
Accuracy: ± (0.8% of Reading + 0.2% of Range to least significant digit (LSD)

AC Current is measured by means of true RMS conversion.
Accuracy: ± (0.8% of Reading + 0.2% of Range to LSD)

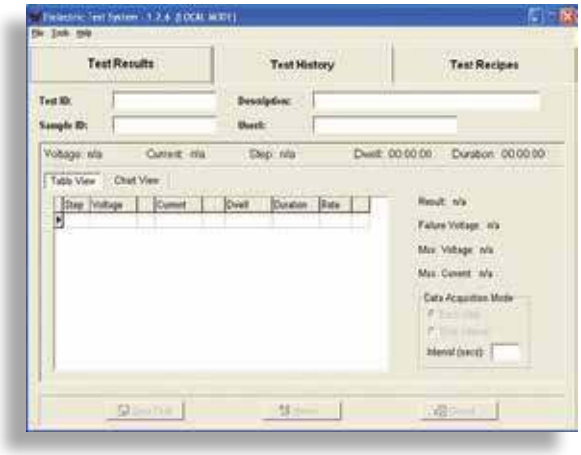
Duration and Dwell Timers. Time is displayed in an HOURS:MINUTES:SECONDS format from 0000:00:00 to 9999:59:59.

Maximum Test Voltage Memory Meter. The maximum applied test voltage level is retained and displayed.

Failure Voltage Memory Meter. The applied test voltage level at the time of a specimen failure is retained and displayed.

Maximum Current Memory Meter. The maximum current level reached during a test is retained and displayed.

Specialty test applications may be included as options within our designs. Please consult one of Phenix Technologies Sales Representatives for further information.



Voltage Regulator

The regulator is an air-insulated, variable autotransformer. Housed in a rugged steel cabinet, the regulator may contain the operator control panel to save space and simplify setup procedures. The regulator cabinet includes a main input circuit breaker and a contactor for high voltage ON/OFF. It is also designed with a limit switch to provide zero start interlock. The cabinet also may be ordered with options such as a writing desk for operator personnel.

SIZE OF THE POWER REGULATOR
(by output kVA based on 1 hour ON/1 hour OFF Duty Cycle)

Input		Output Current		L	W	H	Weight	L	W	H	Weight
208 V	230V	1 hour ON/ 1 hour OFF	Continuous	Inches			lbs	mm			kgs
10.1 kVA	11.2 kVA	49 A	35 A	24	24	60	300	610	610	1524	136
20.3 kVA	22.5 kVA	98 A	70 A	24	24	60	350	610	610	1524	159

Input		Output Current		L	W	H	Weight	L	W	H	Weight
400 V	480V	1 hour ON/ 1 hour OFF	Continuous	Inches			lbs	mm			kgs
19.6 kVA	23.5 kVA	49 A	35 A	24	24	60	350	610	610	1524	159
39.2 kVA	47.0 kVA	98 A	70 A	24	24	60	550	610	610	1524	249
59.2 kVA	71.0 kVA	148 A	105 A	24	24	72	750	610	610	1828	340
78.8 kVA	94.5 kVA	197 A	140 A	24	32	80	950	610	813	2032	431
98.8 kVA	118.5 kVA	247 A	175 A	42	32	60	1150	1066	813	1524	521
118.4 kVA	142.0 kVA	296 A	210 A	42	32	60	1350	1066	813	1524	612
138.4 kVA	166.0 kVA	346 A	245 A	42	32	66	1500	1066	813	1676	680
158.0 kVA	189.6 kVA	395 A	280 A	42	32	72	1650	1066	813	1828	748
192.0 kVA	230.0 kVA	480 A	315 A	56	40	64	1850	1422	1016	1625	840
237.2 kVA	284.6 kVA	593 A	420 A	56	40	72	2350	1422	1016	1828	1066
296.8 kVA	356.1 kVA	742 A	525 A	56	46	92	2850	1422	1168	2336	1292

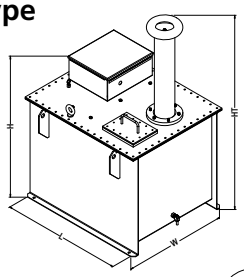
NOTE: Dimensions and weight may vary with final design.

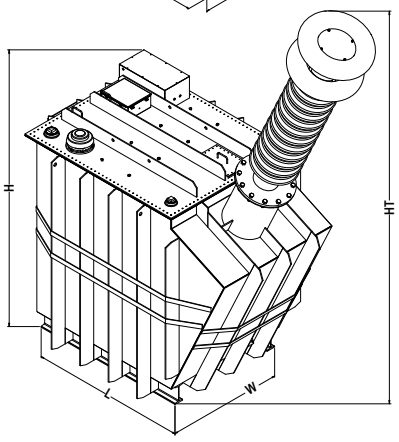
1) Higher power regulators may be quoted upon project specific request
2) Regulator output current is calculated by multiplying the high voltage transformer output voltage x high voltage transformer output current, dividing by the input (mains) voltage and then multiplying by 1.05 to account for losses. (Voutput * Ioutput)/ Vinput)* 1.05 =Regulator Output Current. The appropriate regulator is then selected based on the current and duty cycle of the system. Regulator dimensions include control mounting.
3) If the controls are mounted in a separate control console, the height of the regulator will be reduced by approximately 5" (127mm).
4) Regulator accepts input mains voltages from 208-240V or from 380-600V.
5) Additional components such as line filters, burn chokes and compensation reactors will increase power regulator cabinet dimensions.
6) Testing in severe environmental conditions will affect the size and design of the enclosure for both the regulator and the HV transformer.

Type and Size of the High Voltage Transformer

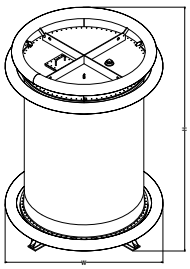
AC dielectric tests for many test specimens use high current/high power that requires a separate HV transformer. The transformer will be one of two types: a grounded (dead) steel tank with a high voltage output bushing; or a cylinder type that uses fiberglass cylinders to achieve the required high voltage isolation. Cylinder type units can be designed to be stacked to obtain either higher output voltages (series) or higher currents (parallel). Both types are filled with mineral oil. Phenix Technologies transformers use copper windings and a high permeability steel core to provide units with a long, reliable, and efficient service life.

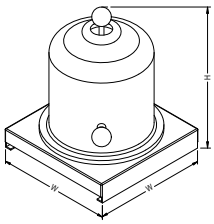
TANK Type





CYLINDER Type





Up to 100 kV

Power Ratings kVA 1 Hr ON / 1 Hr OFF (5 Min ON/15 Min OFF)	Voltage Rating kV	Output Current mA	Tank Type: Length inches mm	Width inches mm	Height inches mm	Weight lbs kgs	Cylinder Type: Length inches mm	Width inches mm	Height inches mm	Weight lbs kgs
7.5 (10)	30	250 (300)	28 712	28 712	47 1200	717 325	27 685	27 685	28 712	452 205
	50	150 (200)	28 712	28 712	47 1200	717 325	27 685	27 685	28 712	452 205
	75	100 (133)	34 850	28 712	49 1250	827 375	27 685	27 685	30 762	474 215
	100	75 (100)	36 902	28 712	54 1375	937 425	27 685	27 685	30 762	507 230
20 (30)	30	667 (1000)	28 712	28 712	47 1200	772 350	X	X	X	X
	50	400 (600)	31 790	28 712	47 1200	838 380	X	X	X	X
	75	267 (400)	34 864	28 712	52 1310	1058 480	X	X	X	X
	100	200 (300)	38 970	31 787	53 1350	1200 544	36 910	36 910	46 1170	1014 460
40 (60)	30	1333 (2000)	30 762	28 712	47 1200	1058 480	X	X	X	X
	50	800 (1200)	30 762	28 712	47 1200	1058 480	X	X	X	X
	75	533 (800)	36 927	35 890	52 1325	1874 850	X	X	X	X
	100	400 (600)	38 965	35 890	61 1550	2039 925	39 990	39 990	46 1170	1500 680
60 (85)	30	2000 (2833)	35 890	28 712	47 1200	1257 570	X	X	X	X
	50	1200 (1700)	34 864	32 813	52 1310	1433 650	X	X	X	X
	75	800 (1133)	41 1053	36 927	56 1430	1951 885	X	X	X	X
	100	400 (850)	41 1053	38 965	61 1550	2403 1090	39 990	39 990	50 1270	2094 950
100 (140)	30	3000 (2000)	38 977	34 876	47 1200	1984 900	X	X	X	X
	50	2000 (2800)	36 902	32 813	49 1250	1984 900	X	X	X	X
	75	1333 (1867)	40 1016	38 965	59 1500	2810 1275	X	X	X	X
	100	1000 (1400)	50 1270	46 1170	65 1650	3858 1750	43 1100	43 1100	57 1450	2976 1350
200 (280)	50	4000 (5600)	48 1220	38 965	52 1310	2866 1300	X	X	X	X
	100	2000 (2800)	50 1270	50 1270	65 1650	4519 2050	X	X	X	X
300 (420)	100	3000 (4200)	50 1270	50 1270	65 1650	4519 2050	X	X	X	X

Above 100 kV

20 (30)	150	133 (200)	47 1200	32 813	98 2500	2425 1100	41 1040	41 1040	58 1470	1808 820
	200	100 (300)	83 2100	42 1066	98 2500	4300 1950	41 1040	41 1040	61 1550	2315 1050
40 (60)	150	266 (400)	80 2030	36 927	95 2415	3153 1430	52 1325	52 1325	61 1550	3748 1700
	200	200 (300)	112 2844	44 1118	106 2695	4850 2200	52 1325	52 1325	61 1550	3748 1700
60 (85)	150	400 (566)	65 1651	40 1016	96 2438	3748 1700	58 1475	58 1475	62 1575	4189 1900
	200	300 (425)	134 3400	46 1170	84 2134	5511 2500	58 1475	58 1475	62 1575	4189 1900
	300	200 (283)	83 2120	54 1360	160 4075	10,582 4800	58 1475	58 1475	90 2290	5511 2500
100 (140)	150	667(933)	103 2616	46 1170	81 2060	4795 2175	50 1270	50 1270	64 1625	3637 1650
	200	500 (700)	152 3850	55 1385	69 1750	7385 3350	57 1450	57 1450	77 1950	5400 2450
	300	334 (467)	145 3685	60 1525	162 4125	14,000 6350	65 1660	65 1660	88 2240	7937 3600
200 (280)	200	1000 (1400)	128 3260	57 1460	113 2870	10,692 4850	70 1780	70 1780	81 2050	8377 3800
	300	667 (933)	111 2825	63 1590	172 4370	14,991 6800	70 1780	70 1780	95 2420	10,141 4600
	400	500 (560)	246 6240	72 1820	138 3500	21,825 9900	84 2130	84 2130	122 3100	16,755 7600
300 (420)	200	1500 (2100)	128 3260	57 1460	113 2870	10,692 4850	70 1780	70 1780	81 2050	8818 4000
	300	1000 (1400)	175 4450	69 1760	151 3830	21,164 9600	70 1780	70 1780	95 2420	10,582 4800
	400	750 (1050)	146 3708	72 1820	237 6010	24,250 11000	84 2130	84 2130	122 3100	16,755 7600
	500	600 (840)	102 2600	114 2900	326 8280	41,888 19000	87 2210	87 2210	170 4320	25,794 11700
400 (585)	300	1333 (2000)	228 5800	72 1820	201 5100	20,945 9500	73 1850	73 1850	98 2500	13,007 5900
	400	1000 (1426)	228 5800	72 1820	201 5100	24,250 11000	84 2130	84 2130	126 3200	21,164 9600
	500	800(1170)	107 2720	115 2920	326 8280	46,297 21000	87 2210	87 2210	170 4320	28,660 13000
500 (710)	500	1000 (1420)	115 2920	115 2920	326 8280	50,706 23000	87 2210	87 2210	170 4320	31,967 14500

X – Units not Available

The cascaded cylinder type transformers are contained in an oil-filled enclosure characterized by its cylindrical shape. The enclosure is vertically divided into three sections. Two sections are fiberglass isolating sections separated by a steel center section floating at half the transformer's potential. The core is constructed out of high quality grain oriented laminated steel surrounded by layer type copper windings. Each transformer is equipped with balancing and tertiary windings which transfer power to the next module in the cascade. The tertiary windings also allow the operation of modules in parallel without having to un-stack the cascade.

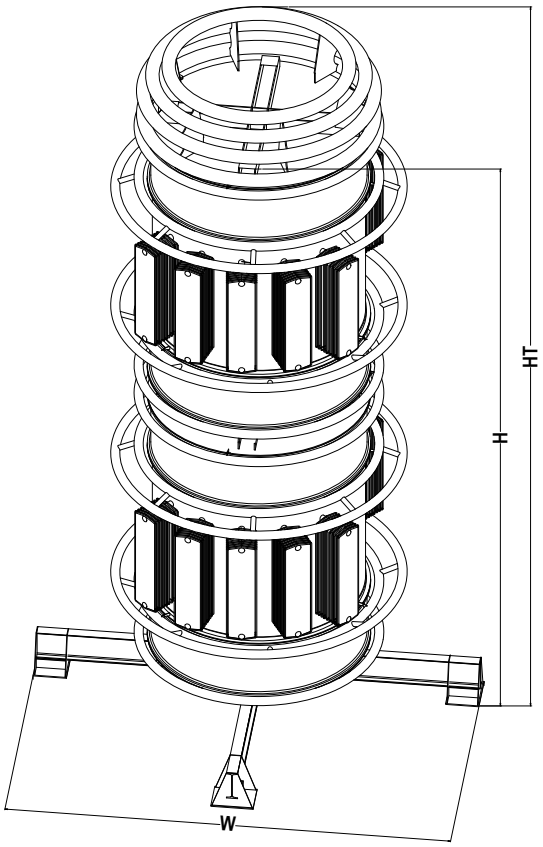
Each transformer is equipped with surge arrestors and a temperature gauge mounted in the steel section of the cylinder. For units with continuous duty cycles, either radiators or a forced oil cooling system are used to meet the extra cooling requirements. Cylinder type transformers are designed for indoor, low pollution environments.

Cascaded, Cylinder Type

Power Ratings kVA 1 Hr ON / 1 Hr OFF 5 Min ON /15 Min OFF	Voltage Rating kV	Output Current mA	Individual Cylinder Length inches mm	Width inches mm	Height inches mm	Weight lbs kg	Cascade Total Length inches mm	Width inches mm	Height inches mm	Weight lbs kg
200 (140)	2 x 200 = 400	500 (700)	49 1250	49 1250	107 2730	13,007 5900	117 2970	117 2970	241 6115	29,320 13300
400 (560)		1000 (1400)	65 1650	65 1650	107 2730	18,740 8500	117 2970	117 2970	241 6115	40,785 18500
800 (1120)		2000 (2800)	76 1930	76 1930	107 2730	23,150 10500	117 2970	117 2970	241 6115	50,044 22700
250 (350)	2 x 250 = 500	500 (700)	88 2235	88 2235	95 2413	22,500 10200	102 2590	102 2590	240 6096	43,650 19800
500 (700)		1000 (1400)	95 2410	95 2410	96 2450	27,560 12500	117 2970	117 2970	244 6200	58,422 26500
1000 (1400)		2000 (2800)	100 2550	100 2550	100 2550	36,375 16500	117 2970	117 2970	252 6400	76,060 34500
300 (420)	2 x 300 = 600	500 (700)	91 2310	91 2310	108 2750	23,150 10500	117 2970	117 2970	252 6400	52,470 23800
600 (840)		1000 (1400)	91 2310	91 2310	110 2794	26,015 11800	126 3200	126 3200	256 6500	55,336 25100
1200 (1680)		2000 (2800)	100 2550	100 2550	110 2800	38,580 17500	126 3200	126 3200	256 6500	80,470 36500
750 (1050)	2 x 350 = 700	1000 (1400)	100 2550	100 2550	126 3200	40,785 18500	126 3200	126 3200	307 7800	84,880 38500
1400 (2100)		2000 (2800)	110 2800	110 2800	142 3600	46,300 21000	126 3200	126 3200	339 8600	95,900 43500
2800 (3920)		4000 (5600)	119 3020	119 3020	180 3800	55,115 25000	140 3560	140 3560	358 9100	112,435 51000
800 (1120)	2 x 400 = 800	1000 (1400)	116 2950	116 2950	140 3550	41,445 18800	117 2970	117 2970	341 8660	83,775 38000
1600 (2240)		2000 (2800)	112 2850	112 2850	146 3700	50,706 23000	126 3200	126 3200	354 9000	104,720 47500
2400 (3360)		3000 (4200)	112 2850	112 2850	153 3880	55,555 25200	140 3560	140 3560	364 9250	13,075 59000
3600 (5040)	3 x 300 = 900	4000 (5600)	112 2850	112 2850	149 3790	61,070 27700	156 3950	156 3950	504 12800	190,700 86500
2400 (3360)	3 x 400 =1200	2000 (2800)	112 2850	112 2850	148 3760	58,200 26400	184 4675	184 4675	543 13800	181,880 82500

NOTE: Dimensions and weight may vary with final design.

CASCADED CYLINDER Type



Interconnect Cables

Phenix Technologies supplies a shielded, multi-conductor control cable from the regulator to the transformer. Phenix includes a standard control cable of 20 feet (6m) for units up to 200 kV; 30 feet (9m) for units 200-300 kV; and 40 feet (12m) for those above 300 kV. If a separate control cabinet is ordered, a control cable from the regulator is also included. Special length control cables or power cabling are optional items. If ordered, power cables must be in compliance with local codes.

Optional System Components

Control Desk

- **Control Desk:** Added table space enhances the operator's workstation for observing and recording test results.
- **Casters:** Enables easier movement of test system within testing area
- **Multiple Output Taps:** To extend testing range.
- **Low Voltage Line Filters:** Installed on AC lines to prevent electromagnetic interference (EMI).

  Benefit: Low voltage line filters suppress high frequency noise that is present on mains. This noise which interferes with partial discharge measurements is typically generated by electronic switching devices such as motor drives, power supplies and/or ballasts for lights. The filters are high attenuation multi-stage LC filter networks that provide a typical minimum attenuation of about 80 db from 30 kHz to 20 MHz and are connected between the output of the regulator and the primary of the high voltage step-up transformer.

Low Voltage Line Filters

- **Double Shielded Input Isolation Transformer:** A two-winding transformer has several purposes. Among them are keeping third and multiple harmonics away from sensitive equipment; also to provide an electrostatic shield between primary and secondary windings to avoid transfer of surge/impulse voltages; softening of high frequency noise from the input side.

  Benefit: provides shielding to avoid surge/impulse damages, or to provide a lower level of frequency noise.

High Voltage Filters

- **Burn Choke:** Current limiting choke connected in series with the primary winding offers the capability to "burn" the faults in test specimen at a controlled current. Available with rating from 25-100% of rated kVA.

  Benefit: Used in locating faults during cable or insulator testing.

- **High Voltage Filters:** Located between output of high voltage transformer and test circuit to prevent line borne electromagnetic interference (EMI) from passing through.

  Benefit: Enables sensitive partial discharge and/or RIV measurements to be made.

- **Coupling Capacitors, Injection Capacitors & Partial Discharge (PD) Measurement Systems:** Coupling capacitors allow passage of AC signals to connect in two circuits while blocking the DC component. Injection capacitors in an AC circuit are an option that permits ongoing calibration for partial discharge measurements. Partial discharge measurement is used to detect breakdown in insulating materials creating arcing or sparks when under high voltage stress.

  Benefit: Coupling capacitors are useful in stabilizing voltage and power flow for testing. Injection capacitors ensure continuous review of partial discharge testing. Partial Discharge measuring circuits are critical in measuring cable faults.

- **Standard Capacitors & Tangent Delta (Tan ð) Measurement Systems:** Provides the capability to perform dielectric loss measurements on cable insulation, when assessing the insulation quality of newly manufactured cables, or estimating the insulation quality in service aged cables.

- **Preload and Load Capacitors:** Provide a low loss capacitance typically connected in parallel with the object under test. The preload capacitors are typically used with units equipped with inductive reactive compensation and resistive objects under test. When used in this application, the capacitors provide reactance to compensate the primary compensation and reduce regulator/mains current demand. The other application is to provide additional fault energy/output voltage support in cases where large transients or large partial discharges are expected such as pollution or corona testing.

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TECHNOLOGIES

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