
# Saskatchewan Power Corporation
# Research and Development Centre
## Seven Years of Progress
## 1970-1977

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Fred Ursel, General Manager,
Saskatchewan Power Corporation.

# General Manager's Message

The Corporation believes that public information on its Research and Development activities will be of value and interest to its gas and electric customers and others in the field of energy research. We hope you will find this publication about the Corporation's Research and Development Centre informative.

Since it was established in 1970, the Research and Development Centre of the Saskatchewan Power Corporation has contributed significantly to improved operation of both the gas and electric systems and to energy research in Saskatchewan.

The start of the R & D Centre was modest in line with the desire of the board of directors to concentrate on projects unique to Saskatchewan needs in relation to climate, population and utility research without duplication of research activities or information available from other sources.

With growing awareness of energy problems, the scope of activities was increased to include direct contact and involvement with many groups conducting energy research.

Research work had, of course, always been included in the Corporation's activities but, with the establishment of the Centre, activities which had been divided among many Corporation departments have been co-ordinated and concentrated in one department under one directorship.

We are pleased to have Miklos Barabas as the director of the Research and Development Centre. He brought to the position a broad educational background, combined with outstanding practical experience in the utility business and in the realm of research and, most important of all, a personal dedication and drive that has become characteristic of the entire R & D operation.

His recent invitation to participate at the NATO Science Committee Conference on Thermal Energy Storage is an example of his respect in the scientific community. Mr. Barabas presented the Corporation's view on electric storage heating for the Canadian Prairies with particular reference to the development of the Corporation's off-peak storage furnace pioneered by the research group.

The work of the Centre has attracted engineers from many locations. The department has grown to meet the expanding research needs of the Corporation. The staff presently numbers 22 and includes PhD, Msc., Bsc. engineers from the electrical, mechanical and chemical disciplines, computer experts, technical specialists and administrators. Engineering and operational staff from the SPC gas and electric systems are rotated through the Centre on a project-oriented basis, providing for practical update of scientists and theoretical update of practicing engineers.

The work of the Centre has been co-ordinated with programs of the Canadian Electrical Association and the Canadian Gas Association in which Canadian utilities have combined their funding and efforts to achieve national programs and objectives.

The Centre co-ordinated participation by researchers at the province's universities and other agencies in many of the Corporation's projects.

Under the leadership of the director many things have been accomplished in just seven years; too many, in fact, to mention in detail in this anniversary report. Some of these accomplishments have resulted in worldwide recognition and interest. Forty research projects were actively pursued in 1975 alone including tests on boiler slag, power plant efficiency, aluminum wiring, fly ash utilization, coal gasification and liquefaction, waste heat use and gas quality control. Many of the projects have significant value and social consequence for the public.

The record of the first seven years of the Research and Development Centre operation has confirmed that continuing research and development activity is vital to the Corporation's future operations in the rapidly changing energy field.

A résumé of some of the highlights of these initial years appears in this anniversary publication.

# INTRODUCTION

The need to coordinate the research and development functions of the Saskatchewan Power Corporation in one organized unit led to the establishment of the Research and Development Centre (R & D) in 1970.

Since its inception the Centre has pursued its activities under a well-defined program, coordinated and cohesive with the overall activities of the Corporation. The Centre today supplements Corporation programs and spearheads existing and new programs.

Many indices of the '60s had demonstrated the need for a centralized research body: the information explosion and technical advances of that decade, the increasing difficulty of operating a public utility, the pressing need to search for further energy resources and more efficient conversion technology, and the need to conform with developing environmental constraints.

The R & D Centre has four recognized functions: (a) information search, (b) in-house research, (c) joint research, and (d) laboratory services. In addition, the research staff is available to consult on the problems of other Corporation departments, to conduct in-house courses in speciality areas, to lecture for universities and technical institutes, participate in conferences and seminars and thus be involved in the overall activities of the research community.

The measure of the Centre's achievement, as for any industrial research organization, is the results of their research that influence the decision-making process of the company.

Economic achievement is recognized by the number of projects pursued and implemented by the industry that resulted in economic gain. Technological achievement lies in the development of a better solution to an old problem with resulting improved service, efficiency or reliability. And pragmatic measurement of achievement is the number of short-term solutions that have been found during the Centre's lifetime.

Using any of these criteria for success, Saskatchewan Power Corporation's R & D Centre has fulfilled the expectations of management and today provides an essential function in the Corporation.

# INFORMATION SERVICES

Technical and scientific information is provided to R & D technical staff, management personnel, and Saskatchewan Power Corporation employees to keep them abreast of new developments in electric and gas industries. A technical newsletter is published bi-monthly and distributed to a large segment of the Corporation. Formal research reports are edited and disseminated to communicate new ideas and results of research projects. Instant literature searches are conducted on on-line computer facilities to provide current state-of-the-art information.

Information services are handled by a staff that is innovative and inquisitive, with a thorough technical knowledge of the research being conducted at R & D. The small information staff must be capable of supplying updated information to the research engineers and carrying out the responsibilities of an on-line literary searcher, an abstractor, a librarian, an editor. The staff must be efficient in clerical and typing skills.

The **Can**adian-**O**n-**L**ine **E**nquiry (CAN/OLE) Centre, connected to the Canadian Institute for Scientific and Technical Information of the National Research Council in Ottawa, provides an effective tool in supplementing existing search services. It is a computerized system for the interactive searching of large bibliographical reference files and provides access to approximately three million references from the most applicable data bases available.

This system permits rapid technical information retrieval. A search can be modified in response to replies from the Institute until the search input produces the desired information.

# IN-HOUSE RESEARCH

In-house research is motivated by present and future technological and planning functions of the Corporation. Problems are usually unique to the province: problems caused by our severely cold winter weather and the disruption of service by lightning. We have a medium-sized power system which must serve a large and widely dispersed area. This system also services potash and heavy crude industries which consume large amounts of power.

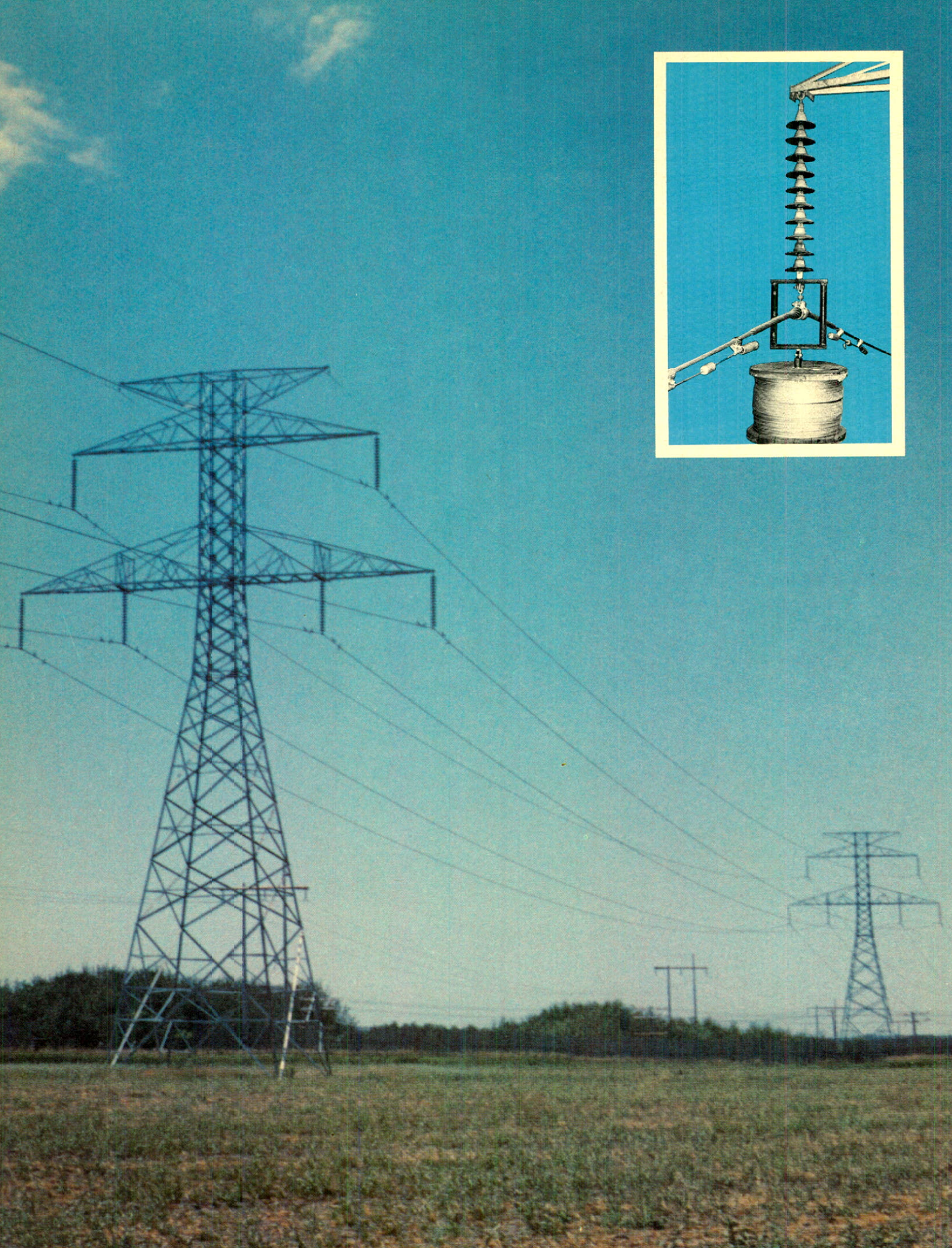
In an industrial organization company policy necessarily dictates that constraints be placed on the selection and management of research projects. These constraints must be clearly defined.

R & D management philosophy is based on the freedom of the individual to ensure that his ingenuity and his ability to search for a new solution to an old problem or a solution to a new problem is not suppressed.

And R & D solutions must benefit not only the Corporation but the community it serves. The desired solution is one that will serve in the future as well as the present.

The Centre is skill-oriented rather than function oriented. Projects are handled by a team approach which enables a researcher to be the leader of a project requiring his special knowledge while at the same time belong to a team headed by a project leader with different expertise.

Thorough efforts are undertaken to design, develop or solve problems in the most economical manner, at the same time assuring an end result that will maintain reliable service to the customer. The implications of a research project are constantly monitored to ensure innovations and solutions that are socially and environmentally acceptable to the public.



# Electric

Activities in the area of Electric Research include transmission line and station hardware-oriented projects, dominantly mechanical and electrical in nature. Vibration and structural engineering work is a continuous function as each year different types and sizes of conductors, dampers or structures must be investigated. Research is power plant oriented either in relation to existing plants or investigation of new power generation methods. Work is continuing on electrical distribution from transmission substations to the customer's meter. Consultation and assistance is also provided to Electric System management.

## Tower Arm Resonance Testing

The steel towers on the opposite page, a familiar site to most, support many of the main electrical transmission lines in the province. Bulk electrical energy is transported through the steel tower-supported transmission lines to the electrical distribution system which feeds electrical power to most homes in the province.

Lattice type steel towers are designed for longevity, assuming that relatively static or stationary conditions prevail. However, if certain parts of the tower experience dynamic movement for prolonged periods caused by wind activating the suspended conductors or individual tower arm members, failures can occur with disastrous results.

A close study of a tower arm (a vulnerable section of a tower prone to failure) under laboratory testing conditions can often reveal weaknesses in the design that could contribute to failure. Analysis of the test results often indicate the most economical methods for reducing the likelihood of material failure under dynamic conditions.

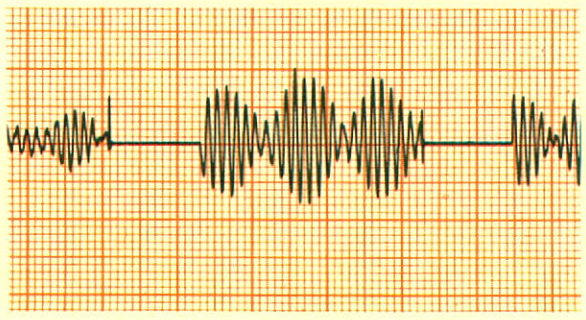
# Overhead Conductor Vibration



A conductor hung between supports is subject to the whims of the wind. A telephone line will hum as a result of the wind blowing over it; transmission and distribution lines experience the same effect, but because of their large diameter and weight the noise is generally undetectable to the human ear.

Line vibration causes noise to be emitted from the conductors. If the vibrations exceed the mechanical strength of the line, failure will result. Vibration measurements, to ensure that conductors are not vibrating beyond their mechanical tolerances, are therefore an important aspect of Transmission and Distribution Engineering.

The need to determine quantitatively the nature of the vibration on a particular line at any given time has long been a utility problem. R & D developed a system that does just that. The HILDA (High Line Data Acquisition) system was developed through in-house research and designed for commercial application by SED Systems Ltd. of Saskatoon. The system consists of two basic assemblies —one mounted on the line being investigated and the other located conveniently at ground level.



# Phase Converter

A growing number of farmers are requesting the provision of three-phase electrical service. Three-phase power has important benefits over the more conventional single-phase power service if large electric motors are used. The cost of upgrading the 70,000 miles of single-phase rural distribution line in the province to three-phase is prohibitive and therefore individual customers have had to use single-to-three phase converters if they required three-phase power.

The Corporation is investigating alternative means of phase conversion in an attempt to reduce the cost and increase the reliability of available converters. One possible course has been extensively studied and simulated on a digital computer. Laboratory and field testing of this alternative is planned.

The outcome of this project will indicate the range of applications that will be possible and the direction further development will take. The implications of successful tests reach beyond fulfillment of satisfying customer requirements, to providing important parameters for planning the expansion and reinforcement of the rural distribution system.

# Switching Station Automation

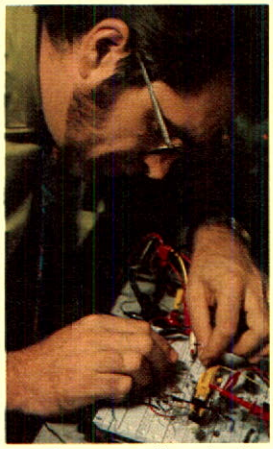
At a switching station transmission lines join and feeders are connected to urban, rural and industrial loads. Switching stations contain transformers to pass power between lines operating at different voltages and large, high speed switches to permit equipment de-energization. The operation of transformers, switches and all other associated switching station equipment is monitored by an instrumentation system.

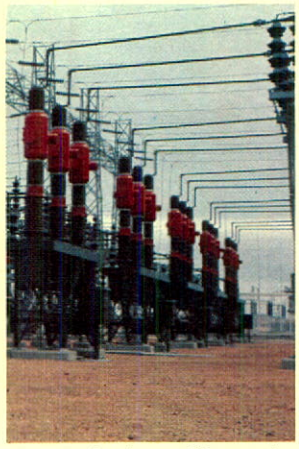
The R & D Centre is working toward the replacement of the conventional instrumentation system with one based on digital computers. As well as the savings in construction costs the computerized approach will permit more flexible and accurate operation of the power system and result in operational savings.

One of the most important functions performed by switching station instrumentation is the detection of failures or faults on the power system. Faults must be identified and appropriate switches or circuit breakers triggered in less than 1/60th of a second if province-wide blackouts are to be avoided. This has been successfully accomplished at the R & D Centre by devising a unique technique to sample and process the power system waveforms. The new computerized system can also aid in fault diagnosis by graphically reproducing the waveforms from the stored samples.

# High Voltage Current Transducer

A combination of fibre optic technology and electronics could improve the performance of current transformers used in Corporation switching stations. Current transformers are used extensively at switching stations to detect fault currents and to trip circuit breakers and other protective equipment. A failure in a current transformer could have serious results for a power utility.





Fibre optics is the use of glass fibres to transmit signals over distances. Its application is of particular interest to utilities; glass fibre is a high voltage insulating material and its use makes it possible to transmit information between two points at different voltage levels.

Glass fibres are also capable of transmitting a larger amount of information on one channel than the copper or metallic conductors used today.

Electronic circuitry could be used to process the fibre optic signal at both ends of the cable. Electronic circuitry is being developed in the laboratories at the Research and Development Center. The circuitry must meet high standards of reliability under severe environmental conditions.

The fibre optic cable is the key link in the system, along with the light emitting diode in the transmitter and the photo-diode in the receiver.

In addition, the optical transmission efficiency of the glass fibres themselves can change with time, due to: changes in the polished surfaces of the cable ends, the effect of a high electric field on the fibres, and the possibilties of breakages in the fibres. For these reasons, it is not practical to transmit an analog signal through the fibre optic cable. To overcome this problem, the analog signal derived from the high voltage line is converted to pulse form at the transmitter and reconverted to analog form at the receiver.

# Power Plant Efficiency



The Boundary Dam Power Station, with a rated capacity of 582 Mw distributed over five units, is the largest and lowest cost generating station on the Corporation's electric system. The plant at this power station is in almost continuous operation at or close to its maximum capacity as a source of cheap base load power. It is reasonable to expect therefore, that any program of efficiency measurement and optimization would commence with an examination of operations at this plant.

The coal consumed by the steam generators is obtained from strip mining operations located in close proximity to the power station. This arrangement helps to keep fuel prices to a minimum — a fraction of the prices which exist elsewhere in the system. However, the enormous quantities of coal which are consumed on base load operations over lengthy periods means that the fuel costs are substantial, and constitute by far the largest part of the overall generating costs. Small improvements in plant efficiency can therefore lead to substantial reductions in fuel consumption. This would have the twin benefits of reducing the cost of power generation to the Corporation and assisting in the conservation of available energy resources.

In addition to reductions in fuel costs improvements in operating efficiency may lead to indirect savings in other areas which can contribute to substantial reductions in the overall costs of generation in the power station and on the complete system. For example, improvements in the combustion characteristics in the furnace can reduce the frequency and extent of slagging and corrosion, which often cause plant derates and breakdowns and resultant increases in operating costs. Substantial reductions in maintenance costs may be achieved, and plant life may be extended as a result of a slower rate of deterioration due to operation under less difficult conditions.

# Air-Inflated Structure

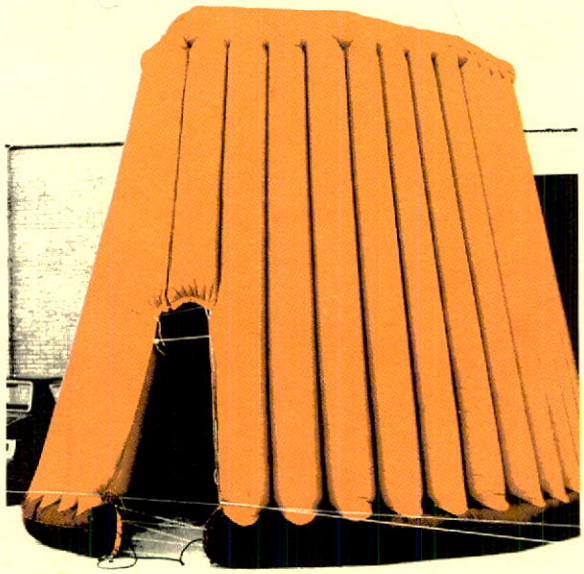
Air structures have received a great deal of attention in the past few years, particularly because the United States' pavilion at Expo 70 was designed with an air supported roof. Today these roofs are being supplied for buildings as large as an 80,000 seat football stadium.

Basic structures include buildings where air pressure inside the building holds the fabric roof in place (air-supported), and structures where pressure inside double walls provides a roof and roof supports (air-inflated). Other structures have included pressurized tubes as beams or arches. Even an inflatable bridge has been built.

The air structure shown here was designed and tested by R & D for electrical transmission maintenance work in the field. The structure was developed primarily to offer workers protection in winter temperatures. The structure is air-inflated so that pressure exists inside the walls and not inside the structure. The top is open to provide clearance for wires running vertically from the unit being repaired. The deflated structure can be rolled up into a bundle and moved easily from site to site.

Pressure for the structure is provided by an industrial fan designed for high static pressure (as high as 18" of water) and moderate airflow. The high pressure is necessary for a stiff structure that will withstand wind loads. The continuous airflow compensates for leakage through sewn seams and small punctures.

Nylon reinforced vinyl was used in the fabrication of this structure. This material is light weight, durable, and flexible over a wide temperature range.



# Natural Gas

Gas research activities have been directed at gas odorant level testing and feasibility studies in the areas of coal gasification and liquefaction. In-house research on natural gas has concentrated on transmission and distribution problems.

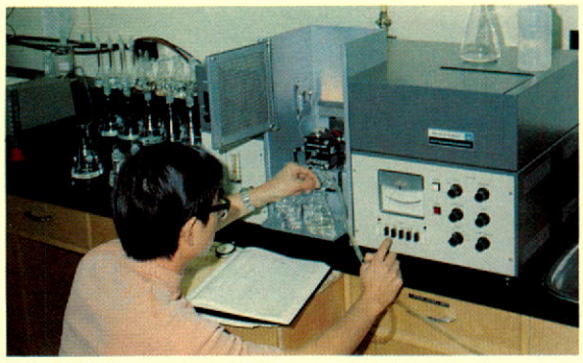
## Coal Gasification

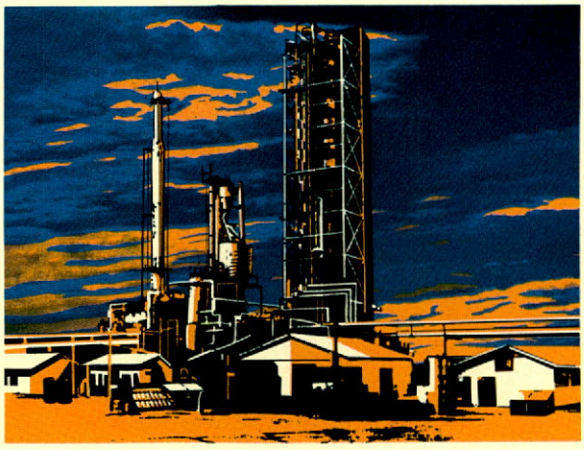
The conversion of coal to natural gas is technically feasible but not yet economically feasible for Saskatchewan. In the future it may be possible to convert some of our provincial coal reserves, estimated at five to six billion tons, into substitute natural gas making Saskatchewan more self-sufficient in that fuel.

The R & D Centre has been engaged in the area of coal gasification for nearly three years. Most of the work to date has been in technically and economically evaluating about 30 coal gasification and liquefaction processes.

A future coal gasification plant in Saskatchewan could possibly resemble the Institute of Gas Technology's Hygas pilot plant shown in the bottom photo.

A preliminary environmental study on gasification is underway through the use of an Atomic Absorption Spectrophotometer (top photo) which measures trace elements in the coal.





Future –
In-situ coal gasification.

Today – Strip mining for coal.

# In-situ Coal Gasification



The Research and Development Centre is supporting the first Canadian underground coal gasification test near Forestburg, Alberta. The testing is being conducted by the Alberta Research Council with substantial financial support from the Alberta Government matched by contributions from thirteen Canadian utilities, international mining and chemical companies and the federal government.

In the present trials, four wells used as injection holes are drilled at the corners of a 30 foot by 60 foot test plot. Air is then injected into the coal zone to increase the downhole pressure to 60 pounds per square inch. An igniter is placed down one of the injection holes to start combustion and air is forced down another hole.

Once the underground fire is established and two holes are linked, air or air and steam are injected into one hole. The gaseous products that result from the chemical reaction are collected through the other hole. The gas that is produced has a low heat value and can be used as a fuel gas. If oxygen is used instead of air, the gas produced has a relatively higher heating value and can be further processed to synthesis gas or substitute natural gas.

The in-situ gasification of coal could prove to be, in certain circumstances, an alternative and perhaps a better way of recovering energy from coal without having to mine it. In-situ coal gasification would have less environmental impact on the land than the disturbance caused by conventional strip mining. The process would be applicable to mining deep-seamed coal that is uneconomical to mine conventionally or difficult to mine because of high slopes or weakness of the overburden.

There is a need to develop in-situ gasification technology beyond its present state. Commercial operations are still ten to twenty years away.


KIMAX

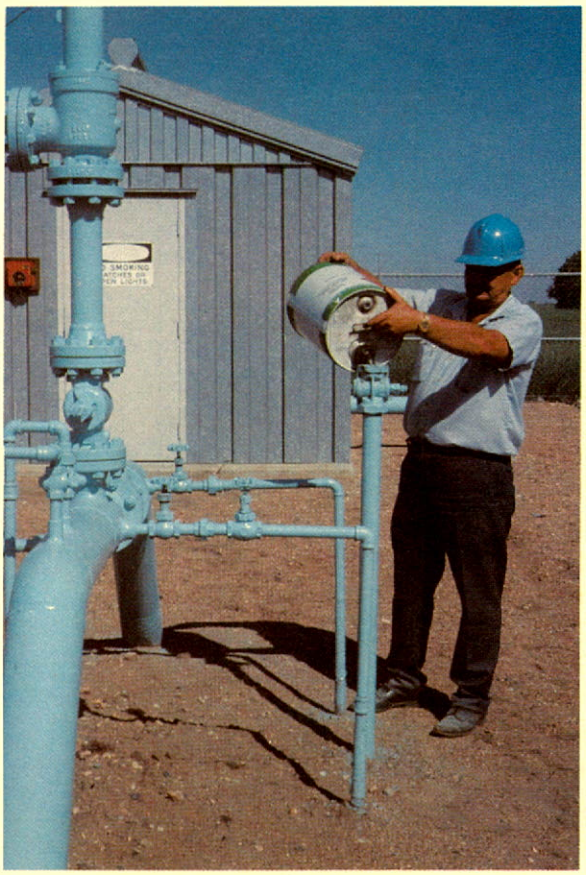
# Natural Gas Safety



Odorants are added to the natural gas before it is fed into gas distribution lines. This odorant serves as a safety measure for the public. It enables the customer to detect a gas leak by the characteristic warning odor. Research was carried out to determine the effect of odorants on plastic pipe distribution lines and to develop a convenient method for the accurate measurement of odorant levels in the pipelines.

Investigations showed that PVC (poly vinyl chloride) pipe is affected in decreasing order by n-propyl mercaptan, methyl sulfide, i-propyl mercaptan and the least by t-butyl mercaptan. No effect was observed on polyethylene pipe. Melting points and vapour pressure properties of an odorant blended in the laboratory, and having minimal effect on PVC pipe were studied.

A colorimetric method and simple apparatus was developed for quantitatively measuring odorant levels under operating field conditions. This method and apparatus were found to be superior to the conventional method of measuring the odorant level by its smell and far less expensive than a chromatograph.



# Energy & Environment

Research activities have been expanded in recent years to incorporate studies of alternate sources of energy and the environmental impact of energy resource development. The increased demand for environmental control and the predicted shortages of presently utilized energy sources prompted a greater devotion of R & D time to these areas.

## Wind Power

Windmills have been used for many years to pump water and to provide electricity, but the energy crisis has prompted a new interest in this power source. Like tides and the sun, winds offer a tremendous energy potential with no fuel requirement. But the wind is unreliable and no energy is obtained on calm days. Conventional windmills are also expensive in terms of cost per unit of power output.

The problem of unreliability can be solved by suitable energy storage systems. Large scale, low-cost storage schemes are being studied. The problem of cost has been approached through new designs like the National Research Council's vertical axis wind turbine. Rather than having a tower to support a turbine, shaft and generator high above the ground, this design features the shaft as the vertical structure with blades attached at the top and bottom of the shaft. The generator is located at the bottom of the turbine such that the weight of the unit is not supported at the top of the structure. The slender blades are curved in the natural shape of a cable or rope supported at both ends.

The National Research Council's wind turbine under evaluation by the R & D Centre was manufactured by Dominion Aluminum Fabricating Limited. Their unit includes a DC motor generator for starting the windmill and generating electricity once the turbine is up to speed. At higher speeds the electricity is generated by means of an alternator. The electrical system thus contains components which are familiar to anyone with a knowledge of standard automobile equipment.

# Waste Heat Utilization

The Saskatchewan Power Corporation assisted the University of Saskatchewan in an experimental use of power plant waste heat. Waste heat from the exhaust stack of a gas turbine operated Saskatchewan Power Corporation natural gas compressor station just east of Saskatoon is heating a greenhouse where more than 700 tomato plants are growing in sawdust. This is a relatively inexpensive method of using waste heat.

The greenhouse, a rounded structure 135 feet long and 26 feet wide, consists of a wooden base and metal frame with fibreglass ends and a polyethylene cover. It is divided into three sections, two of them heated with waste heat from the turbine of the compressor and the third, for purposes of comparison, with conventional unit heaters. A single layer of polyethylene covers two of the sections, while a double layer covers the third. The heat from the exhaust stack reaches a controlled area in the greenhouse at about 149°C, where it is mixed with fresh air and distributed to the two waste heat sections through a combination of metal and polyethylene ducts.

In addition to heat, the gases contain quantities of carbon dioxide that are beneficial for plant growth. The additional carbon dioxide has allowed exceptionally good tomato plants to be grown under the poorer light conditions of mid-winter.

# Electric Storage Furnace

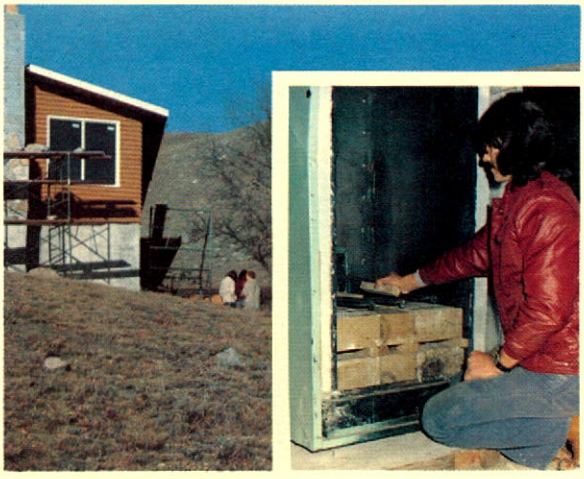
Rising fuel prices and uncertainties in future supplies of gas and oil have prompted many customers to consider electric heating for their homes. While this might not be a concern in areas where the heating load is small, it is of great concern to utilities in areas where the heating load is five times the current electrical energy supplied to the home.

A means of alleviating this situation is the utilization of excess generation and transmission capacity available during the night to provide off-peak electric heating. The R & D Centre has developed an electric storage furnace which utilizes this excess generation and transmission capacity. The furnace is undergoing tests in two Saskatchewan homes and in homes in British Columbia.

The off-peak furnace was designed to store energy in the form of heat. At night when the normal demand for electricity is low, electricity heats the air circulated through the house and also heats special bricks in the furnace. During the day when the normal demand for electricity is high, heat for the house is obtained from the air passing over the hot bricks. The only electricity input required at this time is for the furnace fan and controls.

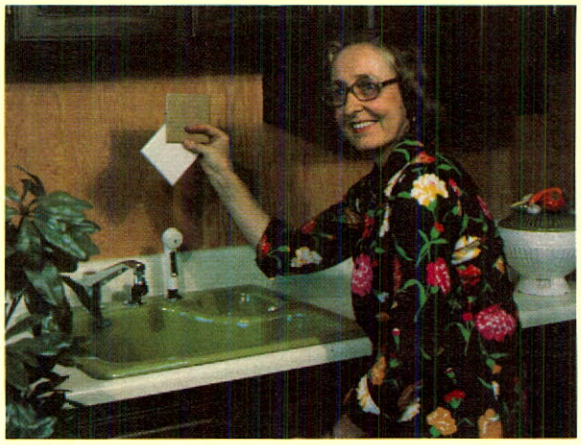
The electric elements used to heat the air and the bricks are similar to the elements in the oven of a kitchen range. Their capacity is high enough that an eight to ten hour operation at night will provide all the heat required for a full day.

Similar heat storage units are in use in England, Europe, and Japan although these units are usually of the room "radiator" type rather than a central heating furnace. Their heat storage capacity is also much less, but sufficient for the climatic conditions in which they are used.



# Fly Ash Utilization

Coal-fired power plants such as Boundary Dam Power Station at Estevan generate large amounts of by-product ash that is harmful to the environment. Disposing of this fly ash, as the residue is called, has traditionally been a problem at power plants.



Continuous efforts are made to find ways of using fly ash productively. Today it is used in the construction industry as an additive to cement. The demand for fly ash for this purpose required the addition of a bagging plant to the No. 1 unit at Boundary Dam.

The Saskatchewan Power Corporation sold 15,500 tons of fly ash in 1976, some of which was used for road bedding and soil stabilization. The Research and Development Center co-operated with the Fly Ash Research Institute of the University of North Dakota in developing and testing fly ash bricks and decorative tiles. Research into the feasibility of using fly ash for manufacturing rock wool will soon be underway.

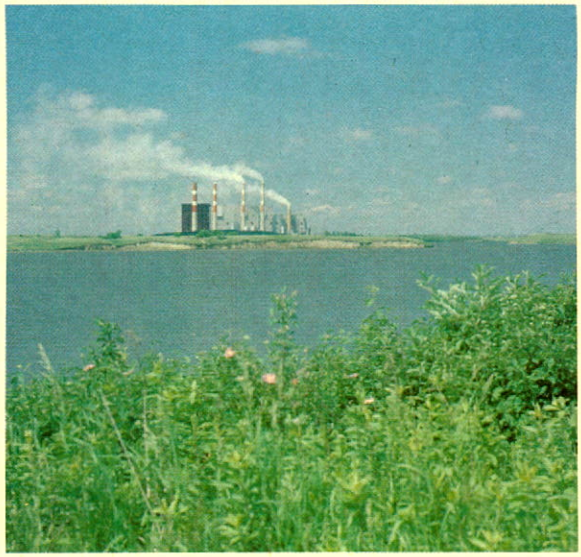
# Environmental Monitoring

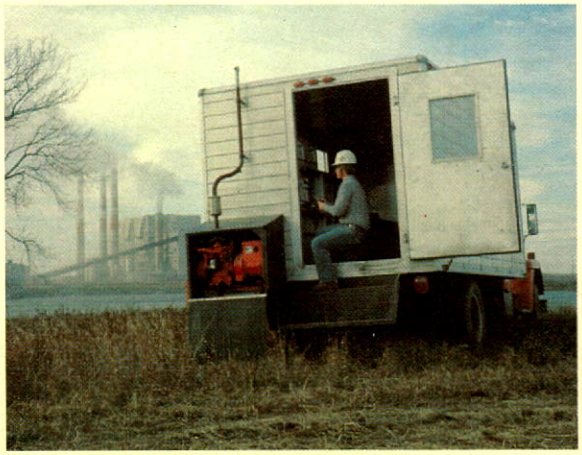


Increasing industrial and public concern over the protection of the environment caused the Corporation to expand its research activities into environmental matters. These activities involve the monitoring of stack emissions and the measurement of water and air quality at the Corporation's power plants and natural gas installations. Studies to evaluate the effects of chemicals presently used for weed and brush control were also carried out.

The Corporation established and initiated an Environmental Monitoring Program to monitor the environmental effects of its natural gas and electricity generating and distribution activities.

R & D assisted in the development of an environmental monitoring mobile van and trained a monitoring team to carry out these activities. This monitoring is now done by the Coal and Environment Division of the Corporation. The R & D Centre acts as a consultant and conducts environmental research, analytical and calibration work for this division.





# Reclamation



For nearly 100 years, coal miners have been digging out the coal from the vast coalfields at Estevan first by underground tunnelling and more recently by strip mining. In strip mining, the land or overburden covering the coal seams is scraped aside to enable the miners to remove the lignite coal. The result is mounds of "spoil" piles which are barren and unsightly. At Estevan and Bienfait there are an estimated 12–14 sections of mined-out area some of which is on Saskatchewan Power Corporation property. The real value of the land has been in coal recovery for energy production.

After mining, the challenge exists to restore the land and perhaps even give it surface value that it didn't have in its original state.

An experimental program began in 1970 to reclaim coal spoil piles created by strip mining operations near the Boundary Dam Power Station at Estevan. Since that time, the Corporation's reclamation program has transformed spoil piles into areas of grass and tree growth. A number of techniques and types of seed, shrubs and trees were used, some successfully and some not.

Experimenting in these areas will continue into the future to establish the optimum degree of graded slope and to test types of vegetation to determine those with the highest survival and growth rate. Much of the reclaimed land boasts a healthier growth of shrubs and trees than that which exists on the surrounding prairie. These reclaimed areas now serve as wildlife refuge. Future plans envisage areas for fishing, canoe trails, recreation, and pasture, hay and cereal crops.

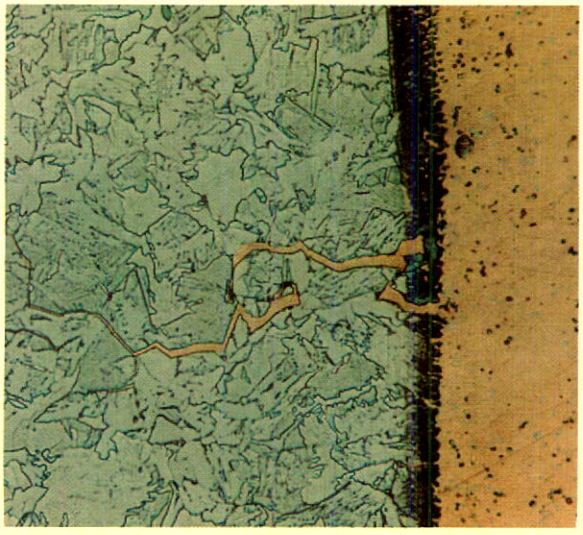
# LABORATORY SERVICES

Laboratory services are essentially provided for research projects in the necessary and important experimental phase. Laboratory facilities are at the disposal of Corporation personnel who have unique problems but lack the sophisticated equipment, instrumentation and qualified staff.

## Metallurgy

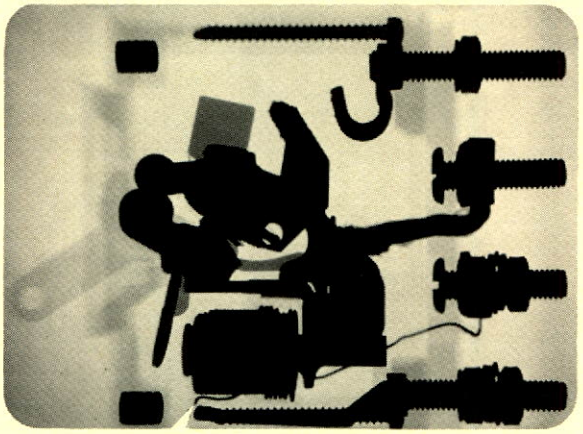
The evaluation of materials is a laboratory service which entails a more in-depth investigation of various components or equipment. Microscopy and metallurgical breakdown analysis play a very important part in these evaluations. Items requiring complete analysis include gas pipe, gas valves, corrosive deposits on conductors and insulators. Modes of failure in particular, are constantly being microscopically and metallurgically analyzed. When a piece of metal is to be examined under a metallurgical microscope, the surface of the metal must be polished. Polishing with coarse to fine grades of polishing paper followed by polishing on diamond paste pads bring the metal surface to a mirrorlike finish. The sample can be examined in this highly polished condition or stained with a special solution to reveal the metallic structure.

Staining the polished surface reveals the microstructures of the metal, and it is the interpretation of this structure when it is examined under the microscope that will indicate such information as method of production, heat treatment and nature of surface defects. The sample below is a copper deposit on a section of steel pipe seen through a microscope.



# Non-Destructive Testing





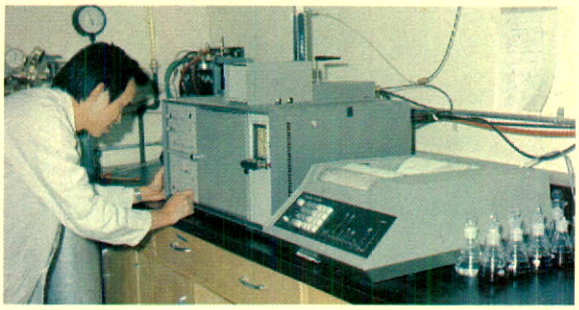
One of the most common non-destructive testing methods in the examination of materials or components is the use of X-rays. In the portable X-ray unit, the "gun" emits a train of high energy, high intensity X-ray pulses of short duration. The object to be examined is placed between the beam of X-rays and a photographic film. The material of the object will absorb the radiation, but where there is a discontinuity such as a crack or a void, there will be less absorption. The X-rays not absorbed by the material will pass through the photographic film and expose it in the same way as light falling upon it.

The portable X-ray unit consists of a high voltage pulse generator for the conversion from the standard power supply to the high voltage necessary for the generation of the X-rays and a "gun" in which the X-rays are produced.

In the photograph above, the defect in the encapsulated electrical circuit can be seen in a positive print made from the X-ray negative.

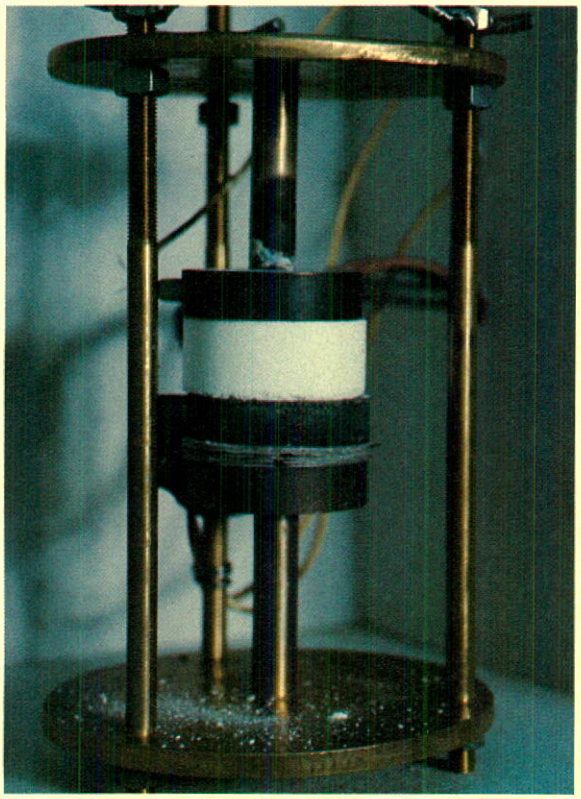
# Chemical Laboratory

Although the Corporation's main activities are electricity and natural gas production and distribution, chemicals and chemistry in one form or another play a large role in these activities. Because of this, a number of research projects are chemical in nature. The chemical laboratory plays an important role in analytical and chemical research work.



The laboratory is equipped with modern instruments for complete coal analysis, water and waste water analysis, air pollution analysis, trace element analysis, metal analysis, oil and fuel analysis, etc. Although the laboratory is used for research, it can be used for short-term problems (analytical and otherwise) from the field and provides assistance to other departments of the Corporation in solving problems of a chemical nature.

In the photograph below, chemical laboratory equipment is being used to measure the thermal conductivity of sodium sulfate.

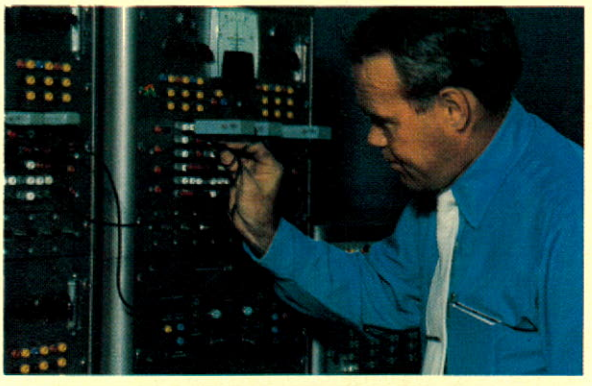


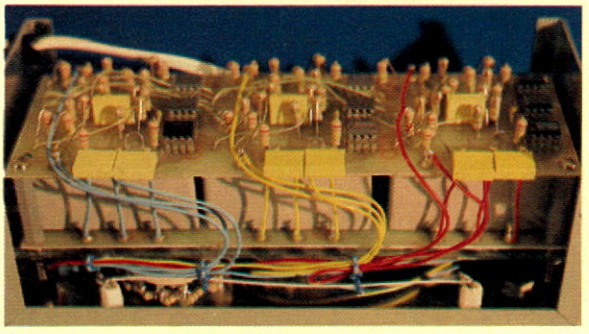
# Simulation Facilities

Much time and money can be saved by comparing various problem solutions using simulation rather than conventional experimental techniques. Typically, a mathematical model or simulation investigation is used to eliminate all but the most promising solutions from a thorough laboratory experiment investigation.

The Corporation has several simulation facilities with various capabilities at its disposal. Several digital computer systems, rented, shared, and owned, support a variety of special and general simulation facilities in either interactive or batch mode. Digital simulation has been used, for example, in the switching station automation and phase converter experiments. The analog computer has been used in investigations of the heat storage furnace and is particularly useful where actual equipment is to be interfaced with the simulation or where trial and error solutions are used.

Simulation is also accomplished by scale modelling. An example of this is the power system model that has been built for use initially in the switching station automation project. In this model, all the voltage and current levels have been reduced by known scale factors. System reaction to specified conditions can then be measured. This unique model holds unaltered both the physical layout and time scale which are essential features to many system studies.





# JOINT RESEARCH

Research unique to Saskatchewan circumstances is a Corporation priority. The relatively small size of our Corporation in comparison with other Canadian electric and gas utilities has restricted our projects to research not pursued by other organizations and requires the most efficient use of our research and development facilities.

Several research projects are contracted out to Saskatchewan and Canadian universities and the Saskatchewan Research Council. Through joint research programs with the Canadian Gas Association and the Canadian Electrical Association, the Corporation supports projects of common interest to Canadian utilities. Continuous dialogue with these organizations ensures that research programs are not duplicated.

The Corporation contributes financially to the Canadian Gas Research Institute formed in 1972 to undertake research projects of concern to gas utilities. A federal grant of $160,000 enabled the Institute to establish a building and laboratory equipment. Canadian gas utility funds support the research of the CGRI.

The Saskatchewan Power Corporation has more than financial input into the projects undertaken by the Institute. At the Corporation's suggestion the Institute investigated flue damper and spark ignition applications toward a saving of natural gas in gas furnaces. With this device residential dwellers may be able to turn off furnace pilot lights in the summer and save money as well as conserve energy.

In the first five years of operation CGRI projects have included the design of improved heat exchangers in gas furnaces and a new corrosion-resistant gas water heater.

The CGRI has been involved in emission analysis of gas plant furnaces for environmental control. The Institute has also developed a pipeline locator that can prevent serious damage to underground lines. The device attaches to construction digging equipment. It locates buried pipeline and automatically stops within six inches of the pipe.

A portable device to test thermal couples and thermal piles of gas furnaces developed by the Institute may someday save the homeowner money on service calls. When a pilot light is out, this equipment will tell immediately if the fault lies with the thermal couple. The CGRI also pioneered the development of a gasline leak detector that pinpoints leaks more effectively than it has been possible in the past.

The Canadian Electrical Association is supported in such research projects as sulfur hexafluoride technology, environmentally acceptable overhead transmission lines and distribution systems, the development of compact and aesthetic sub-transmission line designs, a study of problems associated with pipelines occupying joint-use corridors, and peak load management, to name a few.

Contracts are given to research organizations which provide expertise not available within the Corporation. It does not pay for the Corporation to have on staff, for instance, a full-time biologist and his necessary laboratory equipment when utility R & D seldom requires his expertise. It does make sense to contract work, as we are now doing for a study of microbial protein production from power plant waste heat and flue gases, to a University of Regina biology professor.

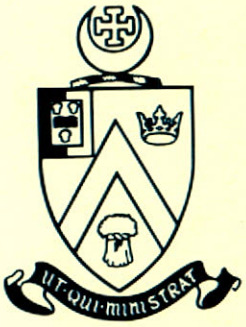
The availability of outside skill and equipment reduces our cost and at the same time avoids duplication of research efforts.

The Saskatchewan Power Corporation has a standing arrangement with the University of Saskatchewan engineering faculty that stems from a Joint Power Research Grant started in 1961 with the electrical engineering department. In 1975 the grant was extended to include all engineering disciplines.

Under the agreement, the Corporation provides a yearly grant to support four postgraduate students in research that is chosen in common interest with the faculty of the engineering college. Projects undertaken are decided by a joint SPC-faculty committee.

A yearly technical seminar is given by the Corporation for the students and faculty and reciprocally the faculty and students conduct a seminar for SPC personnel.

Nearly every research engineer on staff at the R & D Centre in Regina is a member of an engineering skill association – the Society of Mechanical Engineers, the Engineering Institute of Canada, the Institute of Electrical and Electronic Engineers, the Canadian Information Processing Society. These connections enable the Centre to keep abreast of world developments as well as allow staff to attend various technical conferences and present papers on their research.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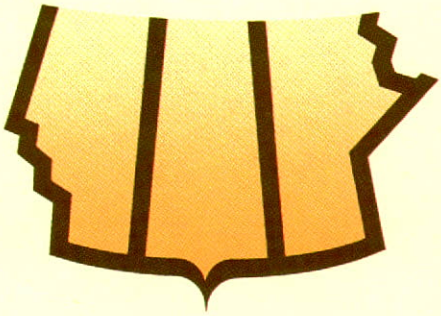


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