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Saline water conversion

- 9 OCT 1989

CENTRE FOR ARAB GULF STUDIES

UNIVERSITY OF EXETER

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

In the name of God,
Most Gracious,
Most Merciful

**We made from water
every living thing**

God speaks the truth

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God speaketh the truth
every living thing
We made from water
Most Merciful
Most Gracious,
In the name of God,



b1565350X



**His Majesty
King Fahd Bin Abdul Aziz Al Saud**

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**His Royal Highness
Prince Abdullah Bin Abdul Aziz Al Saud**

Crown Prince, Deputy Premier and Head of the National Guard



**His Royal Highness
Prince Sultan Bin Abdul Aziz Al Saud**

Second Deputy Premier Minister of Defence and Aviation, and
General Controller



On our youth rests a big responsibility — they are the pillars of the present, and the imaginative minds of the future.

Fahd Bin Abdul Aziz



In the name of God, most merciful, most compassionate.

Thanks for Allah and peace be upon his prophet.

Daily, in this flourishing era, development and construction efforts continue country-wide. Comprehensive planning and integrated activities are organized for maximum impact on improvement of the lives of the Saudi Arabian people, in satisfying their needs and aspirations and in providing the means for dignified and happy living.

The Saline Water Conversion Corporation has a very important role to play in this development process. Because of the importance of its function of providing potable water from the sea, and the magnitude of this task, it has become one of the pillars of development in our land.

I would like to note here that SWCC, while engaged in the building and operation of desalination plants and power generation stations, has never neglected the development of human resources. It has achieved good results in the training and qualification of Saudi citizens to assume the management responsibilities of administration, operation and maintenance of its plants throughout the Kingdom, and has developed a comprehensive program for training Saudi youths in operations and maintenance skills.

I am optimistic that this Corporation has a bright future in serving our country and its people. I am also pleased with the dedicated manner in which the staff of administrators, senior managers and technicians of SWCC perform their duties, just as I am with the other members of the staff of the Ministry of Agriculture and Water who are dedicated to the same objective, namely that of providing potable water to all of our people, as one of the principal duties of the Ministry.

May Allah make our work blessed and acceptable in his sight. May he guide our leaders in working for the good of our religion, the Muslim nation, our country and all Muslims.

Abdul Rahman A. A. AISheikh



His Excellency
Dr. Abdul Rahman Abdulaziz Alsheikh
Minister of Agriculture and Water
and Chairman of the Board of Directors
of the Saline Water Conversion Corporation

Members of the Board of Saline Water Conversion Corporation



His Excellency Dr.
Abdul Rahman bin Abdul Aziz Al-Sheikh President
Minister of Agriculture and Water



His Excellency Dr.
Saleh Al-Mutairi Member
Deputy Minister of Manuipatties and
villages for Manuipatties Affairs



His Excellency Dr.
Saleh Almutairi Member
Deputy Minister of Finance and National
Economy for Planning & Budget Affairs



His Excellency Mr.
Abd Alah Mohamed Al-Golakah Member
Governor of the Corporation



His Excellency Mr.
Abdul Aziz Al-Shoraber Member
Deputy Minister of Petroleum and Mineral
wealth for Financial and Administrative Affairs



His Excellency Mr.
Hussein Segiry Member
Deputy Minister of Planning



His Excellency Engineer
Yousef Al Hamoud Member
Deputy Minister of Industry and
Electricity for Electricity Affairs

History of the Saline Water Conversion Corporation

Water resources in the Kingdom of Saudi Arabia are largely limited to underground water, which is used both for drinking and agriculture. There is no surface water except for a few oases, and no streams except in the extreme Southwestern part of the country.

The idea of desalinating seawater as a supplementary source of potable water, in order to save underground water for agricultural use, was conceived as a means of supporting the immense and rapid physical development, the cultural and economic progress and the population increase forecast for the Kingdom. It has proven to be the best solution to the problem of providing sufficient potable water.

Saudi Arabia now leads all other countries of the world in desalination capacity.

As early as 1928, His Majesty the late King Abdul Aziz, may God bless his soul, ordered the installation of conventional boiler/ condenser units for distilling seawater to provide potable water to Jeddah. This Royal grant was the first action ever taken in the Kingdom to use distillation as a practical method on a significant scale.

With the ever increasing demand for water, the need was soon recognized for organized planning and development effort on the conversion of seawater into potable water. In 1385 H (1965), an office was established in the Ministry of Agriculture and Water to carry out the necessary feasibility studies and preliminary steps for installing desalination and power generation stations on the coasts of the Red Sea and the Arabian Gulf. In 1392 H (1972) this office was designated the Ministerial Office for Water Desalination and continued its planning and plant installation activities as well as supervision of the plants already in production in Jeddah, Al-Wajh and Duba.



In 1394 H (1974) a Royal Decree established the Saline Water Conversion Corporation as an independent Public Corporation. The newly born Corporation continued the work of its predecessor in supplying water to the cities of the Kingdom. It established single-purpose (water only) and dual-purpose (water and electricity) plants along both coasts.

Initially, the operation and maintenance of these plants along with the selection and hiring of the necessary trained personnel, were entrusted, under contract, to specialized companies. These plants included Jeddah Phase I, Duba, Al-Wajh, Umm Lujj, Al-Khafji and Al-Khobar.

Beginning with the inauguration of the Jeddah Phase II plant, in 1398 H (1978) the Corporation itself assumed the responsibility for all functions, including spare parts and personnel, of Operations and Maintenance. Non-Saudi experts were hired directly and only as needed to assist in these functions under the supervision of specialized Saudi management and technical personnel.

By 1403 H (1983), SWCC was able to extend this principle to the operations and maintenance of all its plants. This became possible because from its earliest beginnings, the Corporation had paid special attention to the training of Saudis to enable them to perform these tasks efficiently.



AL-KHOBAR Desalination

The Corporation is organized as follows:

1. The Board of Directors:

The Board establishes general policies under which all Corporation activities are carried out, and maintains board surveillance of its affairs and progress.

2. Executive Administration:

The Governor of SWCC is its Chief Executive Officer, with responsibility for the overall conduct of Corporation affairs. Three main sectors of the Corporation each headed by a Deputy Governor, are in turn responsible to him. They are:

- 0 Technical Affairs and Projects. This group includes the supervision of all projects from the planning stage through to completion and acceptance of the installation, as well as computer operations, Research and Development and Training functions.
- 0 Administrative and Financial Affairs, which administers Financial Planning and follow-up, the annual budget, general administrative affairs (purchasing, housing, etc.) and personnel matters.
- 0 Maintenance and Operations, which is responsible for all aspects of running SWCC's desalination and power plants, pipelines and associated installations.

Conversion of Seawater

There are various methods by which saline water may be converted into "fresh" potable water of low salt content.

Factors which determine the selection of the most appropriate method of desalination include:

(1) The composition of the seawater.

On the average, seawater contains about 35,000 parts per million (ppm) of total dissolved solids (TDS). However, the TDS of the water in the Arabian Gulf averages 56,000 at al-Khobar, and varies from 38,000 to 43,000 in the Red Sea at Jeddah.

(2) The temperature of the seawater feed, and other natural factors.

In the design of desalination plants, temperature must be considered in order to insure that the plant will yield its design capacity at the chosen design temperature. If the temperature of the feed increases or decreases, productivity is affected.

Other factors which affect production and which must be taken into consideration in plant design are tidal action, seawater depth in the area of the plant intake and pollution.

(3) Production costs of water and electricity.

The process must be selected to yield the optimum capital costs and operating costs, based on the latest advances in desalination technology.



Methods of Desalination

(1) Distillation Processes

A) Multistage flash Distillation

This method depends on the fact that the boiling temperature of a liquid is directly proportional to the pressure; as pressure decreases, so does the boiling temperature. In the MSF process, the heated seawater is conducted into successive chambers at successively lower pressures.

Under these conditions, additional boiling takes place in each of the chambers. The vapor produced in condensed on cool surfaces and collected as distilled water.

Most of the largest desalination plants use the MSF process.

B) Conventional distillation, using Solar Energy.

In simple distillation, vapor produced by heating seawater at ordinary pressure is condensed on cool surfaces and collected. The use of solar energy for heating the seawater is being studied to determine how to reduce production costs. The use of solar energy is still in the experimental stage.

C) Other distillation methods include:

- 0 Distillation in vertical tubes.
- 0 Multistage multieffect distillation.
- 0 Vapor compression.

(2) Desalination using membrane technology.

A) Reverse Osmosis

In this process, seawater under pressure is exposed to semi-permeable membranes which allow the passage of water but retard the passage of the dissolved salts, thus producing a stream of purified water and a separate stream of more highly concentrated brine.

B) Electrodialysis

In this process, seawater feed at atmospheric pressure is introduced into cells which contain two different kinds of membranes, one of which permits the passage of positive ions and the other negative ions. Under the influence of an electrical charge, the ions are removed from the seawater to produce a purified product stream and a concentrated brine.

3) Desalination by Freezing.

4) Desalination by Chemical Methods.

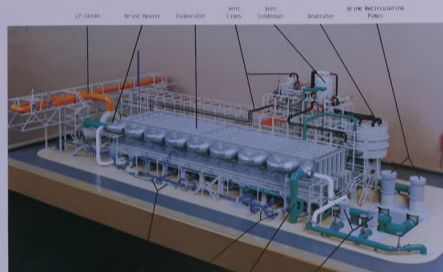
A Simplified Description of an MSF Plant.

Incoming seawater is screened to remove suspended material which would otherwise damage the pumps used in the process. The feed is also treated with sodium hypochlorite in order to control biological growth, and then stored in holding tanks for use as required.

The process is managed through the use of sophisticated instrumentation for such purposes as controlling flows through various pumps and taking measurements of pressures, temperatures and other parameters throughout the entire system, from the intake through the distillation process and chemical dosing and storage of the product water.



Concentrated Brine Discharge



M. S. F.
Desalination Unit

Before the seawater enters the distillation process itself, it is treated with chemicals such as polyphosphate to prevent the formation of scaling residues inside the condenser tubes. It is also deaerated to remove dissolved gases. The seawater feed is then heated to optimum distillation conditions, using steam-heated heat exchangers.

The MSF process requires many pumps for various purposes such as circulation of brine in the process, discharge of rejected concentrated brine, and moving the product water to the chemical treatment area.

In addition to the sophisticated instrumentation for process control, there are also controls for fire warning and other safety purposes.

The product water is treated with such chemicals as chlorine, carbon dioxide and lime in order to make it conform to International specifications for potability. It is then stored in tanks to await distribution as needed.



Electric Power Generation Plants

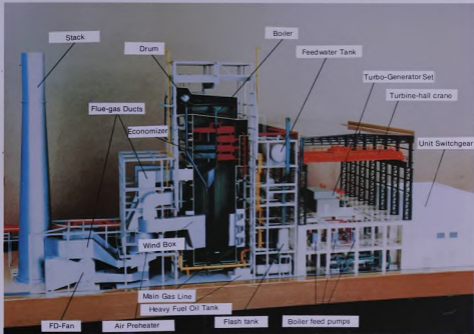
A Simplified Description of a Power Generation Plant

A power generation plant consists, basically, of boilers to produce steam which in turn is used to run steam turbines for generating the power.

Part of the power generated in SWCC plants is used for internal needs such as in the residential compounds, or pumping stations, or in the process itself. The rest is exported from the plant to an electrical network.

The power generation plant includes various auxiliary facilities such as transformers, fuel storage, fire-fighting systems and standby electric batteries to provide for the electrical needs of the process in case of power outage in the network.

Computer systems are used for all measurement and process control purposes.



Electric Power Generation Plant

The Activities of SWCC

The scope of activities of SWCC is proportional to the major responsibilities assigned to it. Its tasks may be summed up as follows:

- 0 The preparation of studies related to the installation of desalination and power generation plants.
- 0 Contract administration and supervision of the construction of facilities.
- 0 Operation and maintenance of facilities.
- 0 Hiring, qualification and continued training of technical and administrative Saudi personnel and supervision of foreign personnel.
- 0 Carrying out applied technical research related to desalination and power generation.
- 0 The use of computers.



AL-JUBAIL Desalination Plant

In addition to the construction and operation of desalination plants, the Corporation provides the following:

- 0 Supply of product water by pipeline to coastal and inland cities and villages.
- 0 Supply of excess electric power generated in dual purpose plants to the national electrical power grid.
- 0 Housing and social services for its employees.

STUDIES :

The Corporation carries out studies of various kinds such as:

- 0 Optimum size, type and location of single or dual-purpose plants in the light of projected needs for potable water and electricity in various regions of the Kingdom and the availability of potable water from other sources.
- 0 Technical and economic aspects of the use of treatment chemicals and additives which can affect production rates.
- 0 Materials of construction most appropriate for its plants, based on process and site specific factors.



Supervision of Plant Construction Plants, Pipelines and Compounds

- 0 The Corporation carries out studies on final design of its plants, taking into consideration both technical and economic factors.
- 0 It then follows up with supervision of the construction phases of its desalination and power plants, pipelines, and associated facilities.



A general View of the AL-KHOBAR Plant

Operations and Maintenance of Facilities 4500 SWCC Personnel engaged in Operations and Maintenance

In the early years, SWCC plants were supervised and operated under contract by specialized companies. However, the role of such companies was gradually reduced until it was ended completely in 1403H (1983). This change has resulted in marked reductions in the costs of operations and maintenance. At the same time Saudi personnel have been trained and have proven themselves fully capable of carrying out the following responsibilities:

- 0 Administration and operation of the desalination and power plants and associated facilities.
- 0 Control of all process variables in the production of water.
- 0 Carrying out the necessary operational and preventive maintenance of all equipment. This maintenance work is done periodically-daily, monthly or annually, as required. Each plant or section of a plant is shut down annually for major maintenance tasks.



Operations and Maintenance Activities

The Corporation has followed a policy designed to achieve both efficient and economical operations and maintenance, as follows:

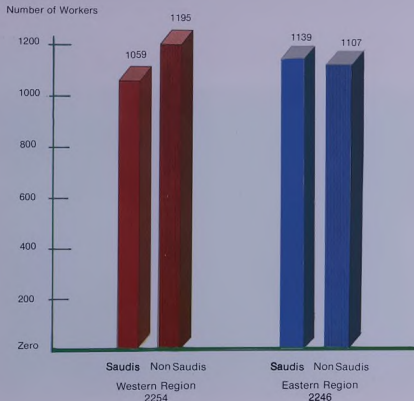
- 0 Revision of plant organization charts and job descriptions for optimum use of individual capabilities.
- 0 Organization of the financial and administrative functions of operation and maintenance at individual plants into two branches, or regions, the Western Branch, with headquarters at the Jeddah plant for all Red Sea facilities, and the Eastern Branch, located in the city of Al-Khobar, for plants along the Arabian Gulf. These two Branches are responsible to Management at Central Headquarters in Riyadh.
- 0 Coding of spare parts and standardization, where possible, at each plant, as a basis for centralized computer control of spare parts, to eliminate unnecessary and expensive duplication, obtain lowest prices for parts and reduce overall cost of acquisition.



Control Room

Number of Workers in Operation and Maintenance Saudis and Non-Saudis

Nationality	Western Region	Eastern Region	Total
Saudis	1059	1139	2198
Non-Saudis	1195	1107	2302
Total	2254	2246	4500



Personnel :

Since SWCC plants continue to increase in size and complexity, they require highly qualified, trained personnel for their operation and maintenance. With the goal of having its facilities staffed by fully qualified Saudi nationals, SWCC has trained 286 employees in the various disciplines needed, at various plants on the Eastern and Western coast.

The Corporation has also designated 128 young Saudis having the necessary basic qualifications for further study and training in various foreign countries, in order that they might become thoroughly skilled in the most modern techniques required for the administrative as well as technical aspects of operation and maintenance of the many facilities.



Control Room (Training in progress)

SWCC is in the process of establishing two modern training centers, one at Al-Jubail and the other at Yanbu.

The one at Al-Jubail will be part of the corporation's principal Research, Development and Training Center, and will be able to accommodate 750 technical trainees at a time. Its curriculum is designed to cover all of the specialized skills needed for safe and efficient operation of the plants.

The other center, at Yanbu, will be able to handle about 300 trainees at a time.

Both centers are to be provided with the most modern equipment, and staffed with highly qualified teachers.

In addition, SWCC has sought assistance for Saudi universities and vocational training centers for training selected personnel in specific technical disciplines. It has also made arrangements with the Institute of Public Administration and its various branches for training others in financial and administrative skills.

The long term goal of the Corporation is to have qualified Saudi personnel filling all of the technical and administrative posts in all its facilities.

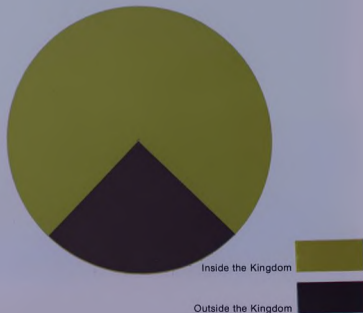


Training Class

Trainees According to Place of Training

Number of Employees Trained
1981 To 1984

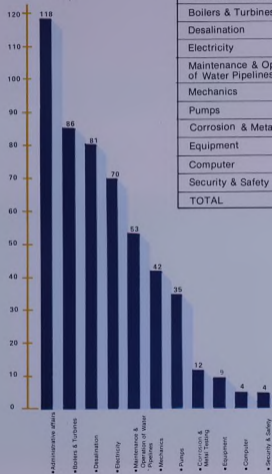
Place of Training	Trainees	
	Number	%
Inside the Kingdom	386	75%
England	57	25%
U. S. A.	48	
Italy	20	
Sweden	2	
Switzerland	1	
TOTAL	514	100%



Trainees According to their Specializations

1981 To 1984

Specialization	Trainees	
	Number	%
Administrative affairs	118	23
Boilers & Turbines	86	13.7
Desalination	81	15.8
Electricity	70	13.6
Maintenance & Operation of Water Pipelines	53	10.3
Mechanics	42	8.2
Pumps	35	6.8
Corrosion & Metal Testing	12	2.3
Equipment	9	1.7
Computer	4	0.8
Security & Safety	4	0.8
TOTAL	514	100.-



Research :

Recognizing the importance of applied research in the light of rapid advance in the technologies of both saline water conversion and power generation, SWCC management has charged the Research Department with the following responsibilities:

- 0 To assist other SWCC Departments in carrying out their duties on a thoroughly scientific basis.
- 0 To make recommendations on methods of solving current or imminent plant problems such as corrosion and scaling of surfaces in desalination equipment, as well as on designing future plants so as to minimize such problems.
- 0 To develop specifications for materials of construction, appropriate for specific conditions such as seawater temperature and salinity or seasonal humidity conditions, at given sites on the Western and Eastern coasts.
- 0 To estimate future needs for potable water and electric power for all communities and industrial purposes throughout the Kingdom.
- 0 To make scientific surveys of the requirements for delivery of potable water from the plants to the users, or between plants, by pipeline.
- 0 To maintain constant awareness of the state of the art in development of alternative energy sources such as nuclear, solar or wind energy.
- 0 To maintain surveillance of the technical and economic aspects of processes for the recovery of useful minerals from concentrated desalination plant effluents.

The research centers at Jubail and Yanbu are intended to carry out these programs as well as to provide for the training of Saudi personnel for all positions in the Research Department itself.

To supplement its own research activities, SWCC maintains contact with various scientific institutes, universities, suppliers and other commercial firms both within and outside of the Kingdom, and arranges for symposia, lectures and field visits for the purpose of exchanging views and achieving cooperation in the field of desalination.

Thus the Corporation now cooperates with the Bureau of Reclamation (BuRec) of the U.S. Department of Interior in U.S. and the Japanese International Cooperation Agency (JICA) in the fields of desalination power generation and training.

SWCC is also establishing a data center at its Riyadh headquarters. This center will contain comprehensive information on technical, administrative and financial matters and data on individual plants and projects as well as operations and maintenance. This information will be computerized, using sophisticated hardware and software, and will be available through remote terminals to the plants and research centers. Extensive library facilities will also be provided.



Training Workshop

The use of Computers by SWCC

Recognizing the importance of computers in this modern age, SWCC was among the first Saudi Government organizations to begin using them. An early use was in establishing and updating estimates of water needs in the Kingdom for the next twenty years.

The Corporation now operates many computers for two general categories of use, namely in operations process control and in general data processing for all Departments, thus increasing efficiency and decreasing manpower needs and costs.

Uses of the computers to date have included the following:

- 0 In 1397 (1977) a computer program was developed for estimating the costs of construction for single and dual-purpose desalination plants, taking into consideration such factors as inflation rates and site-specific data. This program was expanded in the following year to include estimation of operating costs, based on such factors as labor costs (for example, with varying percentages of Saudi manpower) and the costs of fuel and chemicals.
- 0 In 1399 (1979) an initial program in Arabic was developed for salary administration. In the following years this program has been expanded to cover other financial and administrative aspects of employee remuneration such as overtime and travel expenses, and extended to include the Operations and Maintenance Department.
- 0 In 1402H (1982) a program for general book-keeping was established for the Financial Department.
- 0 In 1403H (1983) a program based on the coding of spare parts according to the SHELL/MESC system, was introduced to handle all aspects of centralized spare parts inventory control.
- 0 Also, in 1403H, programs for reconciliation of SWCC books with bank statements and for determining depreciation rates and adjusting the value of the fixed assets of the Corporation were introduced. In addition, other aspects of employee record keeping were implemented, such as a program for keeping records on phonechanges at the Al-Jubail housing compound.

- 0 Other systems, for following the status of purchase orders and record keeping on automobiles at the various plants (number, insurance status, where located, etc.) have been instituted.

Future uses for computers are envisaged, including:

- 0 More comprehensive data on plant operations process efficiency in all plants, based on daily production data.
- 0 Storage and retrieval of additional information on personnel.
- 0 Inclusion of other plant equipment in the data bank on performance and efficiency information.
- 0 Information on SWCC's technical library
- 0 Additional financial data



- 0 Relevant data on SWCC's suppliers (contractors, subcontractors, consultants and the like) on previous projects, and those under consideration for future projects.

In view of the scope of SWCC's operations and responsibilities, the use of computers is now considered indispensable both for daily operational needs at any plant and for communication between plants.

The use of computers is expected to increase steadily based on their effectiveness in process control and as tools for general management of the Corporation.



Desalination Projects

SWCC desalination and power plants may be divided into those already in operation, under construction, or in planning, as follows:

Plants in Operation:

These consist of 21 plants, 15 located at a sites along the Red Sea and 6 at 3 sites on the Arabian Gulf: They range in capacity from 60,000 to 253.5 million U.S. gallons per day (GPD). Their total design capacity is 481 million GPD, which could be increased to 550 million by increasing the operating temperatures. In addition, these SWCC plants produce 3481 megawatts (MW) of electric power.

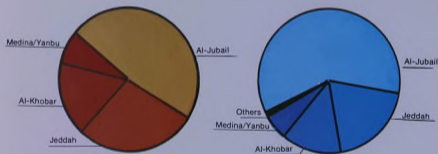


AL-KHOBAR Plant-Second Phase

Plants in Operation

Western Region:

Name (Location)		Start Up date	Installed Capacity	
			Water Million U.S.G.	Power M.W.
Al-Wajh	Phase 1	1389	0.060	—
	Phase 1	1389	0.060	—
Duba	Phase 1	1390	5.000	50.00
Jeddah	Phase 1	1395	0.150	—
Jeddah	"Rush"	1398	3.200	—
Jeddah	Phase 2	1398	11.400	84.00
Jeddah	Phase 3	1399	23.200	240.00
Duba	Phase 2	1399	0.150	—
Al-Wajh	Phase 2	1399	0.150	—
Farasan Island	Phase 1	1399	0.132	2.30
Haql	Phase 1	1400	0.233	—
Medina/Yanbu	Phase 1	1401	28.500	250.00
Jeddah	Phase 4	1401	58.100	600.00
Rabigh	Phase 1	1401	0.340	—
Al-Birk	Phase 1	1403	0.600	—

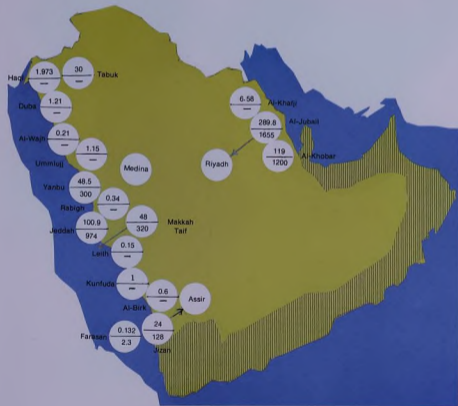


Eastern Region:

Al-Khafji	Phase 1	1393	0.145	—
Al-Khobar	Phase 1	1394	7.500	—
Al-Khafji	"Rush"	1399	0.330	—
Al-Jubail	Phase 1	1401	36.300	360.00
Al-Jubail	Phase 2	1403	253.500	1295.00
Al-Khobar	Phase 2	1403	51.500	600.00

Daily Production

Projects	Water Million U.S.G.	Power M.W.
In Operation	480.555	3481.3
Under Construction	81.840	448.0
In Planning	121.150	650.0





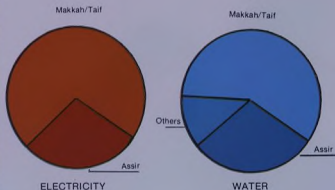
Plants under Construction:

These are six plants construction. Five of these are in the Western Region:

The Assir and Makkah-Taif plant are dual purpose MSF plants, while the rest are small, single purpose reverse osmosis plants.

The Al-Khafji project, in the Eastern Region, will be a single purpose plant with rated capacity of 6.1 million GPD.

The total productivity of these plants will be 81.4 million GPD and 448 MW.



Name (Location)	Installed Capacity	
	Water M.G.D. U.S.	Power M.W.
Makkah-Taif	48	320
Assir	24	128
Ummlujj II	1	—
Duba III	1	—
Haql II	1.74	—
Al-Khafji II	6.10	—

Projects in Planning:

- 0 Leith. Tentatively rated at 150,000 GPD



- 0 SWCC project in Bahrain, a reverse osmosis plant rated at 10 million GPD. SWCC has designed and awarded a construction contract for this plant as a gift to its neighboring Gulf State, Bahrain.

- 0 Medina-Yanbu, phase 2. Tentatively rated at 20 million GPD and 50 MW.
- 0 Tabuk. Estimated capacity 30 million GPD. Electrical generation capacity to be determined.
- 0 Kurfuda. Estimated capacity 1 million GPD, single purpose.
- 0 Al-Khobar phase 3. Estimated capacity 60 million GPD and 600 MW.



Projects under study:

- 0 Jeddah Phase 5. Tentative capacity 50 million GPD, electric power to be determined.
- 0 Al-Wajh Phase 3. Tentatively 1 million GPD, single purpose.
- 0 Thul, Al-Kadima, Mastura and Farasan Island Phase 2: Tentatively 500,000 GPD single purpose plants.



It is estimated that by the end of the third five-year plan (1401 to 1405H, 1981-1985) the systems for delivery of desalinated water in the Kingdom will have reached most of the major cities, wheter located on the coasts or in the interior, including the following cities:

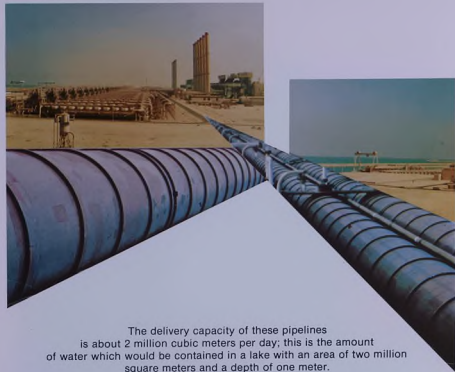
Makkah, Al-Medina, Riyadh, Jeddah, Taif, Al-Khobar, Al-Jubail, Dhahran, Dammam, Sedeer, Al-Washem, Al-Mahmal, Al-Qasim, Abha, Khamis Mushayt, Ahad Rofaida, Yanbu, Duba, Al-Khafji, Umm-Lujj, Al-Birk, Haql, Al-Wajh and others.



Desalination Plant

SWCC Pipelines 3 million meters of pipelines

The total legh of SWCC's water pipelines for supplying potable water to cities and villages spread out along the Red Sea and Arabian Gulf Coasts, as well as in the interior of the Kingdom, is about 3 million meters.



The delivery capacity of these pipelines is about 2 million cubic meters per day; this is the amount of water which would be contained in a lake with an area of two million square meters and a depth of one meter.

Pipelines

Water pipelines extend along both coasts and to many inland cities of the Kingdom. Their total length is about 3 million meters, as follows:

- 0 Two pipelines from Yanbu
 - 0 a 175 km line which feeds Medina
 - 0 a 50 km line which feeds the city of Yanbu.
- 0 Delivery of water through these two lines started in 1401H (toward the end of 1980).
- 0 Twin 60" diameter 465 km pipelines, (930 km total) capable of delivering approximately 830,000 cubic meters (m³) of water per day from Al-Jubail to Riyadh.
- 0 The lines which feed the Eastern Region cities of Al-Khobar, Dammam, Dhahran airport, Katif, Sihat, Safwat and Rahima. The total length of these lines is 240 km, and their diameter ranges from 42 to 16 inches.
- 0 Pipelines varying from 60" down to 6" diameter, total length approx. 46 km, feeding the city of Jeddah from the Jeddah plant.
- 0 Lines feeding the cities of Makkah and Taif. These lines vary in diameter between 56 and 42 inches. Total length is about 246 km.
- 0 Pipelines feeding Abha, Khamis Mushayt and neighboring villages, diameter varying from 42" to 20", total length 215 km.
- 0 Pipelines from Al-Jubail to Seder Al-Washim and Qasim. The line from Jubail toward Riyadh is 385 km long. The line from outside Riyadh to Qasim is 390 km long. There are also 138 km of lateral lines to smaller local communities.



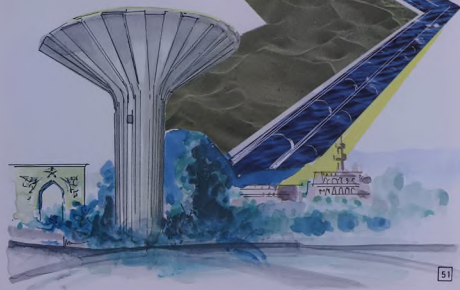
Pipeline

from
Al-Jubail



Length of lines (meters) 930,000
(Double lines)
Pipe diameter (inches) 60
Capacity (m³/day) 830,000

to
Riyadh



Distribution of Water from Al-Jubail Phase I

	To the Royal Commission (Industrial City)	To King Abdul Aziz Naval Base	To the City of Jubail
Length of pipes (meters)	63,877	5007	12,300
Pipe diameter (inches)	66	14	18
Capacity of line (m ³ /day)	528,000	11,424	25,944

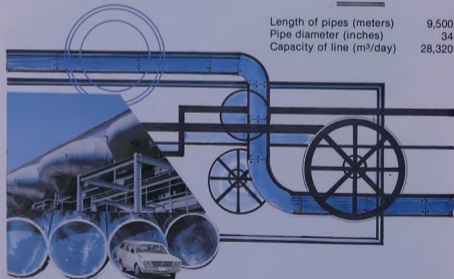
AL-KHOBAR Phase II

Pipelines extend 84 km from Al-Aziziyah to Rahima. Concrete pipes, diameter 44 to 20 inches, supplying the following cities:

0 Qatif	0 Al-Khobar
0 Safwa	0 Dhahran Airport
0 Sihat	0 Dammam
0 Rahima	

Al-Khafji

Length of pipes (meters)	9,500
Pipe diameter (inches)	34
Capacity of line (m ³ /day)	28,320



Water Pipes from Jeddah Desalination Plant

	Jeddah Line No. 1	Jeddah Line No. 2	Jeddah Line No. 3
Length of pipes (meters)	8,961	9,508	9,349
Diameter of pipe (inches)	32	40	32
Capacity (m ³ /day)	60,595	84,500	90,250

Jeddah: Line No. 4A

Line No. 4B

Length of pipes (meters)	9,081	9,081
Diameter of Pipe (inches)	40	40
Capacity (m ³ /day)	121,000	121,000



Water Transfer to Medina and Yanbu

- Pipelines extend from the Yanbu plant to Yanbu City (about 50 km) and to Medina (about 175 km).
- Cities supplied by water are:
 - Medina
 - Yanbu
 - Messayjid



Water Pipelines from Desalination Plants on the Red Sea Coast

	<u>Haql</u>	<u>Al-Wajh</u>
Length of lines (meters)	3,300	900
Diameter of pipe (inches)	12	6
Capacity (m ³ /day)	2,880	1,800
	<u>Duba</u>	<u>Rabigh</u>
Length of lines (meters)	850	4,100
Diameter of pipe (inches)	6	8
Capacity (m ³ /day)	1,680	3,024
	<u>Al-Birk</u>	
Length of lines (meters)	888	
Diameter of pipe (inches)	8	
Capacity (m ³ /day)	2,544	



Delivery of Water to Asir

- 0 Water pipelines extend 102 km from Al-Shuqaiq on the Red Sea to Abha. They are steel pipelines, of diameter varying from 42 to 36 inches. There is a double concrete pipeline that extends for 78 km from Abha to Ahad Rafida, with diameter from 42" to 20". Cities supplied therefrom by water are Abha, Khamis Mushayt, and Ahad Rafida.

0 Delivery of water to Makkah and Taif:

Pipelines extend from Shuaiba on the Red Sea to Taif, total length is about 137 km. The lines to Makkah (96 km) are dual 56" diameter steel pipes.

- 0 From Makkah, there is a single 42" diameter, 41 km pipeline to Taif.
- 0 As part of the Makkah-Taif pipeline, a 13 km, 5 meter diameter tunnel was cut in the Akra mountains in the Al-Huda Region.
- 0 There are four pumping stations on the Shuaiba- Makkah- Taif pipelines.
- 0 These pipes are coated on the inside with cement, on the outside with polyethylene.
- 0 There are four water storage tanks in Makkah, each of 50,000 m³ capacity.
- 0 There are four water storage tanks in Taif, each of 25,000 m³ capacity.
- 0 There are small housing compounds at each pumping station and at the Taif water tank area.

Delivery of water to Seder Al-Washim and Qasim Region.

This pipeline system, previously mentioned, feeds more than 150 cities and villages in this region.

Incentives and Services Provided by the Corporation to Personnel in Operations and Maintenance at the Plants.

SWCC furnishes various incentives and material advantages to attract Saudi manpower and to encourage them to excel in their work, especially in consideration of the remote location of some of the plants.

Incentives:

- 0 Salary levels established in accordance with employee qualifications, experience and performance.
- 0 Bonuses for outstanding job performance.
- 0 Bonuses for extra effort.
- 0 Annual bonuses.
- 0 Additional salary increments for outstanding performance.

Material Advantages:

- 0 Furnished apartments, fully equipped with all utilities and services, for employees and their families.
- 0 Medical care for the employee and his family.
- 0 Support services.



Housing Compounds:

Housing compounds, complete with all utilities and services and sized in accordance with the number of personnel at the site, are built at each SWCC location. The following are the utilities generally provided:

- 0 A small hospital with capability in the most important medical specialties.
- 0 Schools for boys and girls.
- 0 Sports club
- 0 Shopping center
- 0 Post Office
- 0 Police Station
- 0 Fire Station
- 0 Parks



More than 5000 housing units for SWCC employees have been built at various locations, as follows:

Al-Jubail	2463 units	Assir	540 units
Al-Khobar	463 units	Makkah/Taif	497 units
Al-Khafji	38 units	Medina/Yanbu	282 units
Riyadh	111 units	Jeddah	636 units
Haql 3	40 units	Duba	40 units
Ummlujj	33 units		



Areas of Cooperation and Coordination between SWCC and other Saudi Government Ministries and Agencies.

SWCC coordinates with several other Saudi Government bodies in implementing its projects, and providing associated facilities and services. It ensures that any work carried out by SWCC on any of its projects does not conflict with any projects of the other organizations, and that SWCC provides water and electricity to them in the best fashion according to their needs.

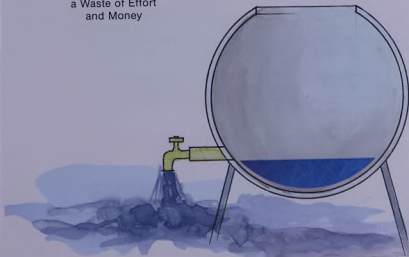
The principal governmental agencies with which SWCC cooperates are:

- 0 The Ministry of Agriculture and Water, regarding the blending of SWCC's desalinated water with naturally occurring water to produce potable water which meets International Health Standards.
- 0 The Ministry of Municipalities and Villages, through the Water and Sewage Departments of specific communities, regarding the supply of potable water by pipeline to these communities and connection of delivery lines with community distribution systems.
- 0 The Ministry of Industry and Electricity, through its agency the General Electricity Corporation, and various Electricity Companies, regarding connections from SWCC electrical generating plants to national electrical grids which in turn supply individual communities, as well as the supply of electricity from the grids to SWCC facilities such as pumping stations.



Economy in Using Water is a Patriotic and Humane Act.

Wasting Water is a Waste of Effort and Money



Conclusion

With unfailing support and direction from H.M. King Fahd bin Abdul Aziz, and his R.H. the Crown Prince, who have stressed the importance of providing for the basic and vital needs of the citizens;

With the wise guidance of H.E the Minister of Agriculture and Water in implementing His Majesty's directions, and in setting up practical programs for desalination;

With the force of the national will and the strength of Saudi youth; the Saline Water Conversion Corporation has made great progress and is continuing in its great overall purpose of providing desalinated water meeting International quality specifications, and in sufficient quantities to every person in every place in the Kingdom.

From its beginning, the Saline Water Conversion Corporation has conducted the necessary studies for the establishment of desalination plants, has supervised their construction, furnished them with the latest machinery and equipment, operated and maintained them, and made all efforts to qualify Saudi personnel to enable them to operate and administer them.

The Saline Water Conversion Corporation has employed scientific methods in its technical research, initiated the use of computers for various Corporation purposes and provided pure water to various Saudi communities whether on the coasts or in the heart of the Kingdom.

We hope that every citizen will be aware of these great efforts and major projects. We also hope that every citizen will economize in the use of water, thereby following the words of the Prophet, God's peace and blessings be upon him.

"Do not waste water even if you are standing by a river"

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