power
circuit
breakers

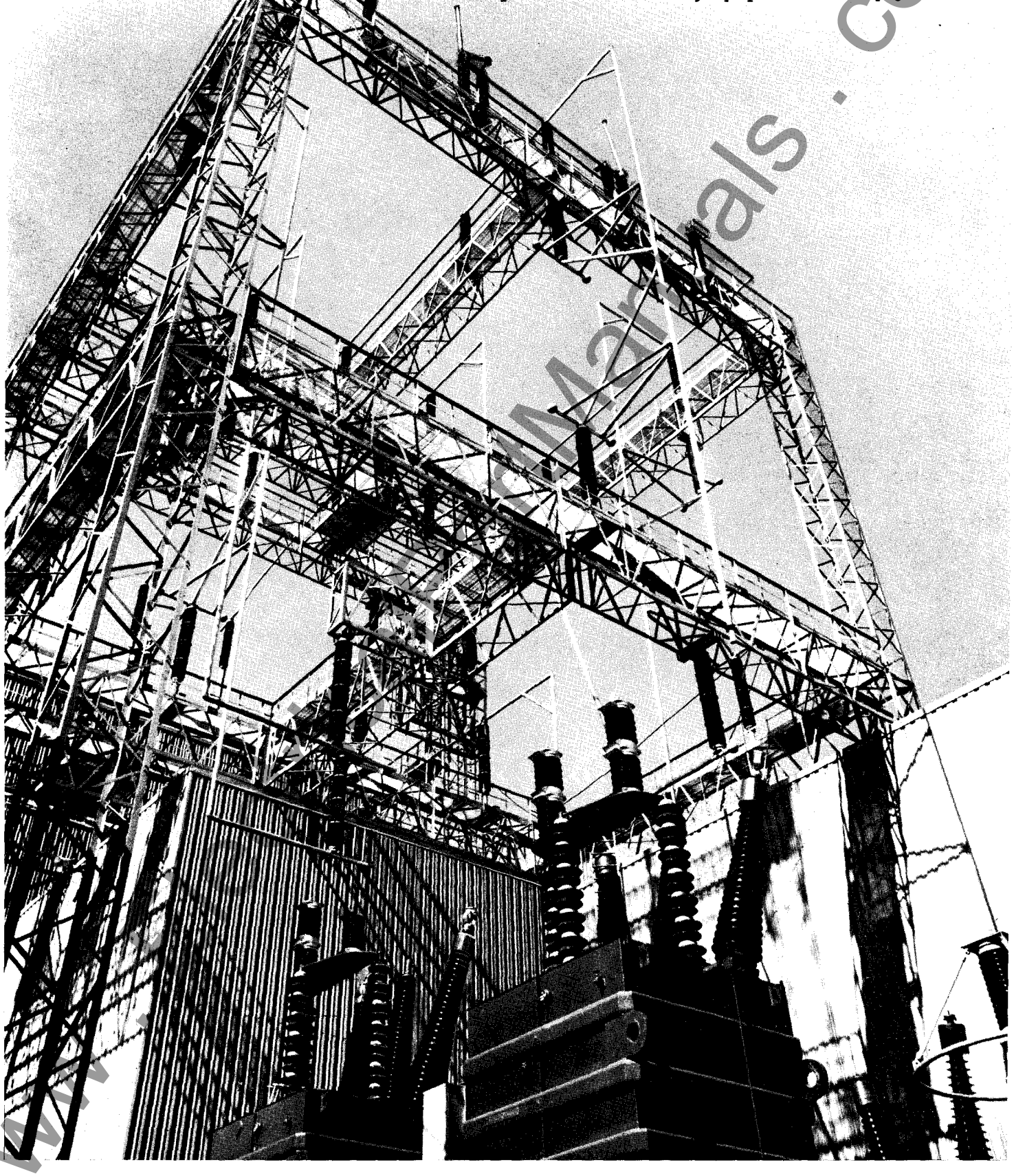
Westinghouse high power laboratory

technical data

33-065

page 1

complete testing facilities for the development of electric u ility equipment



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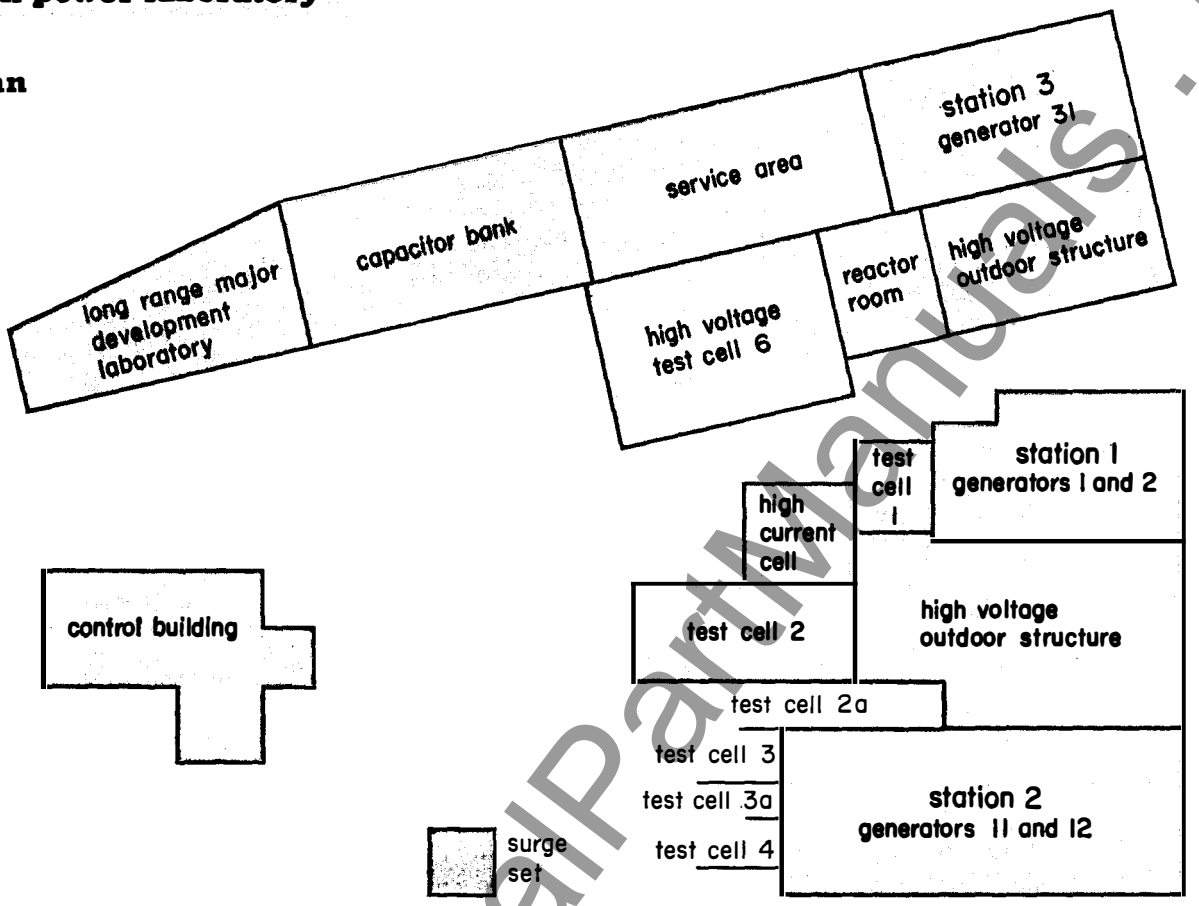
October, 1962
new information
mailed to: E/1139/DB; C/330-334/AD

high power laboratory

plan



application

The Westinghouse high power laboratory is a complete, modern installation equipped for observing electrical apparatus operating in short circuit situations, with actual fault conditions simulated. Since 1925 the laboratory, continually expanded, has been the proving ground for development and verification of new designs for future, as well as existing, demands of electric utility systems.

The efficiency and scope of the high power laboratory facilities cut testing time to a minimum on all equipment from the smallest, 600 volt and below, through the largest power equipment used at the highest transmission voltages. Increased variety of tests, improved instrumentation, and efficient assembly line methods of handling apparatus make possible economical testing, and economical equipment design.

In addition to verifying power circuit breaker designs, tests in the high power laboratory assure superior performance and complete dependability in all Westinghouse products including:

arresters	disconnecting switches	insulators	switchgear
capacitors	fuses	reactors	transformers

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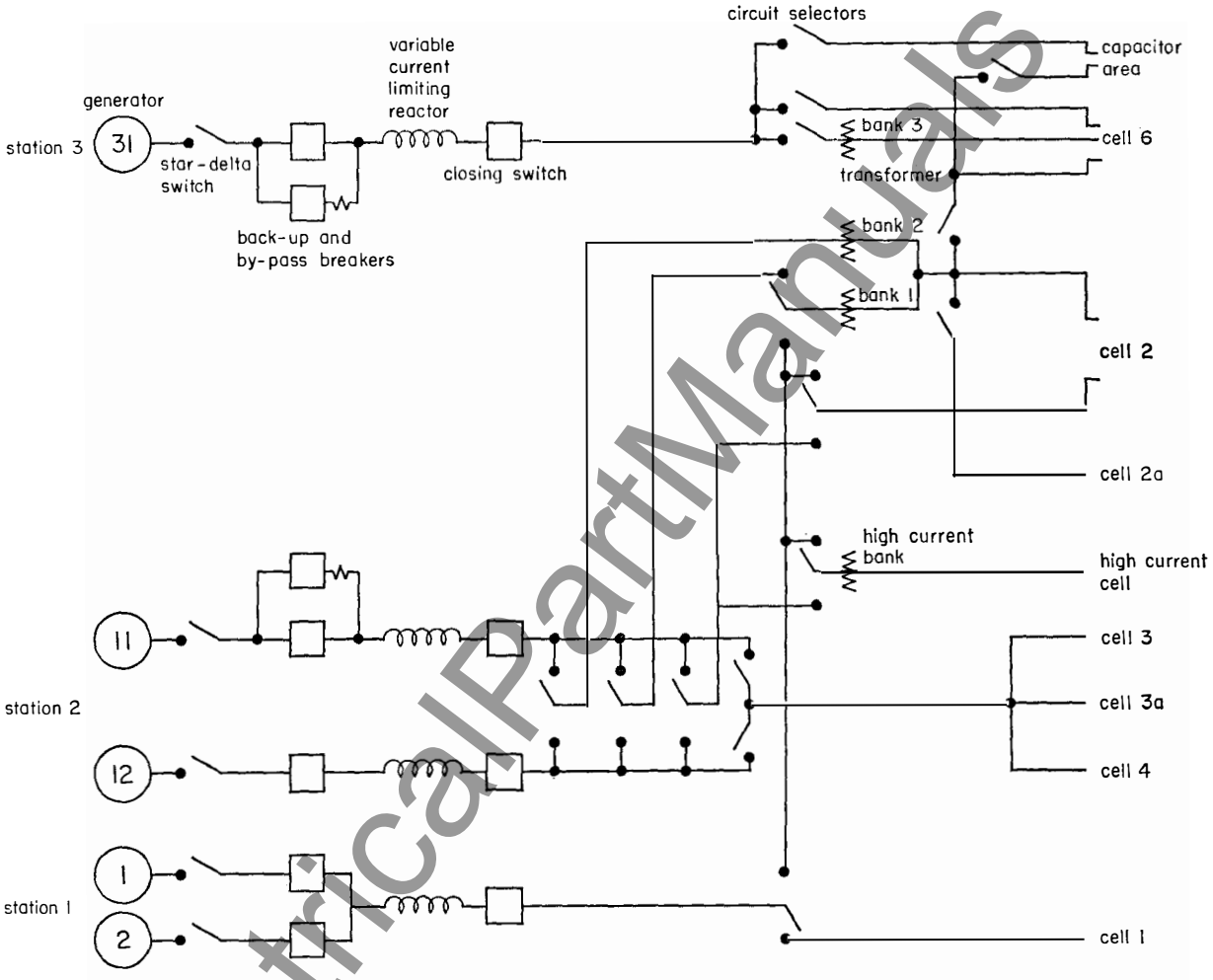
schematic



capabilities

table I

test circuit	maximum mva		
	station 2	station 3	combined
single phase through transformers	1000	1500	2500
three phase through transformers	1700	1500	3200
three phase at 13.2 kv▲	2500	....	....
three phase at 16.5 kv✤	900	3000	3900
single phase at 13.2 kv▲	1250	....	....
single phase at 16.5 kv✤	560	1500	2060

▲ No provision made for paralleling at generator voltages.
✤ Using station 2 at 22 kv connection through transformers; underexciting to 16.5 kv.

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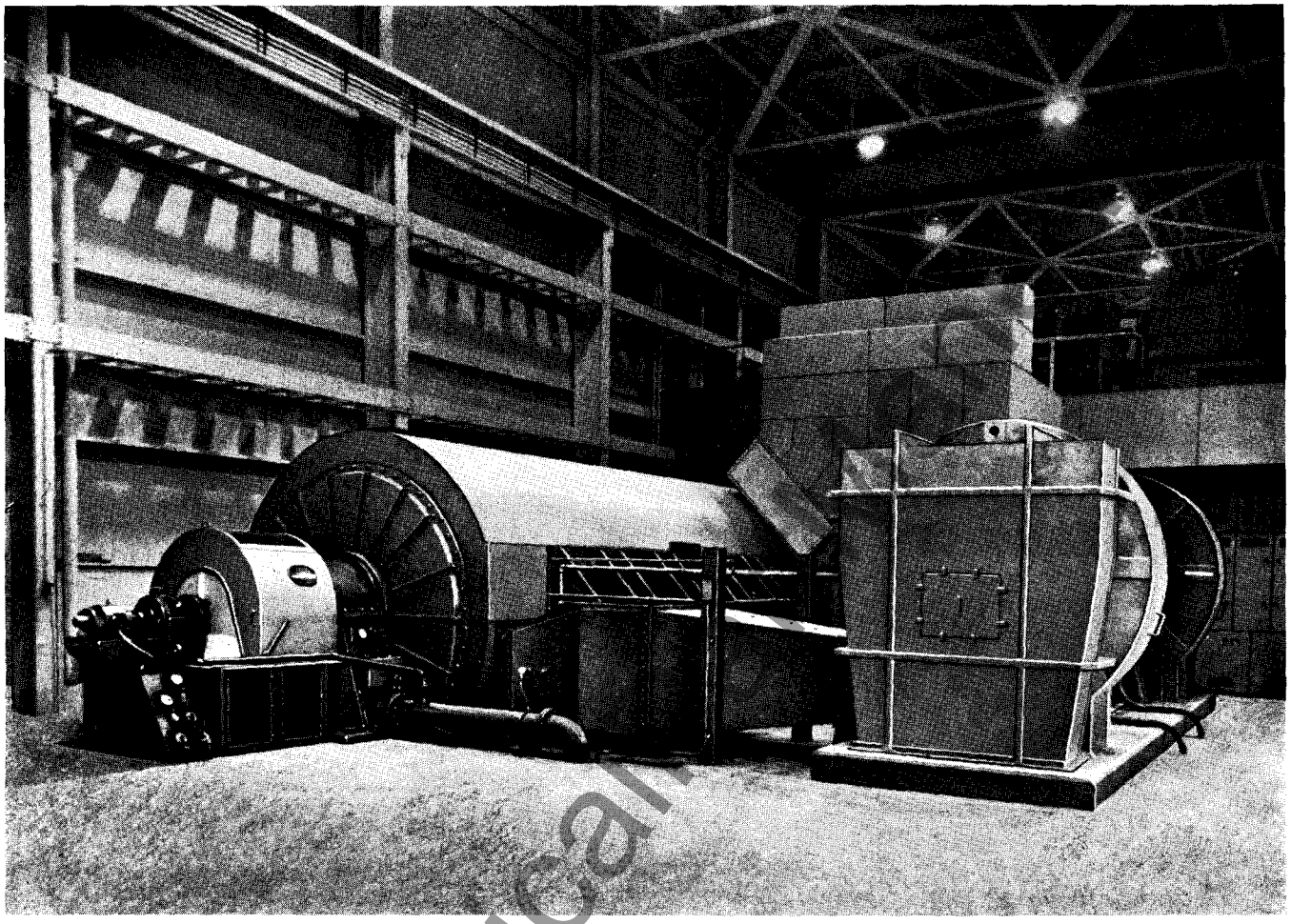
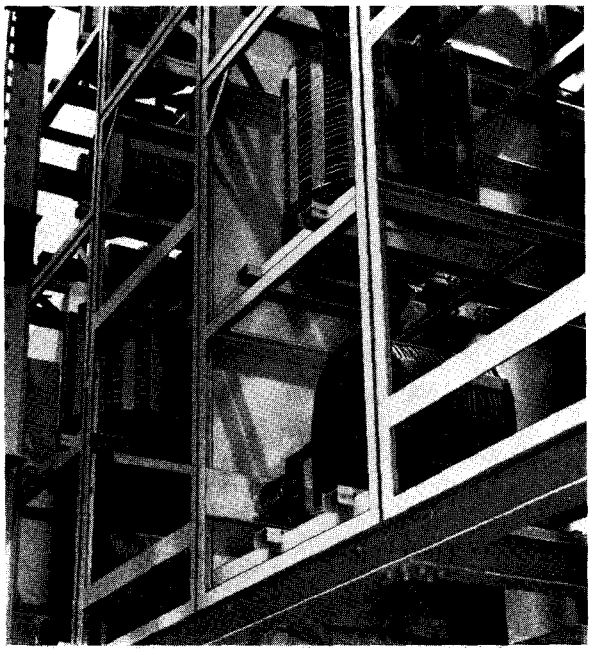
generating equipment



In station 3, above, there is a 3600 rpm generator with a capability of 3000 mva at 16.5 kv.

Station 1 has a two-unit generating set driven by a wound rotor motor. The exciters are separately driven. This station has a short circuit capability of 500 mva and is convenient and economical for testing smaller apparatus.

The two 514 rpm generator sets in station 2 have a combined output of 2500 mva at 13.2 kv.



reactors

Switched reactors, remotely operated from the control room, are used to control test current values.

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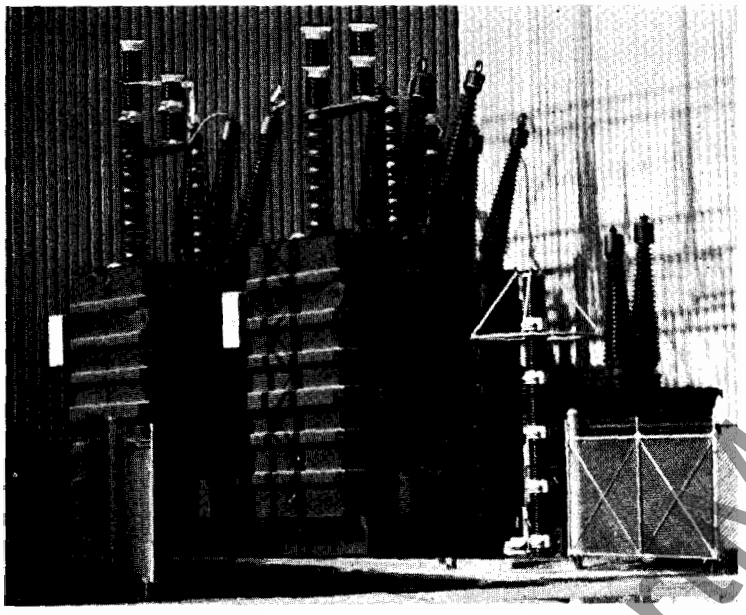
high voltage equipment — transformers



At station 3 are three single phase transformers, each rated at 500,000 kva short circuit capacity. These transformers are used by themselves or in conjunction with the six transformers in station 2 for a wide variety of voltage combinations, as shown in tables II and III.

Insulation to ground for one bank of transformers at station 2 is 132 kv, and 196 kv for the other bank. Transformers at station 3 are insulated for 286 kv to ground.

table II: single phase voltage combinations ●

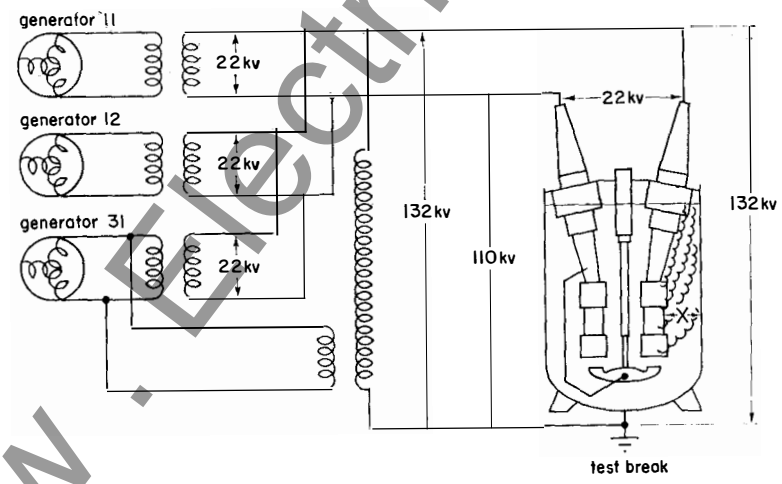
kv	mva capacities		
	station 2	station 3	combined
22	1000	1500	2500
44	1000	1500	2500
66	1000	1500	2500
88	1000	1500	2500
110	....	....	2500
132	1000	1500	2500
154	....	....	2350
176	....	....	2000
198	1000	....	2250
220	....	....	2500
264	1000	1500	2500
352	....	....	2000
396	1000	....	2250
462	....	....	2350
572	....	....	1425

table III: three phase voltage combinations

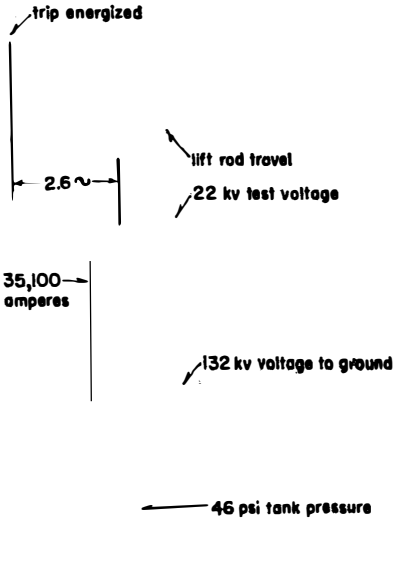
22 ◉	1700	1500	3200
38 △	1700	1500	3200
44 ◉	1700	1500	3200
66 ◉	1700	....	....
76 △	1700	1500	3200
88 ◉	1700	1500	3200
115 △	1700	....	....
132 ◉	1700	....	....
154 △	1700	1500	3200
230 △	1700	....	....
345 △	1275	....	....
495 △	....	....	1830

● All voltages 154 kv and above are made with mid-point grounded
◉ delta connection △ wye connection

biased single phase tests



Special test connections for increasing voltage at tank point "x", to demonstrate insulation strength during high power insulation test.



Oscillogram of high power interrupting test at 22 kv, with 132 kv maintained for several seconds between one terminal and ground by circuit above.

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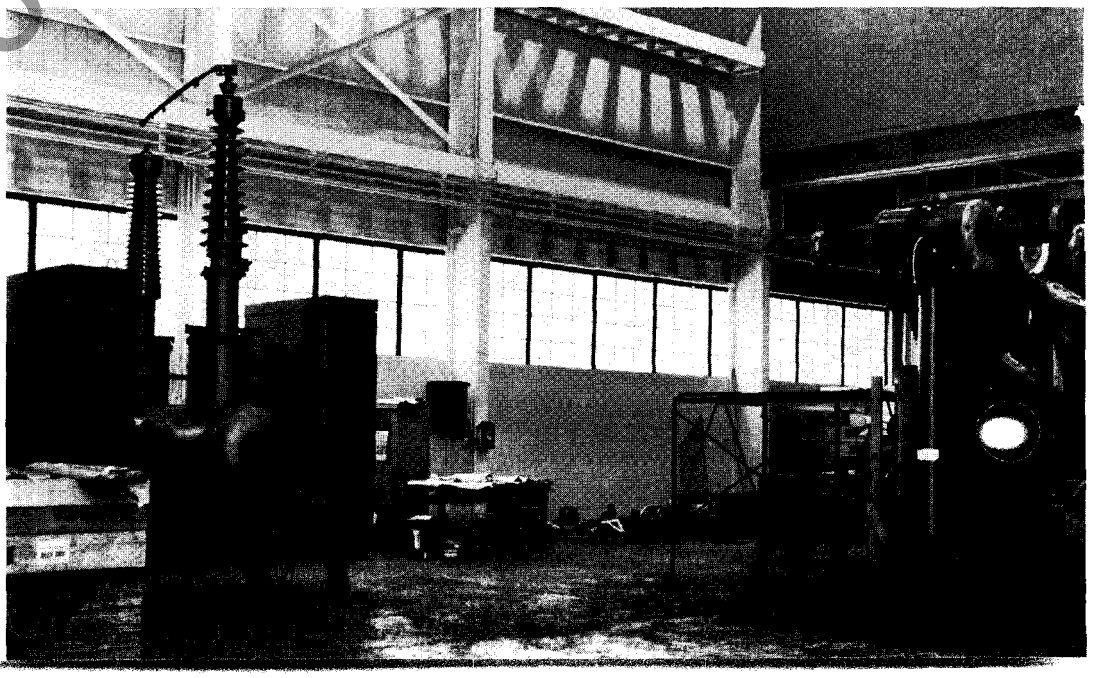
test cell

Two test cells in station 3, one for tests at transformer voltages, the other for tests at 16.5 kv generator voltage, form a semi-circle with test cells of the other stations, facing the control room. The generators, transformers and control of stations 2 and 3 are arranged so that their combined capacity can be directed to station 3 test cells. All three stations can be operated separately with independent tests conducted.

service area

A service and repair shop, equipped with a railroad spur and twenty ton crane, is conveniently located adjacent to the test area. Changes, repairs or adjustments to equipment are made with a minimum loss of time.



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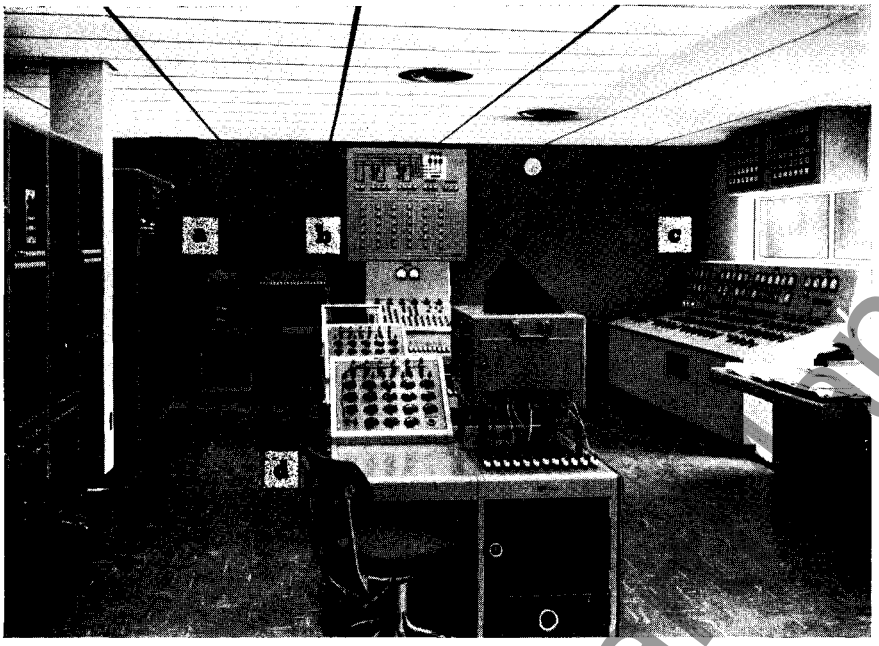
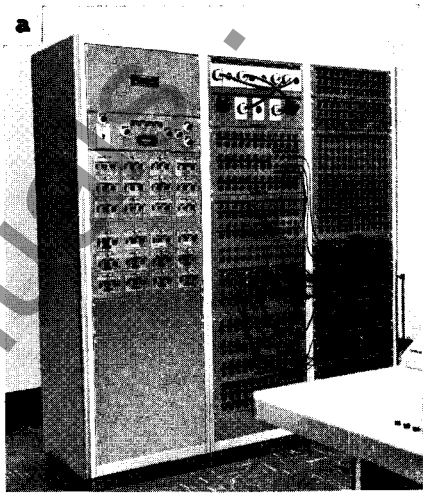
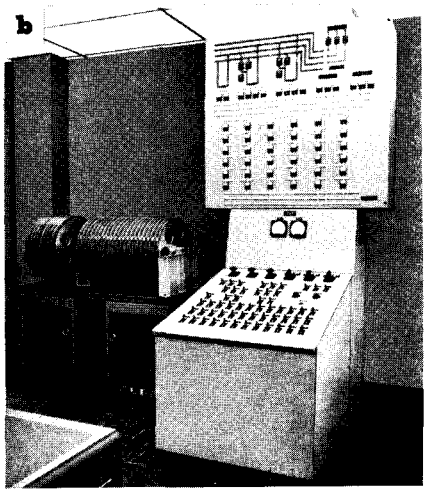
control



The central control room is equipped with the latest Westinghouse control desks, with modern cathode ray and magnetic oscillographs. From this room switches for the reactor groups are remotely controlled, while an analog computer device checks the choice of reactor settings prior to application of fault current to test sample.

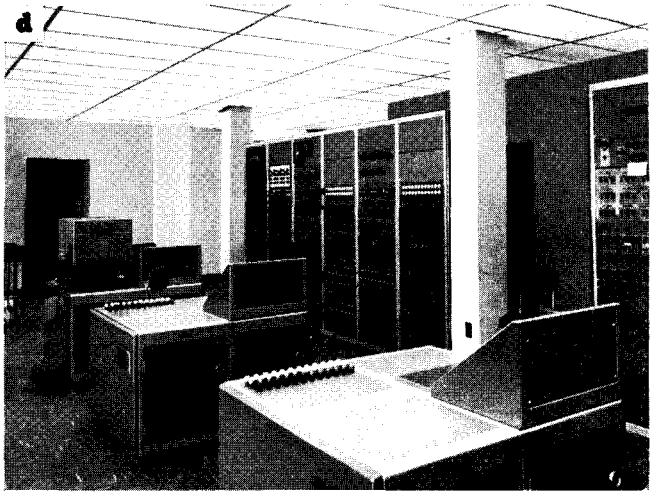


digital sequence timer patch board



analog computer with control panel for determining test current reactor settings

main control desk with test cells in background



control room instrumentation panels and oscillograph tables

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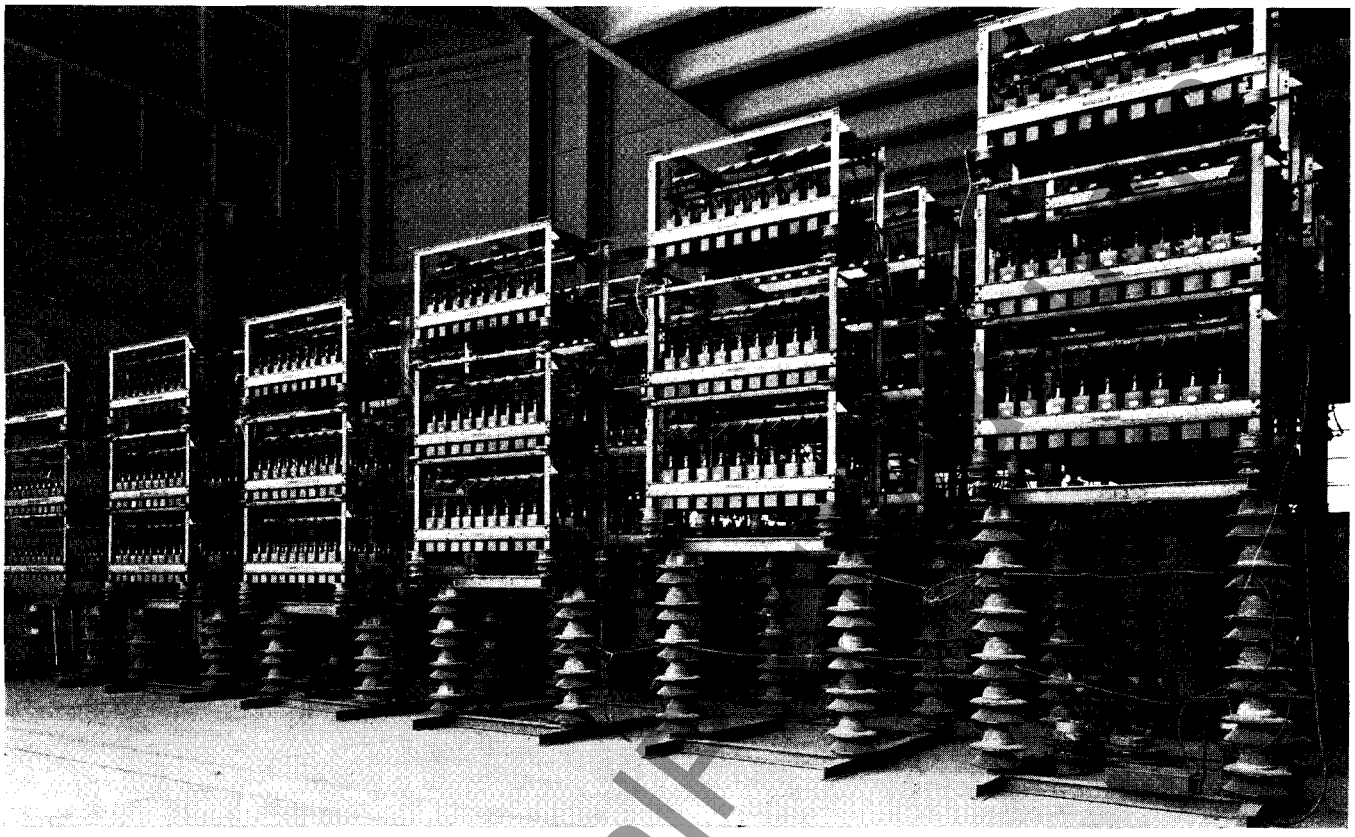
capacitor bank



Capacitors at station 3 for testing up to approximately 100,000 kvar isolated, or 50,000 kvar back-to-back, and for simulating unloaded transmission lines up to roughly 500 miles at 345 kv.

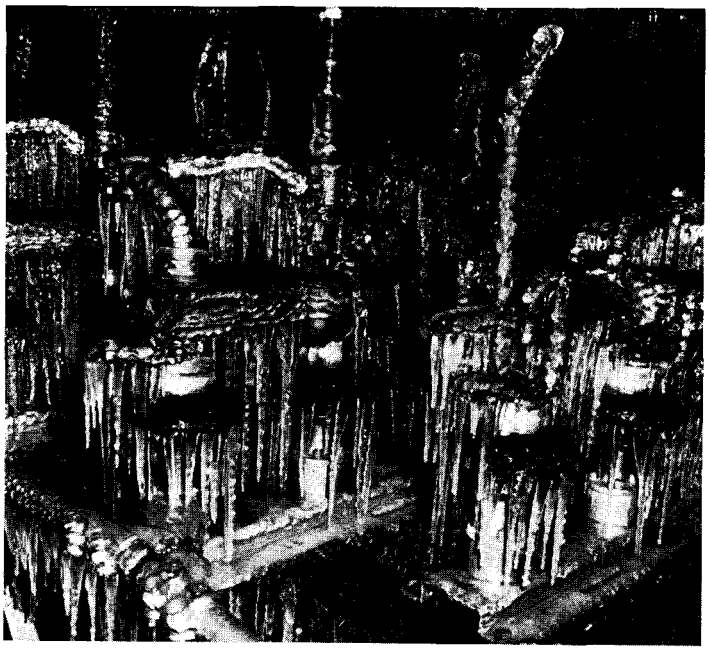
high current test cell

transformers

A bank of low-voltage high-current transformers provides for current carrying tests. These transformers giving open-circuit voltages of 625, 1250, 2500 and 5000 volts are located in the high-current test cell. On the 625-volt connection they are suitable for five-second tests at 200,000 amperes, three-phase or 345,000 amperes single-phase. At these currents the terminal voltage drops less than 50 per cent.

cold room

Tests under severe sleet and low temperature conditions are made in the cold room, where temperatures of −40°F, even in midsummer, can be obtained. At right, testing the V-2 disconnecting switch under heavy icing conditions.



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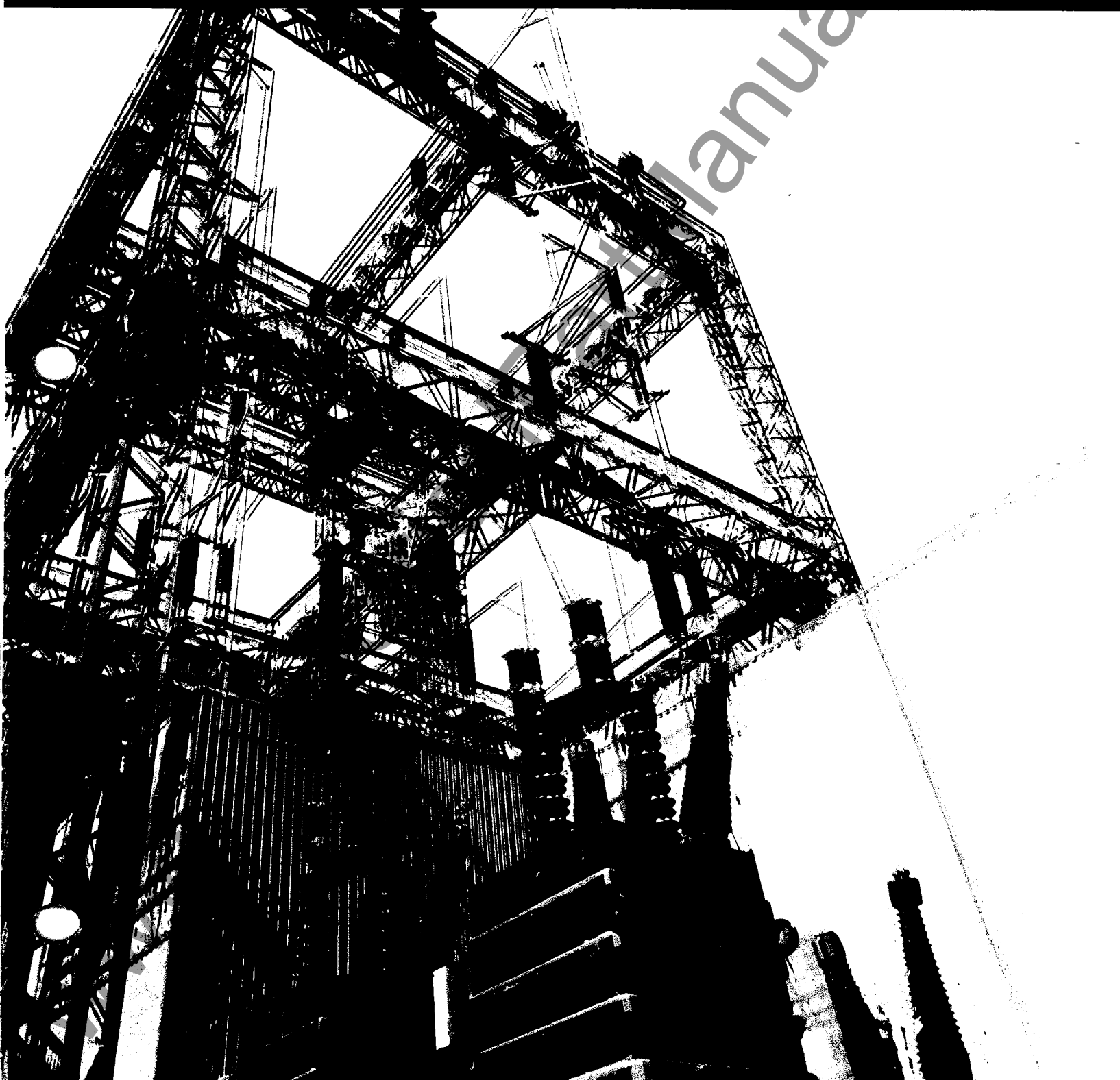
High Power Laboratory



Manual

Application

The Westinghouse high power laboratory is a complete, modern installation equipped for observing electrical apparatus operating in short circuit situations, with actual fault conditions simulated. Since 1925 the laboratory, continually expanded, has been the proving ground for development and verification of new designs for future, as well as existing, demands of electric utility systems.

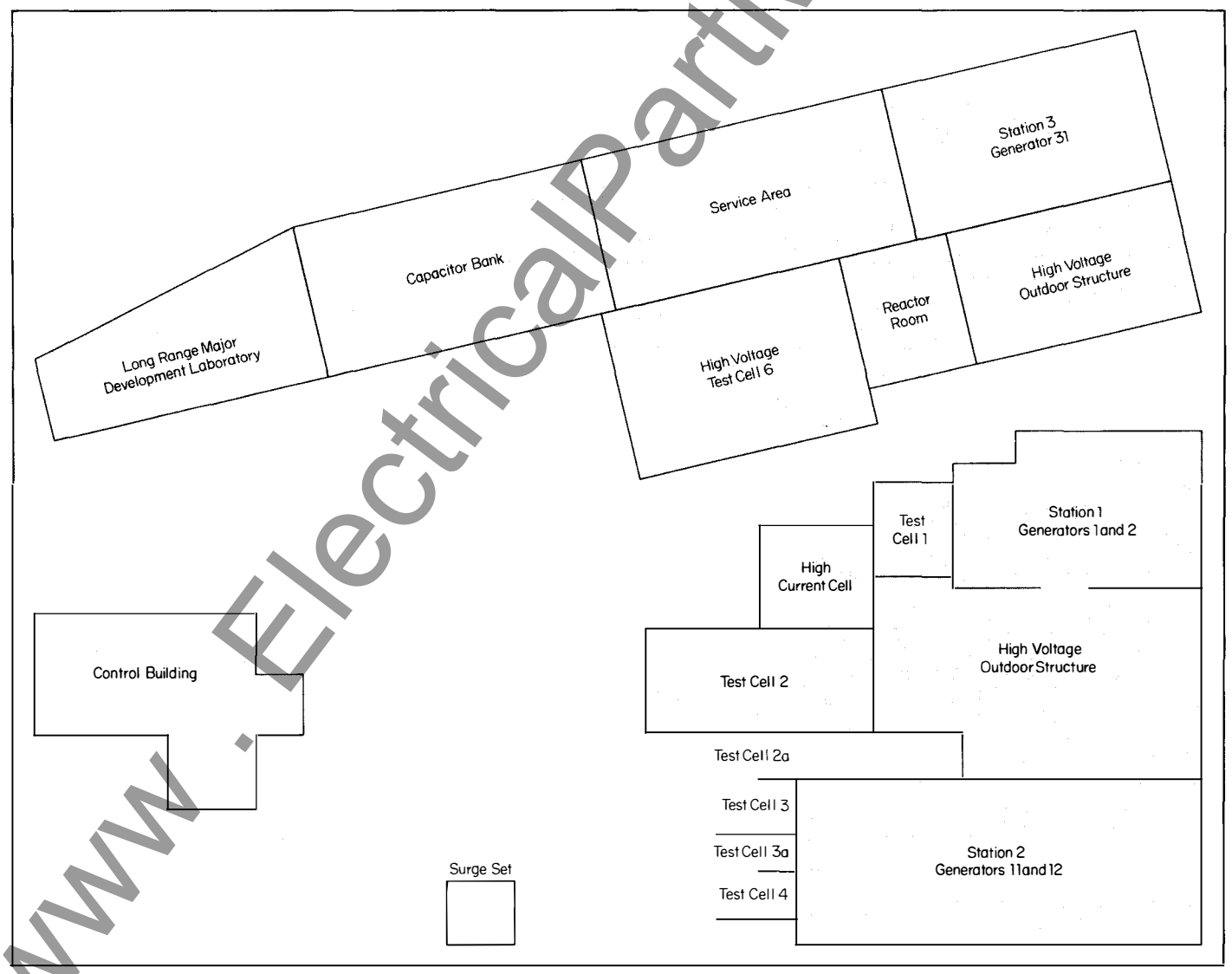
The efficiency and scope of the high power laboratory facilities cut testing time to a minimum on all equipment from the smallest, 600 volt and below, through the largest power equipment used at the highest transmission voltages. Increased variety of tests, improved instrumentation, and efficient methods of handling apparatus make possible economical testing, and economical equipment design.

In addition to verifying power circuit breaker designs, tests in the high power laboratory may be made to prove the performance of a variety of electrical apparatus including:

Arresters
Capacitors
Disconnecting Switches
Fuses
Insulators
Reactors
Switchgear
Transformers

The laboratory facilities are available to companies outside Westinghouse as well as all Westinghouse Divisions. Test results are available only to laboratory users and are kept strictly confidential.

High Power Laboratory Plan



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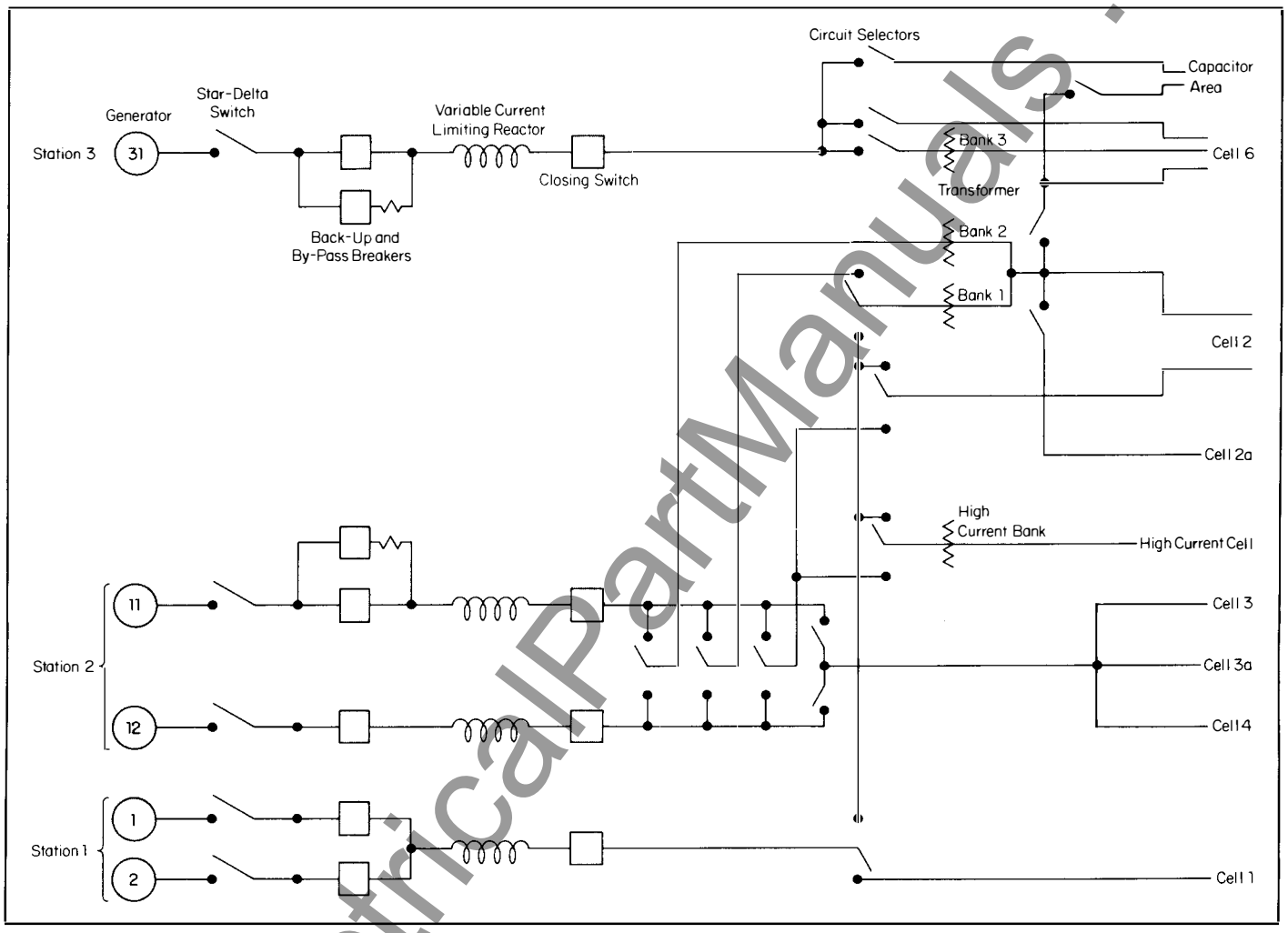
Schematic



Capabilities
Table I

Test Circuit	Maximum Mva		
	Station 2	Station 3	Combined
Single Phase Through Transformers	1000	1500	2500
Three Phase Through Transformers	1700	1500	3200
Three Phase at 13.2 Kv①	2500	....	....
Three Phase at 16.5 Kv②	900	3000	3900
Single Phase at 13.2 Kv①	1250	....	....
Single Phase at 16.5 Kv②	560	1500	2060

① No provision made for paralleling at generator voltages.
② Using station 2 at 22 kv connection through transformers; underexciting to 16.5 kv.

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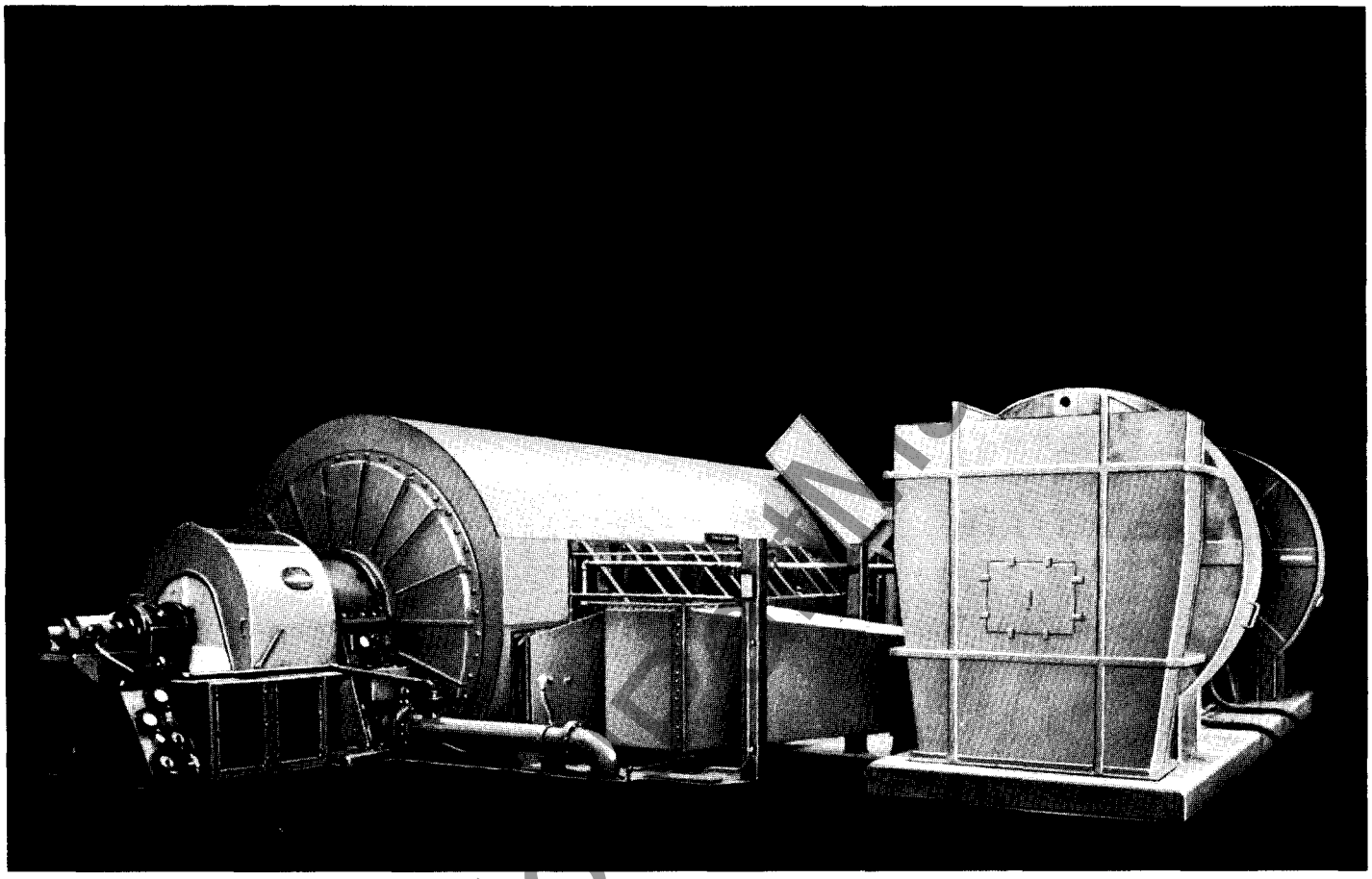
Generating Equipment



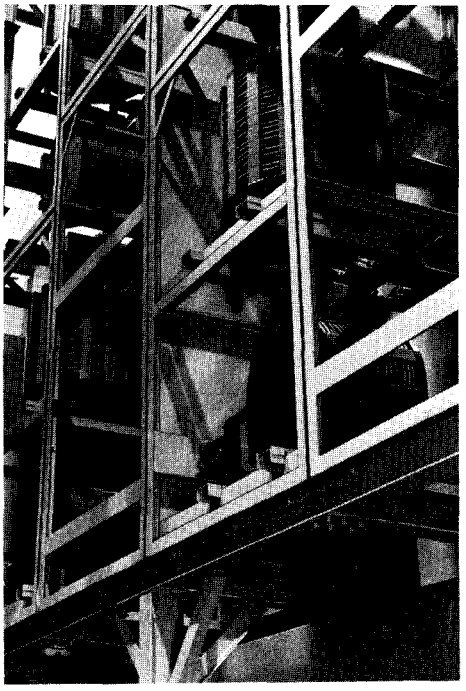
In station 3, above, there is a 3600 rpm generator with a capability of 3000 mva at 16.5 kv.

Station 1 has a two-unit generating set driven by a wound rotor motor. The exciters are separately driven. This station has a short circuit capability of 500 mva and is convenient and economical for testing smaller apparatus.

The two 514 rpm generator sets in station 2 have a combined output of 2500 mva at 13.2 kv.

Reactors

Switched reactors, remotely operated from the control room, are used to control test current values.



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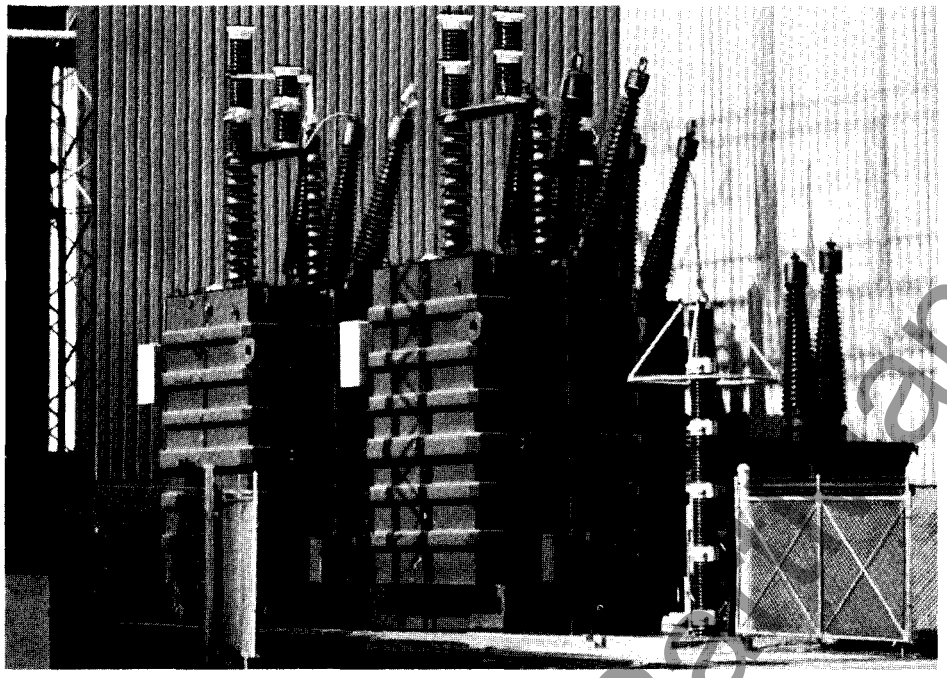
High Voltage Equipment



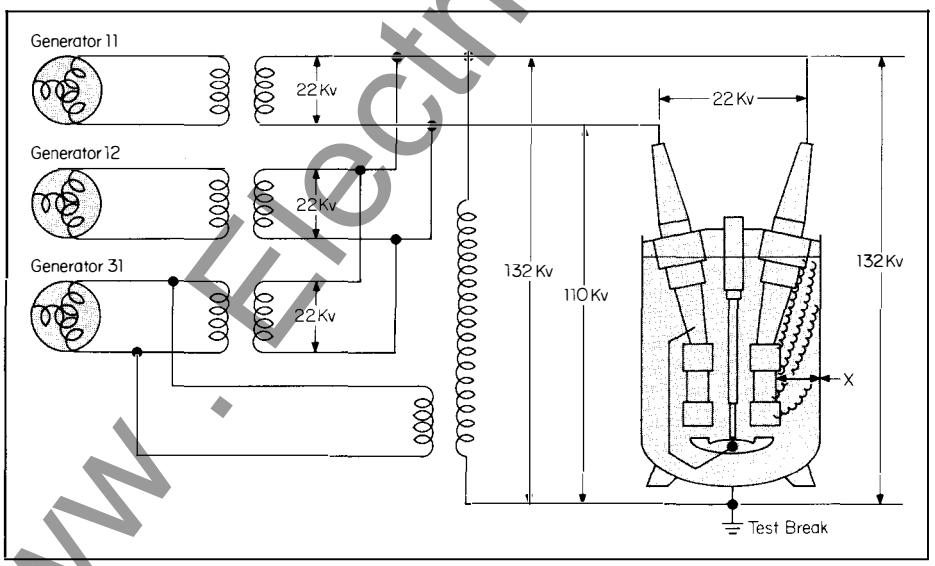
Transformers

At station 3 are three single phase transformers, each rated at 500,000 kva short circuit capacity. These transformers are used by themselves or in conjunction with the six transformers in station 2 for a wide variety of voltage combinations, as shown in tables II and III.

Insulation to ground for one bank of transformers at station 2 is 132 kv, and 196 kv for the other bank. Transformers at station 3 are insulated for 286 kv to ground.

A Weil-Dobke current injection synthetic test facility is available which effectively multiplies the short-circuit capacity of Stations No. 2 and 3 combined by a factor of ten.

Biased Single Phase Tests

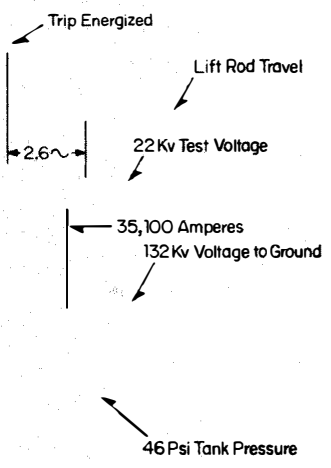


Above special test connections for increasing voltage at tank point "x", to demonstrate insulation strength during high power insulation test.

Capabilities, Continued

Kv	Mva Capacities		
	Station 2	Station 3	Combined
Table II: Single Phase Voltage Combination①			
22	1000	1500	2500
44	1000	1500	2500
66	1000	1500	2500
88	1000	1500	2500
110	....	....	2500
132	1000	1500	2500
154	....	....	2350
176	....	....	2000
198	1000	....	2250
220	....	....	2500
264	1000	1500	2500
352	....	....	2000
396	1000	....	2250
462	....	....	2350
572	....	....	1425
Table III: Three Phase Voltage Combinations			
22②	1700	1500	3200
38③	1700	1500	3200
44②	1700	1500	3200
66②	1700	....	....
76③	1700	1500	3200
88②	1700	1500	3200
115③	1700	....	....
132②	1700	....	....
154③	1700	1500	3200
230③	1700	....	....
345③	1275	....	....
495③	....	....	1830

① All voltages 154 kv and above are made with mid-point grounded.
② Delta connection.
③ Wye connection.



Oscillogram of high power interrupting test at 22 kv, with 132 kv maintained for several seconds between one terminal and ground by circuit above.

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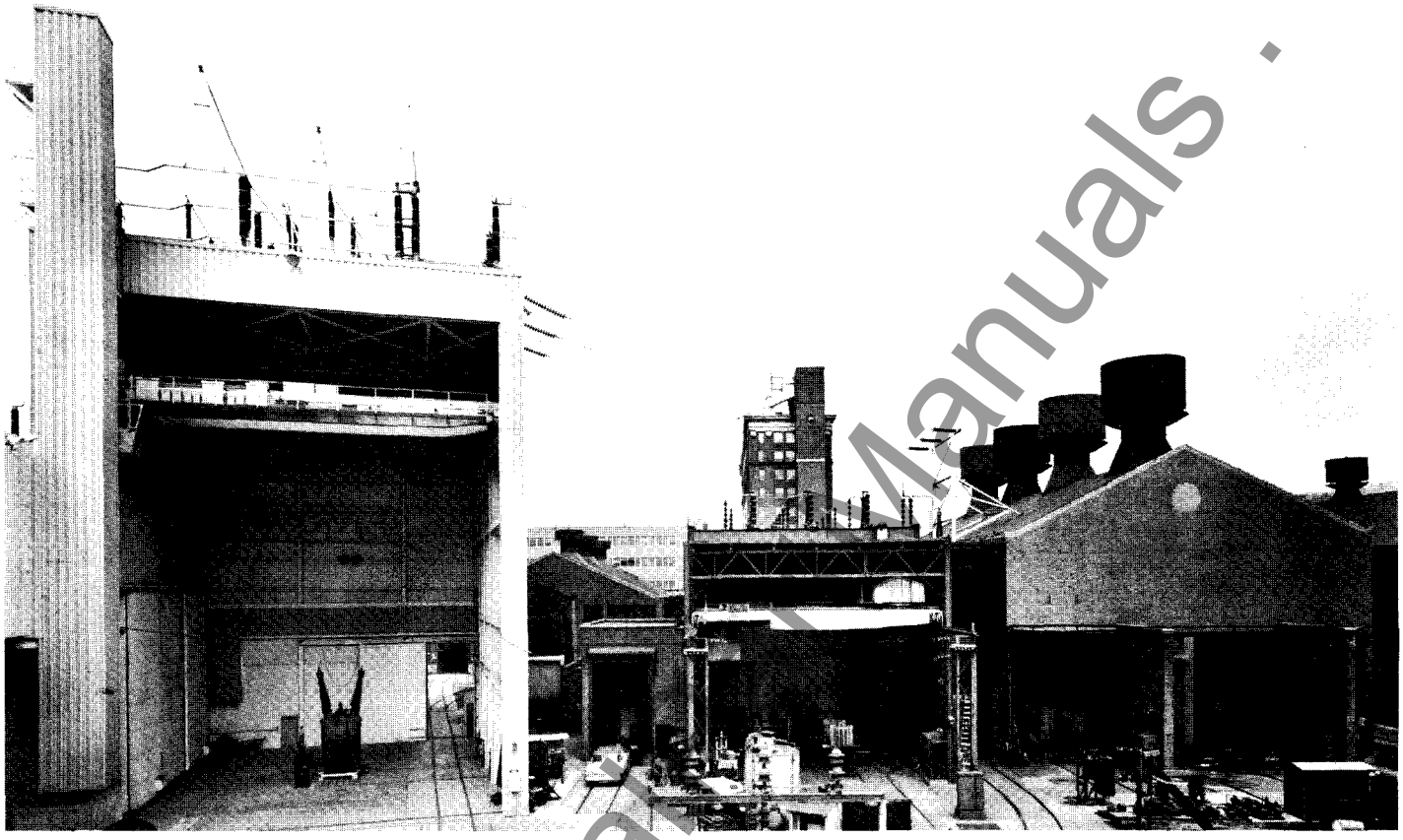
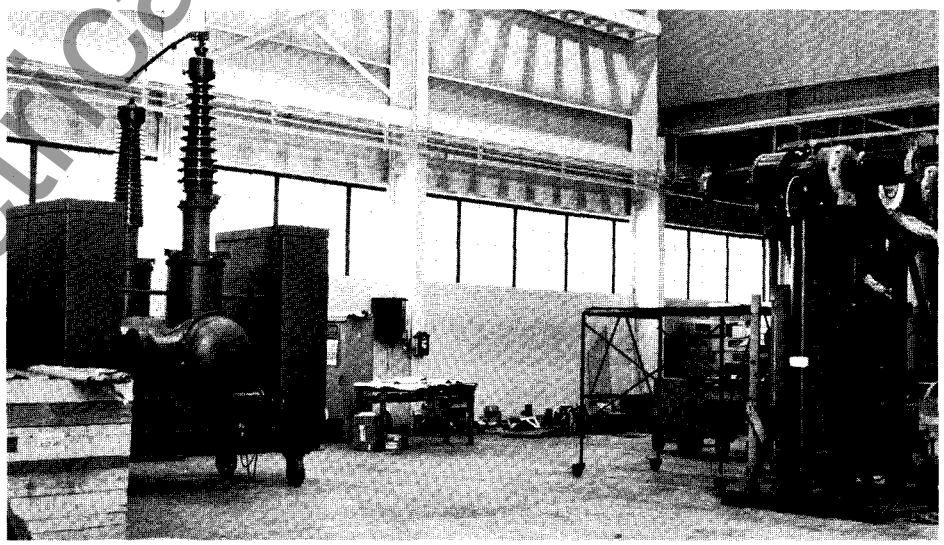


Test Cells

Test cells for stations 3, 1 and 2 are shown left to right as viewed from the control room. Cells are provided to test both at generator voltages up to 16.5 Kv, and at transformer voltages up to 572 Kv. Connections are arranged so that the combined capacity of stations 2 and 3 can be directed to station 3 test cells. All three stations may be operated separately to conduct independent tests.



Service Area

A service and repair shop, equipped with a railroad spur and twenty ton crane, is conveniently located adjacent to the test area. Changes, repairs or adjustments to equipment are made with a minimum loss of time.

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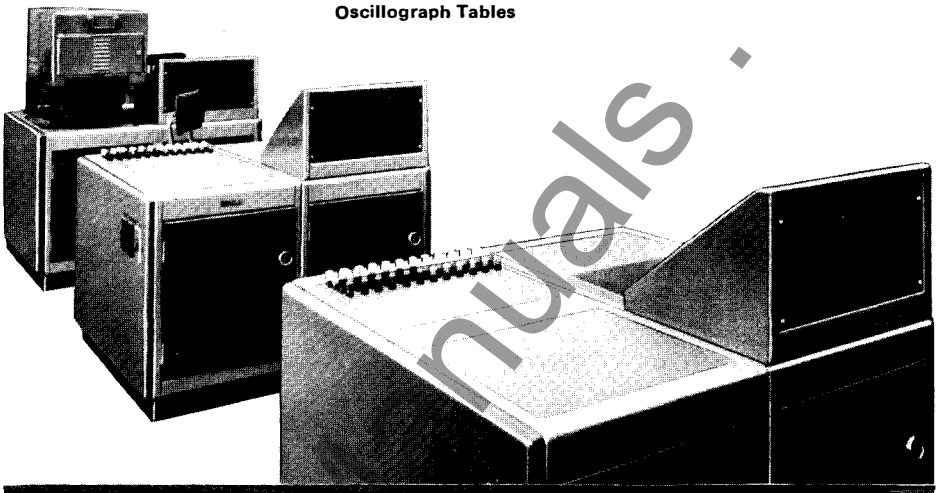
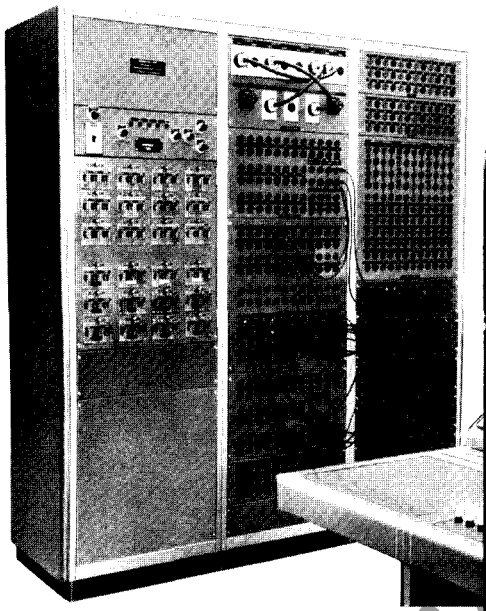
Controls

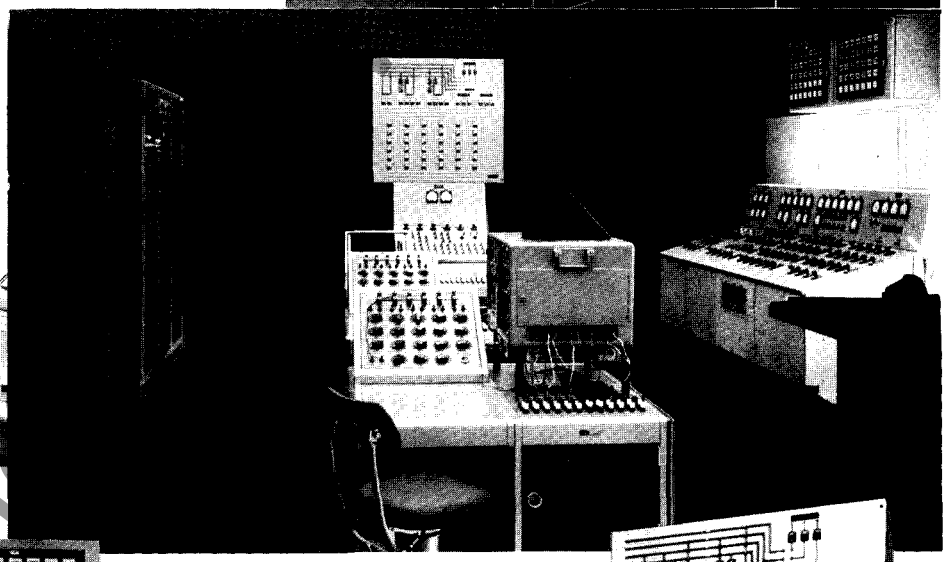
The central control room is equipped with the latest Westinghouse control desks, with modern cathode ray and magnetic oscillographs. From this room switches for the reactor groups are remotely controlled, while the choice of reactor settings is verified on the mimic bus on the control panel. Also included are electronic sequence timers for split-cycle test control, and computer-type storage oscilloscopes.



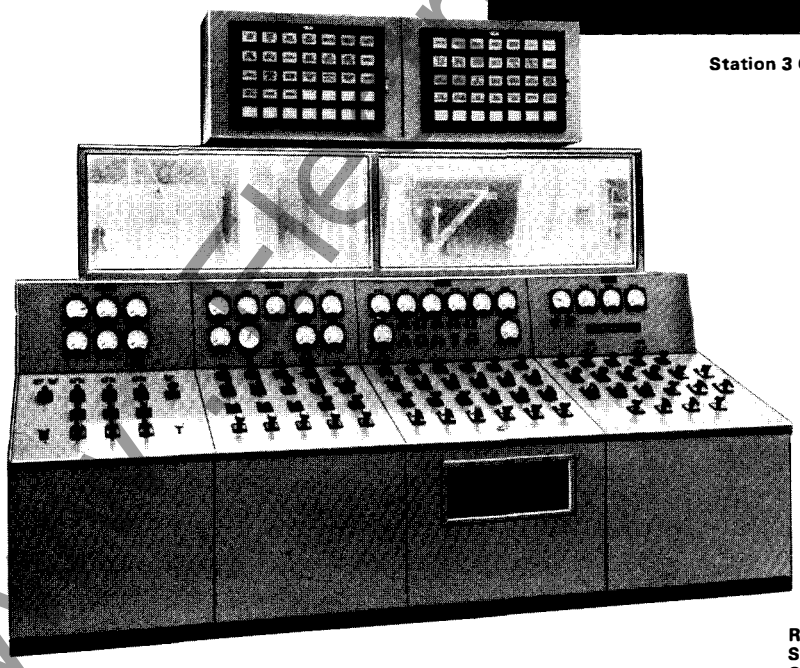
Oscillograph Tables



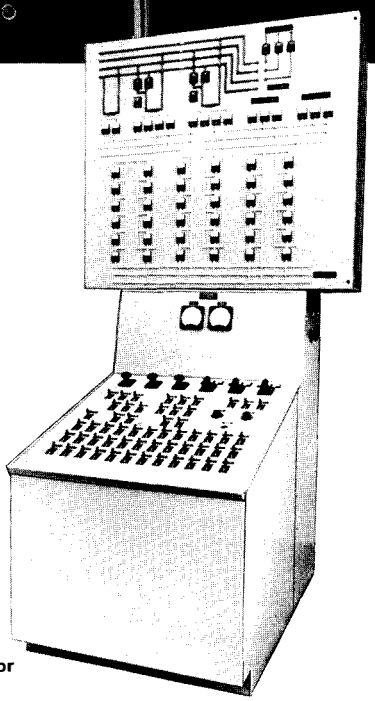
Digital Sequence Timer and Patch Board



Station 3 Control Room



Generator Control Desk



Reactor Control Desk for Selecting Short Circuit Currents

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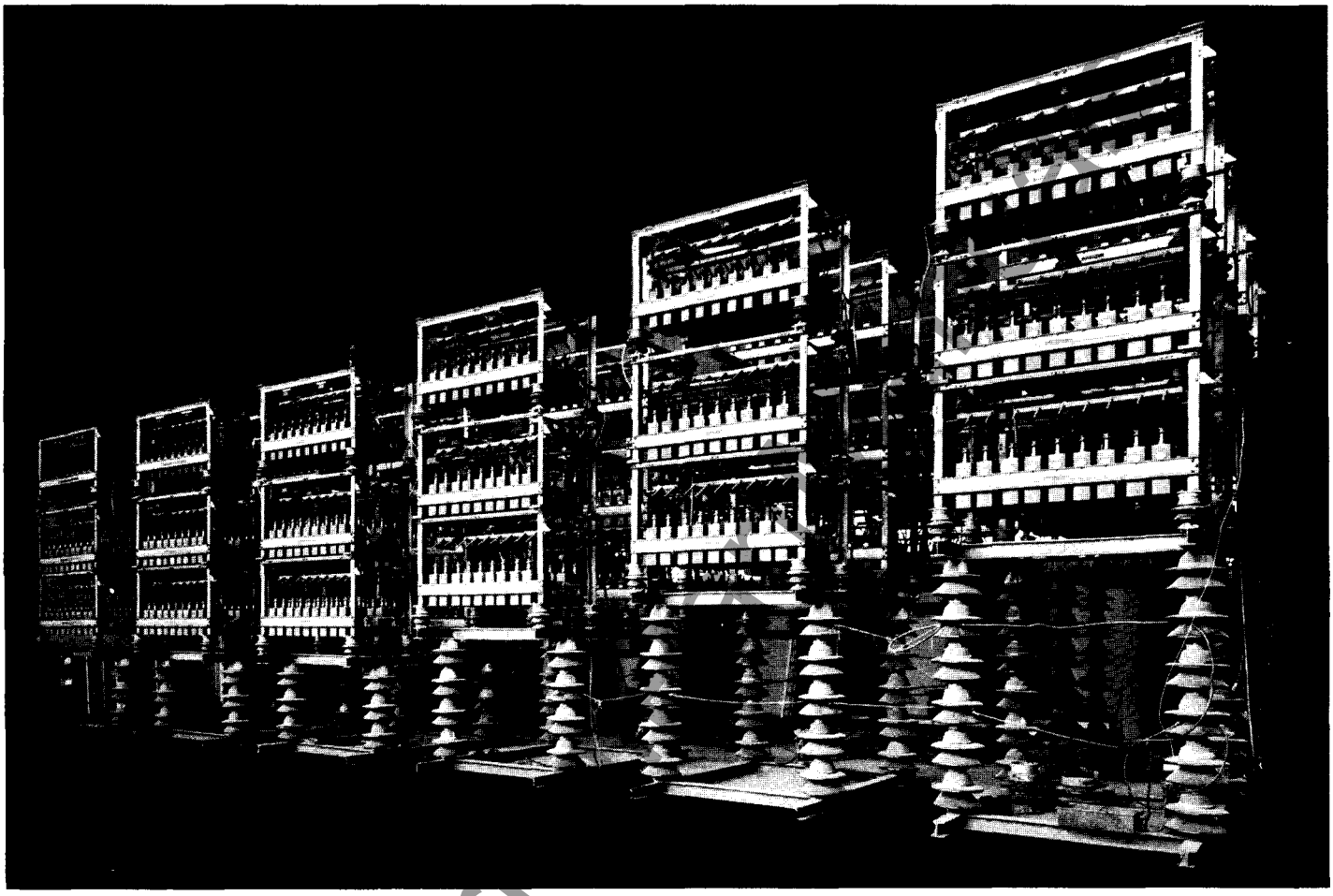
Capacitor Bank



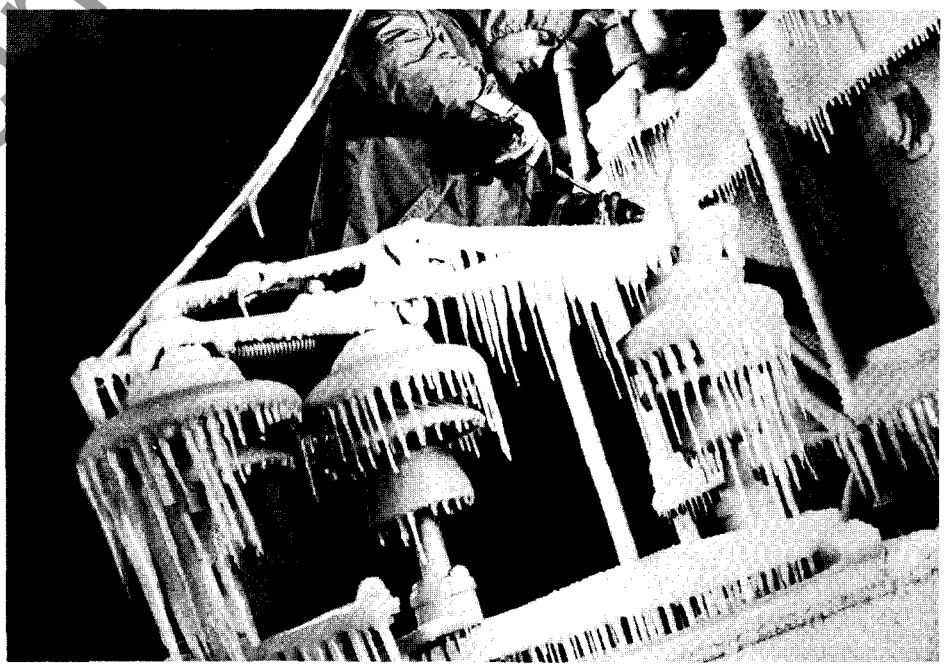
Capacitors at station 3 are for testing up to approximately 150,000 kvar isolated, or 75,000 kvar back-to-back, and for simulating unloaded transmission lines up to roughly 500 miles at 345 kv.

High Current Test Cell Transformers

A bank of low-voltage high-current transformers provides for current carrying tests. These transformers, giving open-circuit voltages of 625, 1250, 2500 and 5000 volts, are located in the high-current test cell. On the 625-volt connection, they are suitable for tests at 200,000 amperes, either single phase or three-phase.

Cold Room

Tests under severe sleet and low temperature conditions are made in the cold room, where temperatures of − 35°F, even in midsummer, can be obtained. At right the V-2 disconnecting switch is being tested under heavy icing conditions.



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