



HIGH POWER RECTIFIER SYSTEMS

For Electrochemical, Electrowinning, Electrorefining,
Electroplating, Special Applications



QUALITY AND TECHNOLOGY
IN ONE PACKAGE

RAPID provides the best value to meet all of your application requirements.



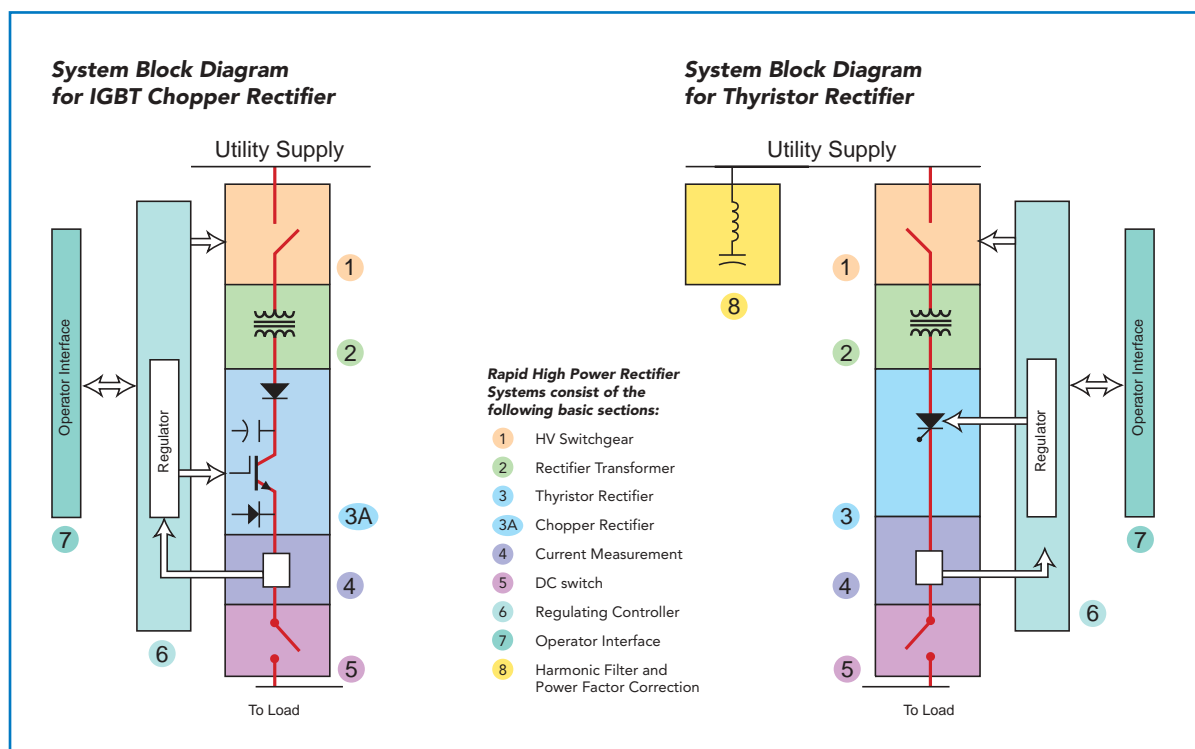
Rapid provides the best value to meet all of your application requirements. Rapid Power Corporation is the largest independent manufacturer of High Power Rectifier Systems. We design, manufacture and test integrated high power transformer – rectifier systems for use in many heavy industrial processes such as electrochemical, electrowinning, electrorefining, electroplating and other specialized applications.

Our manufacturing facility is dedicated to the production of transformers: oil immersed, dry open wound VPI (vacuum pressure impregnated varnish) and cast coil epoxy resin encapsulated*), large phase controlled and chopper style rectifier assemblies and fully integrated control systems for all products offered by Rapid throughout the world.

Our multi-pulse rectifier systems of various ANSI configurations are conservatively designed to provide reliable operation. Rapid Power will supply a rectifier to meet your system requirements and will provide the best value in all applications.

Rapid's system designs may also be provided with auxiliary equipment as required by the specification, including switchgear, power factor correction and harmonic filters, heat exchangers and free-standing cooling systems.

* (Manufactured by Dynapower Corporation)





RAPID ENGINEERING

Rapid High Power Rectifier Systems are engineered to internationally recognized Standards including ANSI, IEEE, IEC, NEMA, UL, CSA, JEC, etc. Rapid Power Corporation application and design engineers will work with the client to determine the optimum rectifier system to meet the specifications. Our design capabilities include the complete High Power Transformer Rectifier System – inclusive of fully integrated operator interfaces and control systems for a single unit or entire multi-unit SCADA network. We can evaluate the impact of the rectifier system on the incoming power grid and design power factor correction and harmonic filtering as required.

Rapid designs and manufactures thyristor rectifiers and fast switching IGBT chopper rectifiers for large applications. With the latest techniques in both rectifier technologies, Rapid application engineers can recommend the optimum rectifier configuration for your project.

System shown is 30,000 amp with 2x15kA choppers.



Rapid has the experience to deliver the most reliable power conversion solutions. Rapid has been manufacturing thyristor controlled transformer/rectifier systems since the commercialization of the thyristor. Today, Rapid thyristor rectifiers are installed worldwide in many different applications providing high quality, reliable operation.

All Rapid high power rectifier systems are designed, manufactured and tested in strict accordance with the latest applicable ANSI & IEEE standards.

The chopper modules shown are rated at 1500ADC and are mounted in a 15,000A, 125VDC Electrowinning Rectifier system.



RAPID has the experience to deliver the most reliable power conversion solutions.

DRY TYPE

VACUUM VARNISH PRESSURE IMPREGNATED EPOXY RESIN ENCAPSULATED CAST COIL*



Epoxy vacuum cast coil transformers manufactured in Vermont, USA. Primary and secondary windings all cast wound with copper conductors. Electrical connectors made using tin or silver plated solid copper bus.

Rapid dry type transformers are designed to be fully integrated with the rectifier section of the system and may be cooled by forced air, direct water cooling or use of a heat exchanger system. Multiple transformer systems used to meet ANSI configurations have been provided in sizes up to 28 megawatt using dry type transformers.

Features:

- Individual transformer ratings to 12,000 kVA
- Primary voltages: VPI 23kV, cast coil 34.5 kV
- Class H – 220°C insulation system
- Temperature rise 80°C, 115°C and 150°C (VPI only)
- Copper windings
- Cooling – convection, forced air, direct water or via a heat exchanger system
- Enclosures NEMA 1, 3R and 4
- All ANSI circuits available

* Manufactured by Dynapower Corporation. See separate literature for details.



14-megawatt dry type transformer (2 x 7-megawatt) section rated at 67,000 amp and 425 VDC for a large electrochemical project.



LIQUID FILLED TRANSFORMERS

Rapid designs and manufactures a majority of its liquid filled rectifier transformers in house for application in our large industrial rectifier systems. This in-house capability enables Rapid to fully integrate the designs of the rectifier and transformer and take sole source system responsibility. The system mechanical integration on the shop floor ensures a smooth installation on site. For large kVA and greater than 34.5 kV AC input voltage systems, we work with a dedicated supplier to provide completely coordinated system integrations.

Features:

- Ratings to 25,000 kVA
- Primary voltages to 69 kV
- Temperature rise 55°C or 65°C
- Mineral oil, silicone fluid and Rtemp
- Copper windings

All ANSI circuits available
Convection cooled, forced air
or forced oil (OA, FOA, FOW)

*ANSI 45 oil filled
transformer designed
for a 22,500 amp, 275
VDC rectifier being
readied for assembly.*



RAPID designs and builds its components and can deliver them to you quickly.

THYRISTOR & CHOPPER RECTIFIERS

36,000 amp, 156 VDC chopper rectifier system complete with ANSI 31 dry type transformer



These are available in 6, 12, 18 and 24 pulse sets with higher order combined systems available. Each multi-pulse arrangement is in an ANSI configuration that is selected for the voltage/current values of the application. The multi-pulse criteria is selected to reduce the supply side harmonic content, reduce output ripple, and provide improved regulation. Features of both rectifier technologies include:

Features:

- Conservative design margins
- Copper bus work
- Heavy gauge construction
- Sub-system integration
- High reliability and maintainability
- Deep hole drilled copper heat sink (water-cooled systems)



40,000 amp DC, 220 VDC 12 pulse electro-winning installation with oil-filled transformers and harmonic filter



THYRISTOR RECTIFIER DESIGN

Rapid designs and manufactures the thyristor assemblies used in our rectifiers. The devices are complete with a rugged RC suppression circuit and driven by a dedicated gate driver. The number of device assemblies required is a function of the configuration chosen and the total DC current required in meeting the specification.

Direct water cooled thyristor assemblies consist of the semiconductor mounted on deep hole drilled copper heat sinks. Forced air cooled thyristor assemblies are composed of extruded aluminum with integrated blower and/or fan assemblies. Larger systems have baffling to ensure proper airflow.

Semiconductor Ratings

Up to 3500 A average
Up to 4500 PRV

Temperature sensors

Heat sink over-temperature protection

Clamps

Spring-loaded clamps with insulation sleeves

Parallel Devices

Current balance is maintained in accordance with ANSI C34.2 standards.

Redundancy

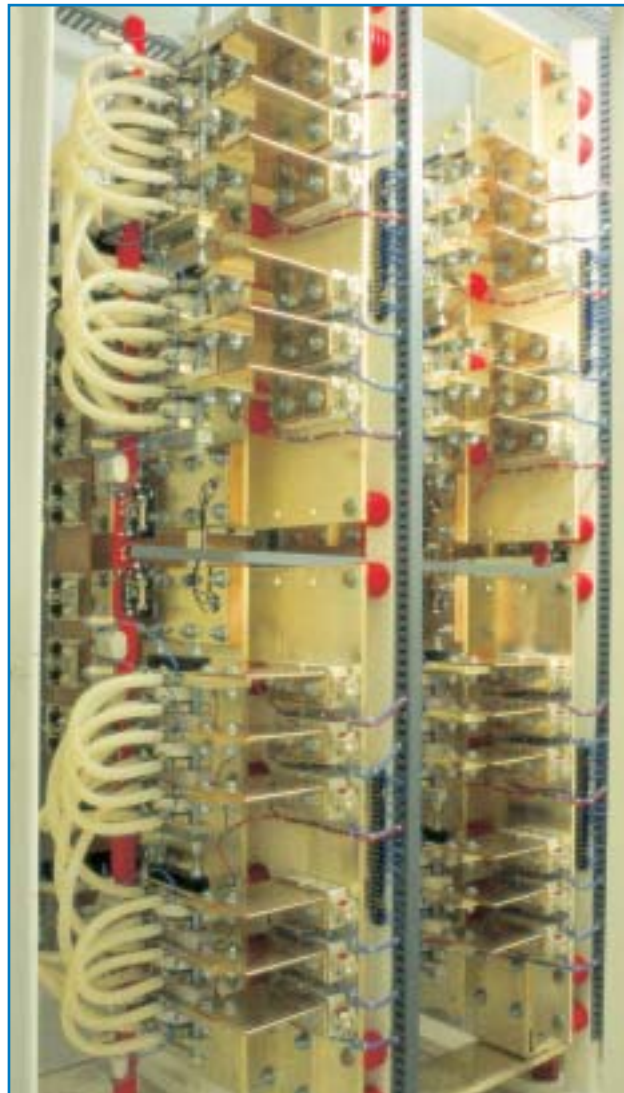
N-1 configuration is available.

Device Fuses

Coordinated high-speed current-limiting fuse with visual indication

Fuse Failure

First fuse failure will alarm and second failure in same leg results in a fault signal if N-1 redundancy is selected.



22,500 ADC water-cooled thyristor stack in N-1 configuration

RAPID has helpful professional service that is available when you need it.

CHOPPER RECTIFIERS DESIGN

The chopper rectifier designs consist of high frequency switching technology in a modular design package that converts the secondary AC voltage to a regulated output DC voltage.

Larger power systems are constructed of multiple chopper modules to obtain the specified current requirements. Each section of modules has a separate set of sensing and protection and receives directions from the main chopper controller. This chopper conversion process has minimal effect on the incoming power system and a high power factor is maintained at the level of a fixed diode converter.

The transformer section is configured to optimize the harmonics. The total module count usually results in a 12 pulse configuration as seen by the utility. The load sees a very smooth low ripple DC over the total range due to compact high frequency output filtering. Rapid designs and manufactures all the water-cooled IGBT power modules used in our chopper rectifiers.

A full control metering, monitoring, and fast protection scheme is integral to all Rapid chopper rectifiers.

Four channel IGBT chopper module rated at 1,500 Amps





Additional Features for the Chopper:

- High power factor over full range
- Low output ripple
- Low harmonic distortion
- Dynamic response
- Modular construction

Semiconductor Ratings

IGBTs up to 600 A average
IGBTs up to 2,000 VPRV
Diodes up to 600 A average
Diodes up to 2,000 VPRV

Drivers

Dedicated fiber optic gate driver

Current Sensing

Independent IGBT current sensing

Buswork

Laminated copper bus structure designed to maintain a low bus impedance and low voltage overshoot

Heat Sinks

Water-cooled copper for cooling of the isolated modules (four IGBT and four diodes) maintaining low junction temperature

Device Cooling

Module heat sink plates are direct contact cooled by means of circulated water. This water path is at ground potential and does not require special treating.

Flow Protection

Flow detectors.

Temperature Sensors

Heat sink over-temperature protection.

Number of Modules

Conservative design margins with multiple parallel modules per section.

Parallel Devices

Symmetrical assemblies with current balance controlled $\pm 5\%$.

Redundancy

N-1 power module configuration is supplied.

Device Fuses

Each IGBT has a coordinated high speed current-limiting fuse with visual indication of the activated fuse.

Fuse Failure

First IGBT fuse failure will alarm and failure of second will result in automatic current reduction or a trip signal being generated.



The above is a section of a 36,000 amp chopper system used on a graphite furnace application.

RAPID systems are assembled with pride and use only the highest quality components.

RECTIFIER CONTROLS

Rapid Power designs and manufactures the rectifier control systems for use in our high power rectifier systems. The integration of this control with commercially available Programmable Logic Controllers (PLC) and Personal Computers (PC) is used to produce a wide range of power rectifier system designs capable of analog or digital control via a variety of serial protocols. The communication network and operator interface may be designed to meet your system control and monitoring requirements.

Basic digital controller and HMI panel



Personal Computer-driven touch screen control running HMI software



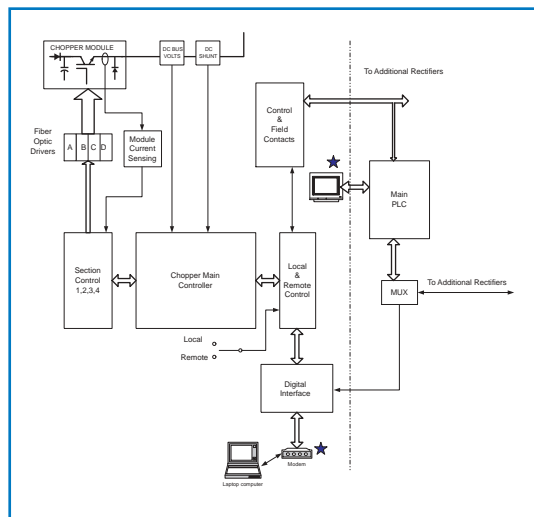
Operator Terminal (Magelis, Panel View, etc.)



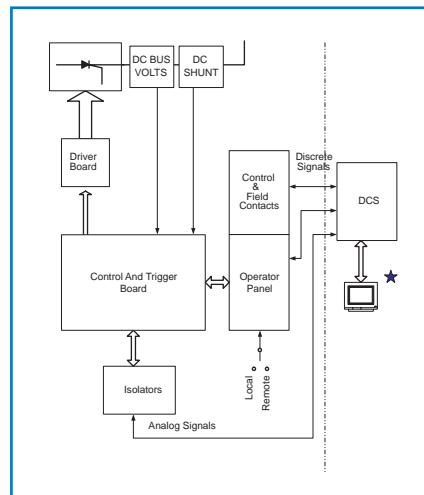
Analog Control panel with recorders



Basic Control and Trigger Board plus driver circuit for analog system



Chopper Rectifier Control Block Diagram



Thyristor Analog Control Block Diagram



COOLING SYSTEMS

Rapid rectifier systems may be designed to be cooled by a variety of cooling methods. These include forced air, direct water, or combination of closed loop heat exchanger systems integral to the cabinet, or free standing, for installation external to the rectifier.

LIQUID COOLED

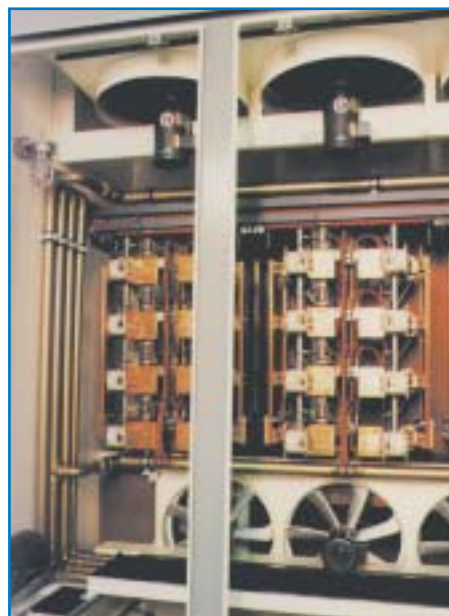
The cooling water is taken from the cooling cubicle through a manifold supply tube to the base section of the rectifier to feed several parallel cooling circuits. The joints in the water circuit are designed to prevent corrosion and includes pressure tested seals. The heat sinks for the liquid-cooled semiconductors are deep hole drilled copper and cooled by means of de-ionized water which flows in a closed loop through the power circuit. The water flows in a counter-current pattern to obtain even temperature distribution. Thermostatic proportioning valves are used to minimize plant cooling water volume based on the operating power when closed loop water to water heat exchangers are selected.

SEALED AIR TO LIQUID COOLED

When portions of the rectifier system cannot be cooled with direct water and using external forced air is not an option, they may be cooled using a sealed air to water heat exchanger. Rapid has extensive experience with cooling sealed dry type power rectifier systems using this method.

FORCED AIR COOLED

Forced air cooled rectifier units incorporate finned aluminum heat sinks and may be operated continuously at full rated current at an intake air temperature of up to 40°C with custom higher ambient temperature designs available.



Air to water heat exchange in a sealed dry-type transformer application. Rectifier is cooled using a closed loop de-ionized water to water heat exchanger, while the ambient and dry-type transformers are cooled by the air to water heat exchanger.



16,500 amp air-cooled thyristor rectifier



Water to water heat exchanger



Liquid to air heat exchanger.

RAPID will help you define your rectifier requirements quickly and efficiently.

HV SWITCHGEAR

Rapid manufactures high power rectifier systems up to 69 kV and integrates commercially available medium and high voltage components into the systems. Rapid coordinates the AC switchgear for complete system integration and safety.

DC DISCONNECT SWITCH

Rapid has extensive experience integrating commercially available DC disconnect switches into our systems as required.

CURRENT MEASUREMENT

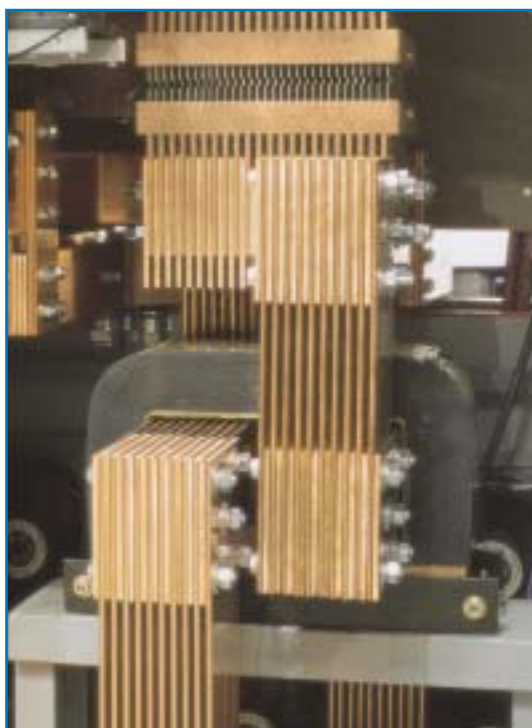
Rapid rectifiers use precision current shunts for the control regulation and for the current measurement of our high power systems. Commercially available current measurement systems for outer loop monitoring can be incorporated in accordance with the specifications of the project.

DC BUSWORK

Rapid uses electrically pure copper bus work exclusively in our rectifier systems. Bus work with plated bolted joints and flexible connections are designed to minimize bus losses and to match the clients' application requirements.



High current DC Switch



30,000 amp precision shunt



High voltage fused disconnect switch



APPLICABLE CODES AND STANDARDS

Rapid designs, manufactures and tests our power rectifiers and transformers in accordance with the prevailing specifications and the following codes and standards.

ANSI Standards

C34.2-1968	Practices and requirements for semiconductor power rectifiers
C57-12.00 & 12.10	Standards for liquid and dry transformers
C57-18.10	Standard for rectifier transformers

IEC Standards

IEC 76	Power transformers
IEC 146	Semiconductor converters
IEC 147	Essential ratings and characteristics of semiconductor devices and general principles of measuring methods
IEC 148	Letter symbols for semiconductor devices

IEEE Recommended Standards

IEEE 519 - 1992	IEEE recommended practices and requirements for harmonic control in electrical power systems
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NEMA Standards

NEMA R1	Safety code for semiconductor rectifiers
NEMA R16	Electrochemical processing semiconductor rectifier requirements

NFPA Standards

70	National Electric Code
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RAPID provides the best value to meet all of your application requirements.

FACTORY TESTING

Rapid has an established high current test facility for the testing of high power transformer/rectifier systems. A complete line up of transformers and rectifiers are tested at rated current and rated voltage with total power levels dictated by our test area capacity.

FIELD TESTING

Rapid Field Service Engineers have extensive experience traveling worldwide to field test, commission and start up major high power rectifier systems. Rapid recommends that large systems have a load capacity large enough to fully test the system parameters. If this is not available, Rapid engineers can usually develop a 'substitute load' that will test the equipment to a satisfactory level. Our field service technicians and system engineers are available at your request for start-ups, preventative maintenance, emergency service and hands-on training with new equipment.



Field testing a high power rectifier with substitute load



Core and coil being tested prior to final assembly



TRAINING

Rapid Service Engineers may instruct our customers' operator and maintenance personnel during the commissioning/start of the unit or during final test at our Corporate Headquarters. This can be operational training and/or full maintenance-repair training for shift personnel.

SPARE PARTS

Rapid maintains a multi million dollar spare parts inventory and has the appropriate factory approved spare parts on hand and ready for your use to assure maximum up-time of your process. Rapid's power supplies are designed for decades of trouble-free use when the installation and routine maintenance guidelines contained in the service manual are followed.

DOCUMENTATION

Rapid engineering develops a complete documentation package for each major system manufactured. A full set of electrical and mechanical drawings enable the client to maintain and service the system. Project documents include the description of the system, control, software and cut sheets of key components.



Spare parts

QUALITY CONTROL

Each piece of equipment we build is rigorously tested and put through a systematic quality control examination prior to shipment. Our test facilities utilize state of the art equipment to verify that the power supply you receive is exactly what you ordered. Our staff of highly competent test technicians performs a full range of operational and functional testing, and maintains complete documentation of all test procedures and results. Prior to shipment, a final quality control inspection is performed.

SALES ENGINEERING

Our Sales Department is staffed by professional sales engineers and can help you select the appropriate piece of equipment for your specific application. From the simplest rectifier to a fully integrated rectifier-transformer system with harmonic filter and power factor correction, Rapid's experienced sales staff can help you define your specific requirements, and then provide you with the solution to your power conversion needs. Contact the Rapid corporate office or your regional office or representative for your power rectifier system requirements.



Our main plant in South Burlington, Vermont contains over 150,000 square feet of modern, fully-integrated manufacturing and engineering facilities, as well as, sales and executive offices.

Rapid manufactures the complete power rectifier system for a variety of applications, specializing in the power transformer and the high power rectifier. Rapid incorporates the latest controls, conversion technologies, and highest quality materials to meet the customer's exact specifications.

Whether your need is a catalog item or "one of a kind", our unique self-sufficiency, understanding and experience makes Rapid Power Corporation the number one choice worldwide for high power rectifier systems.

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**Great product, great service
 and a state-of-the-art facility.**

This is our commitment to you.

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 POWER CORPORATION