Desalination In Saudi Arabia An Overview

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General Manager Desalination Nomac

Historical Background

➔ In 1928 King Abdul Aziz established Kendasa (Condenser) in Jeddah (MED).

➔ 1965 Ministry of Agriculture established desalination department.

➔ 1969 Duba and Alwajh desalination MSF plants commissioned 198 m3/d (52000 gpd) each.

➔ 1974 Saline water Conversion Corporation (SWCC) established.

Jeddah Phase 1

SWCC Plants


Haqil
Duba
Alwajih
Omluj
Yanbu
Rabigh
Almadina
Azizia
Jeddah
Shu-Aiba
Taif
Makkah
Allaith
Qunfutha
Albirk
Shuqaiq
Farasan
Abha
K. Moshait
Buraidah
Riyadh
Kafji
Jobail
Khobar
Hafoof

Daily Production In KSA

East Coast	3.722 M m^3/d
West Coast	3.892 M m^3/d
Total	7.614 M m^3/d
	2.0 BGD

Desalinated Water Distribution According to Process

RO	14%
Thermal	86%
MSF	75%
MED	11%

Basic Principal for Sea Water Intake

East Coast **Shallow water -5m depth**

West Coast **deep Water -17 m depth**

Sea Water Pretreatment

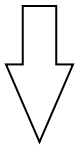
RO

MSF

MED

BASIC DESALINATION ECONOMY

Coupling Desal Plants (Thermal or Membrane) with Power Plant reduces energy requirement for desalination by half.



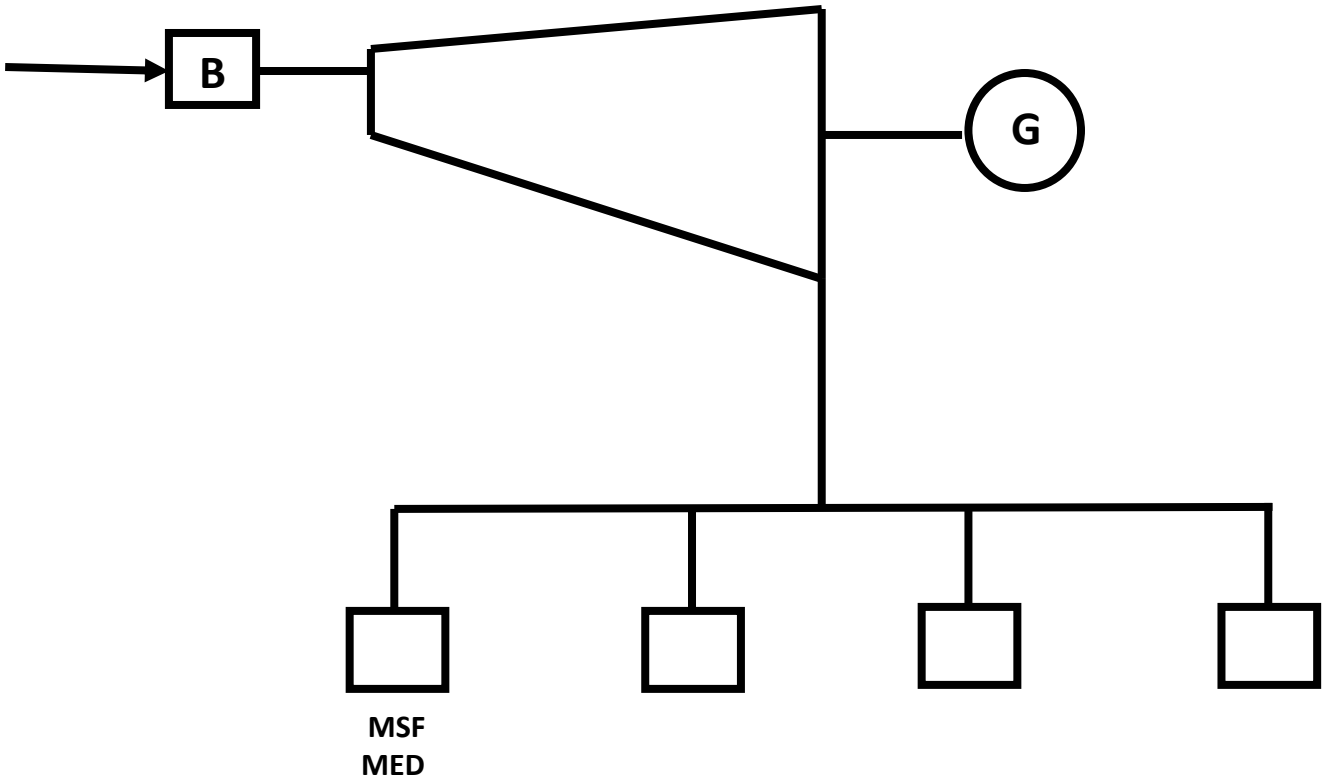
Dual purpose plant or hybrid

Power + Thermal

Power + RO

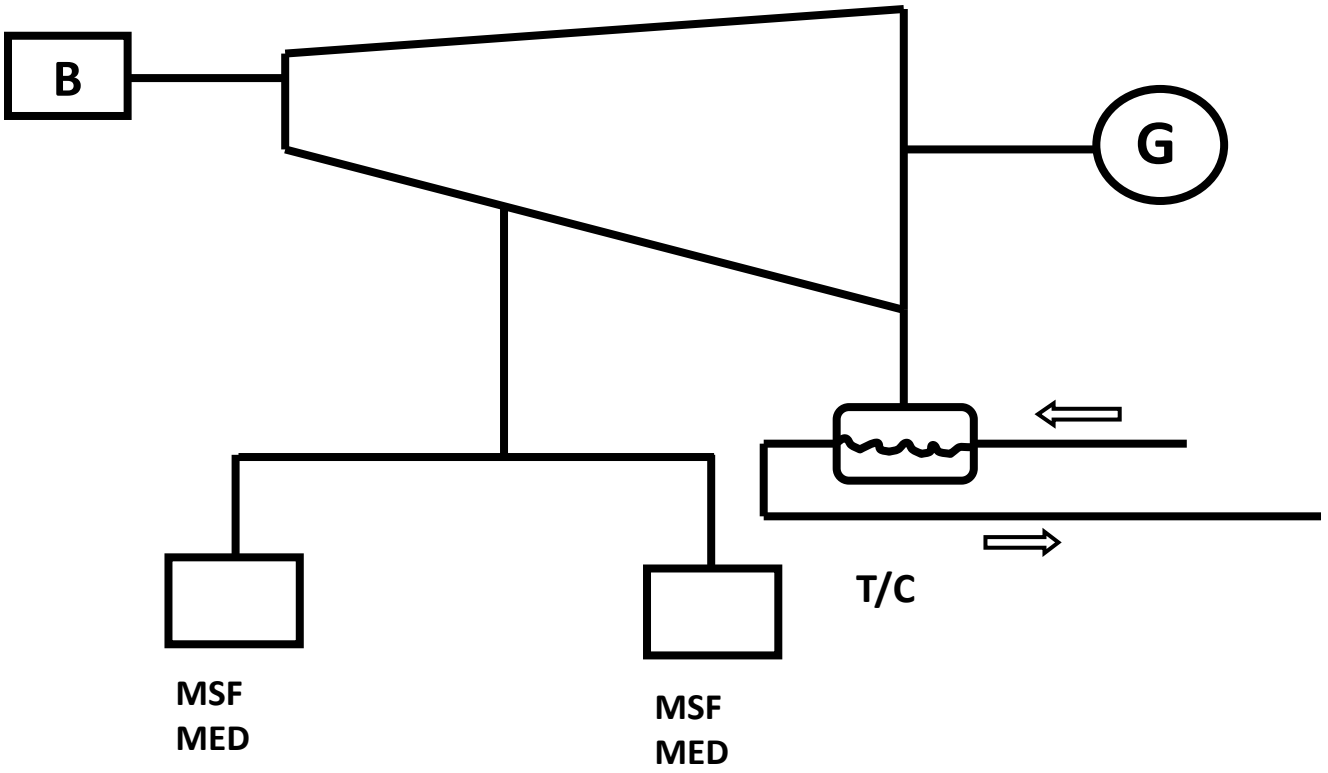
Power + (Thermal + RO)

Dual Purpose Plant Configuration



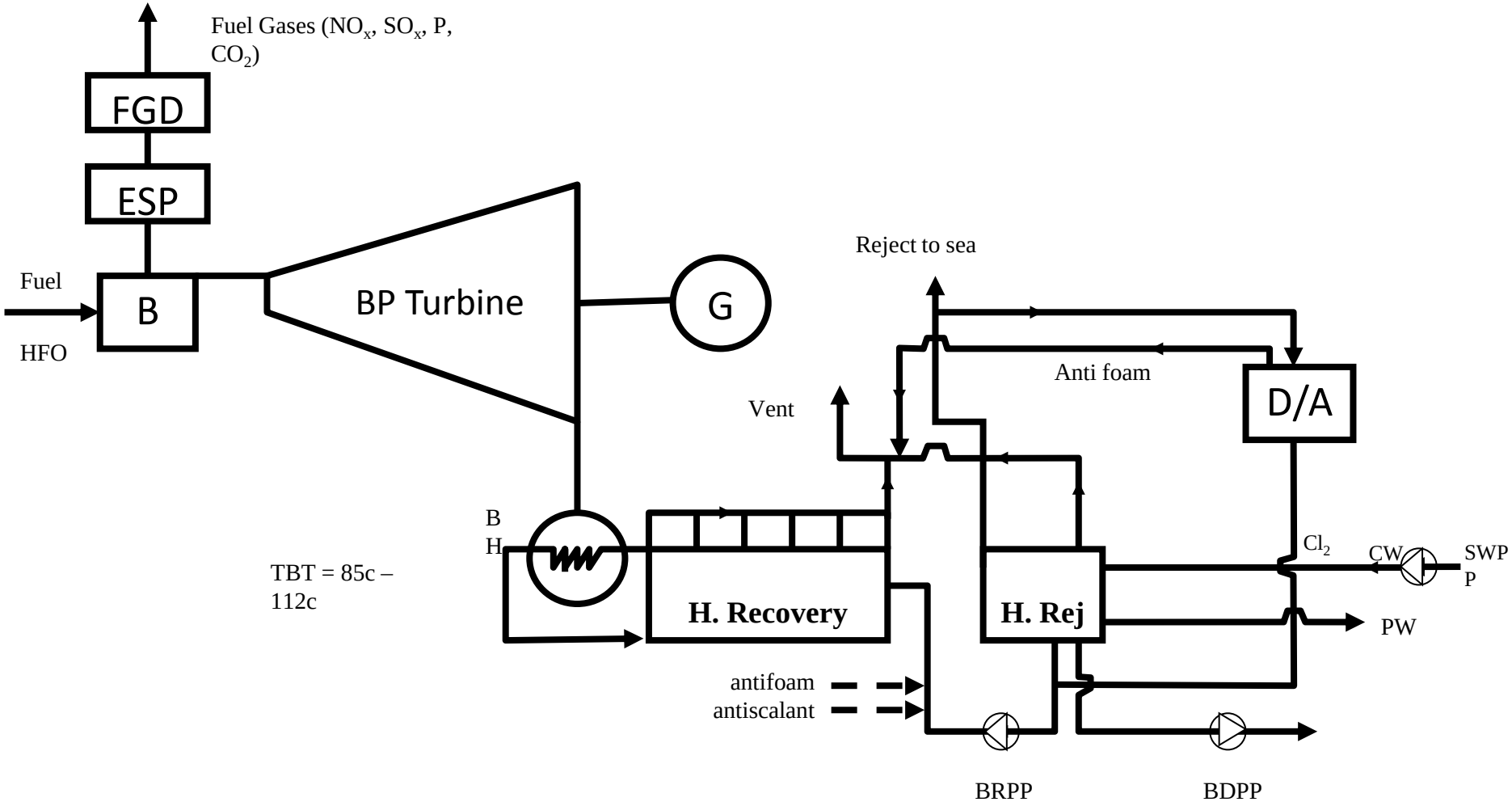
(1) Back Pressure Turbine

Dual Purpose Plant Configuration

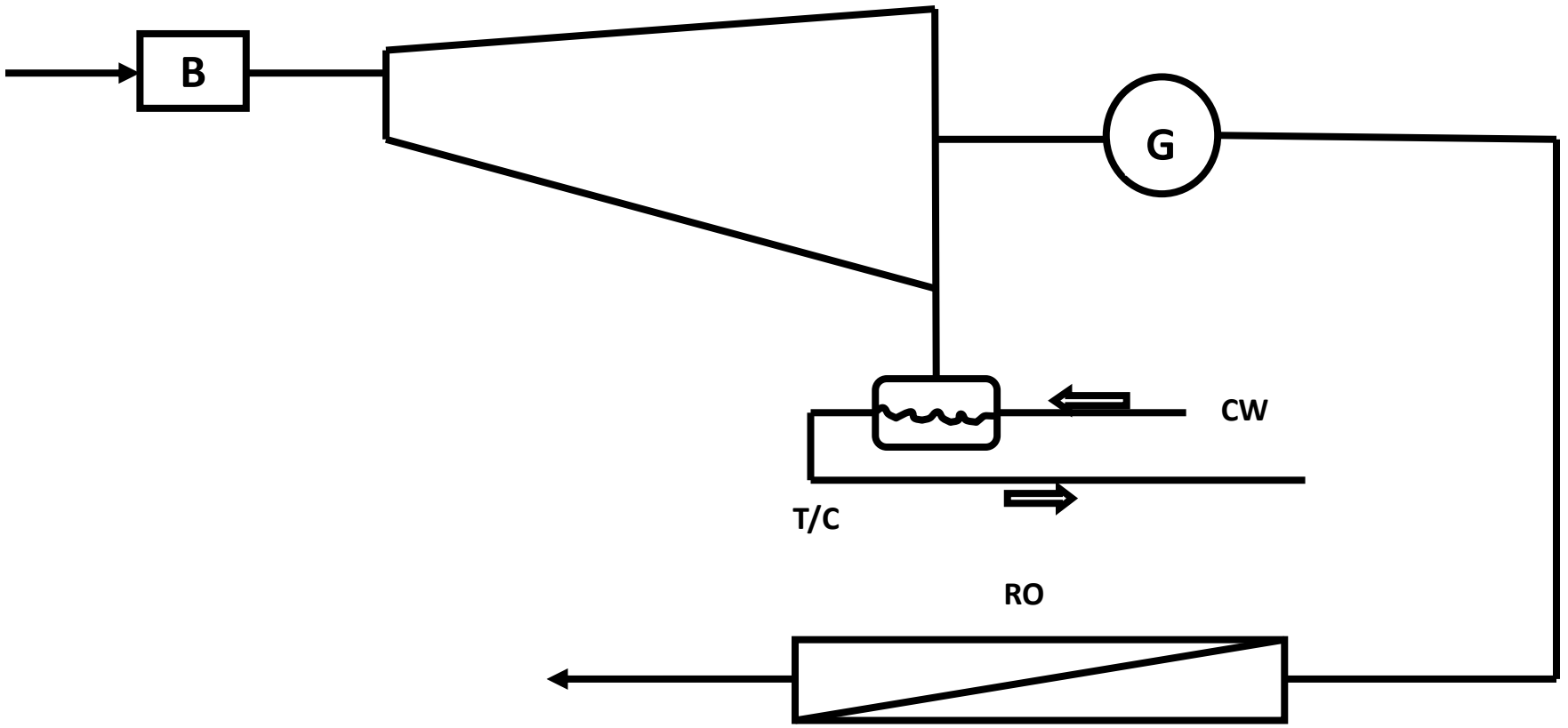


(2) Extraction Condensing Turbine

FLOW DIAGRAM FOR DUAL PURPOSE PLANT WITH THERMAL DESALINATION PLANT

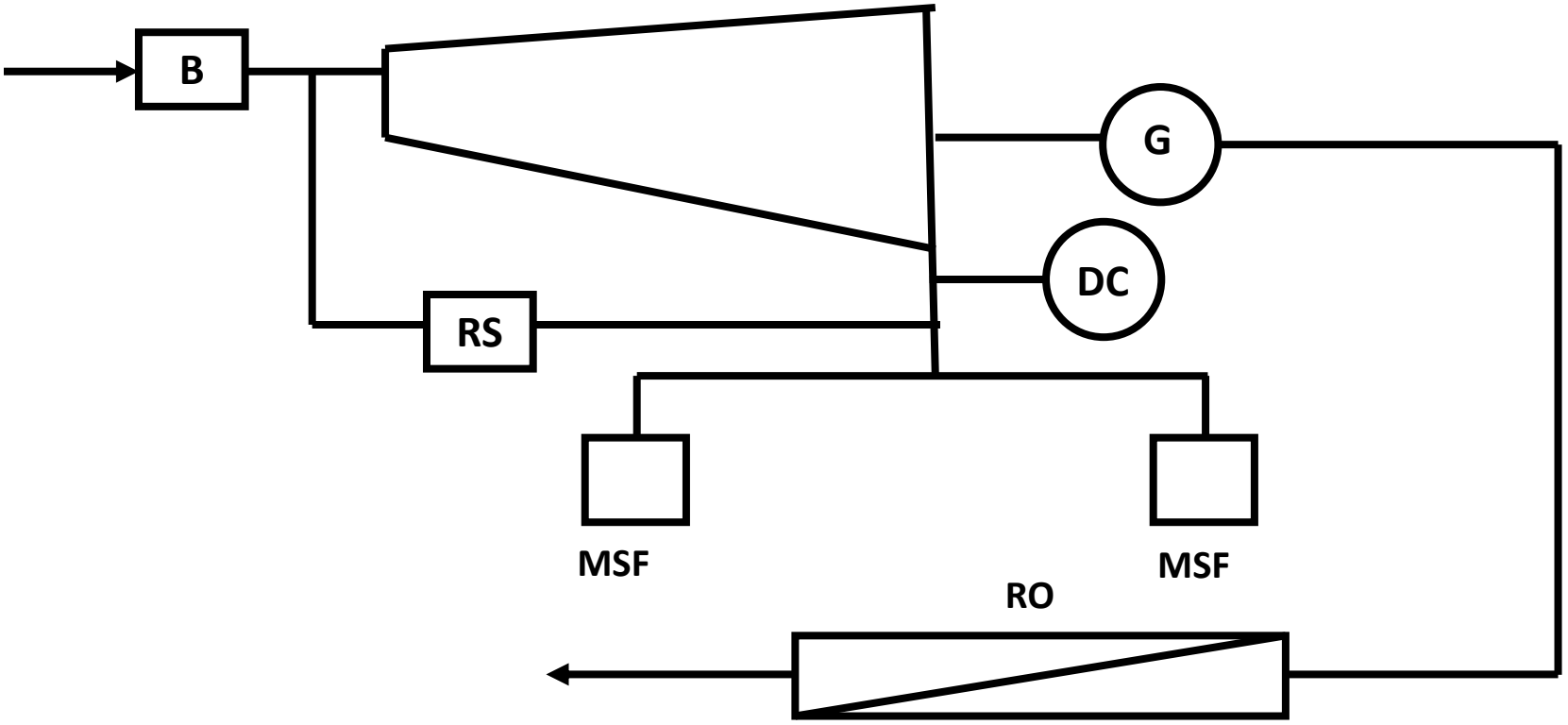


Dual Purpose Plant Configuration



(3) Condensing Turbine

Dual Purpose Plant Configuration



(4) Back Pressure Turbine + Hybridization (Thermal + RO)

Shuaibah Expansion IWPP

Shuaibah IWPP

Project cost
SR 9,188 million ~ $ 2,450 million

Power capacity
900MW (ACWA Net 270 MW)

Water capacity
880,000 M^3/day
(ACWA Net 264,000 M^3/d)

Contract type
20 year PWPA based on BOO

PCOD
14 January 2010

ACWA Ownership
30%

Shuaibah Expansion IWPP

Project cost
SAR 875 million ~ $ 233 million

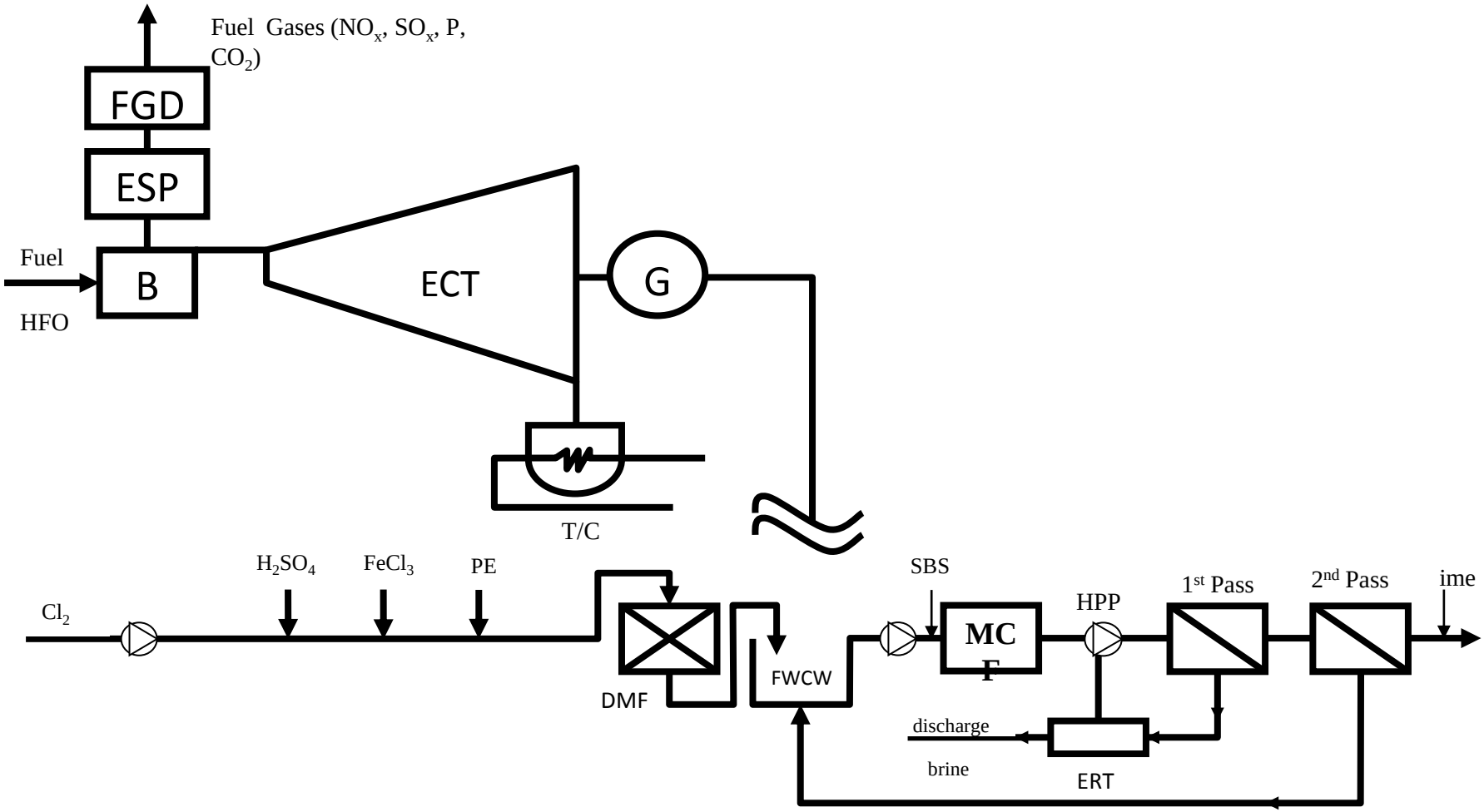
Water capacity
150,000 M^3/day
ACWA Net 45,000 M^3/day

Contract type
20 year WPA based on BOO

PCOD
November 2009

ACWA Ownership
30%

FLOW DIAGRAM FOR DUAL PURPOSE PLANT WITH SWRO



Shuqaiq IWPP

Project cost
SR 6,866 million ~ $ 1,831 million

Power capacity
850 MW
ACWA Net 289MW

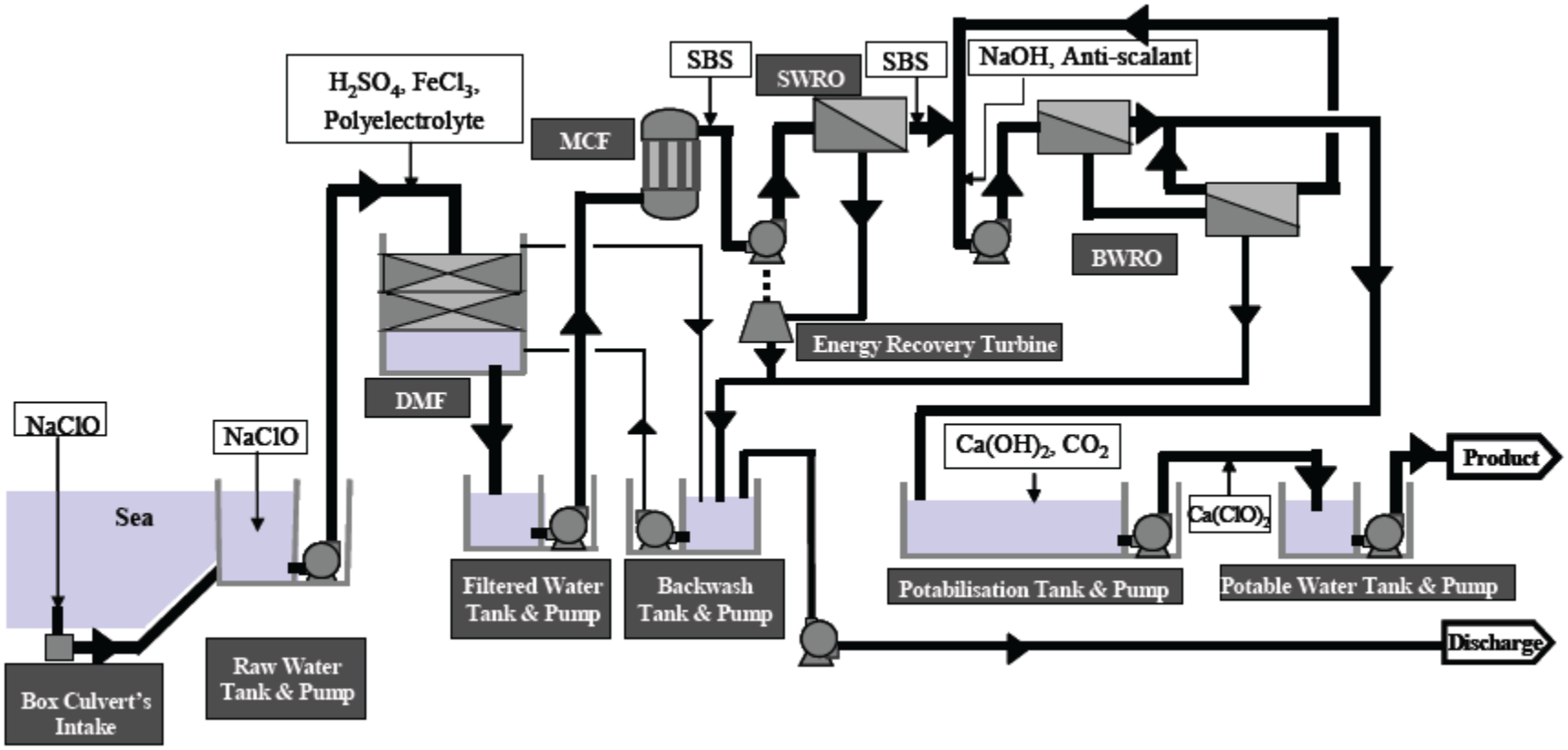
Water capacity
212,000 M^3/day
ACWA Net 72,080 M^3/d

Contract type
20 year PWPA based on BOO

Scheduled PCOD
December 2010

ACWA Ownership
34%

flow diagram for SWRO



Ist Generation

Plant	Conf.	Power (MW)		Water (MGD)	P/W	Chem. Treat	TBT	Comm.		PR
J 1	LT	50	ECT	5	10:1	Acid	120	1970	1980	10
Ak 1	LT	GT		5		Acid	120	1974	1982	10
J 2	LT	25	ECT	5	5:1	Acid	120	1978	2007	10
J 3	CT	62	ECT	5.8	10:1	Ad	107	1979		7
J 4	LT	120	ECT	11.6	10.3:1	Ac/Ad	110	1982	2005	7
M&Y1	LT	75	ECT	6	12.5:1	Ac/Ad	120	1982		10
Job 1	CT	60	ECT	6	10:1	Ad	90	1982		8.5
Job 2	CT	130	BPT	27.6	4.7 :1	Ad	112	1983		8.5

2nd Generation

Plant	Conf.	Power (MW)		Water (MGD)	P/W	Chem.	TBT	Comm	PR
Sho 1	CT	60	BPT	12	5:1	Ad	102	1988	8.5
Shuq 1	CT	80	BPT	15.2	5.3:1	Ad	102	1988	8.5
Sho 2	CT	100	BPT	24	4.2:1	Ad	110	1999	9.0
M&Y2	CT	80	BPT	18	4.4:1	Ad	110	2000	9.0

3rd Generation

Plant	Conf.	Power (MW)	Water (MGD)	P/W	Chem.	TBT	Comm.	PR
Shoaiba 3	CT + RO	1200	232.5	5.2:1	Add.	110	2009	9.5
Shuqaiq 2	RO	1020	57	17.9:1	Acid	-	2010	-
Marafiq	CC+CT MED	2743	211	13:1	Add.	63	2010	9.5
Ras Al-Khair	CC + CT + RO	2500	264	9.5:1	Add.	112	2013	9.5

Rabigh IWSPP

Project cost
SR 4,279 million ~ $ 1,141 million

Power capacity
360 MW
ACWA Net 86MW

Water capacity
134,000 M^3/day
ACWA Net 32,026 M^3/day

Steam capacity
1,230 t/hr
ACWA Net 294 tons/hr

Contract type
25 year WECA based on BOOT

PCOD
June 2008

ACWA Ownership
23.9%

International Barges Company for Water Desalination Ltd. BOWAREGE

Project cost
SR 370 million ~ USD 100 million

Water capacity
52,000 M^3/day
ACWA Net 33,720 M^3/d)

PCOD
First quarter 2008

ACWA Ownership
64.85%

Marafiq / Jubail IWPP

Project cost
SR 12,588 million ~ $ 3,360 mil

Power capacity
2,743 MW
ACWA Net 549 MW

Water capacity
800,000 M^3/day
ACWA Net 160,000 M^3/d

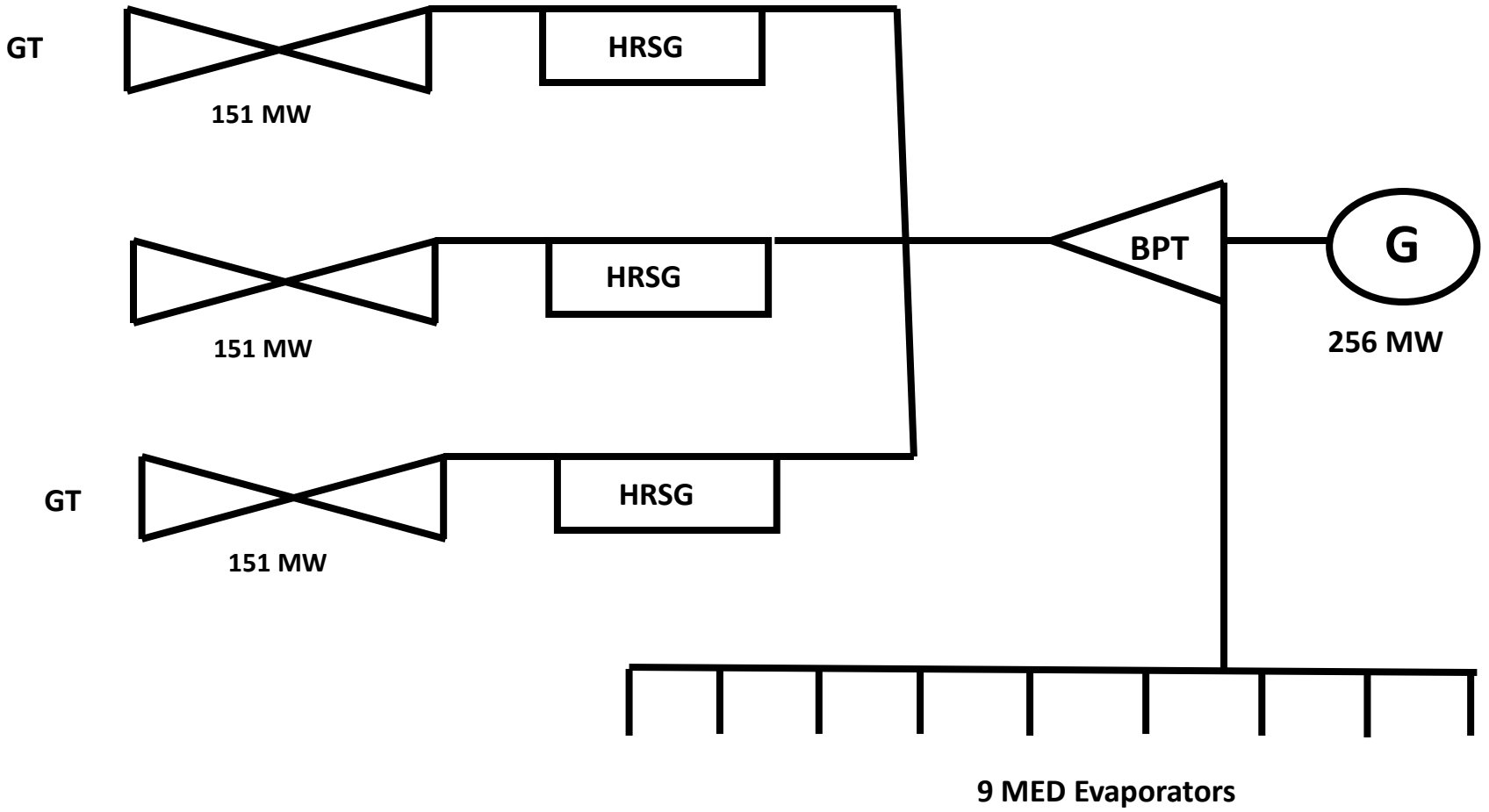
Contract type
20 year PWPA based on BOOT

Scheduled PCOD
March 2010

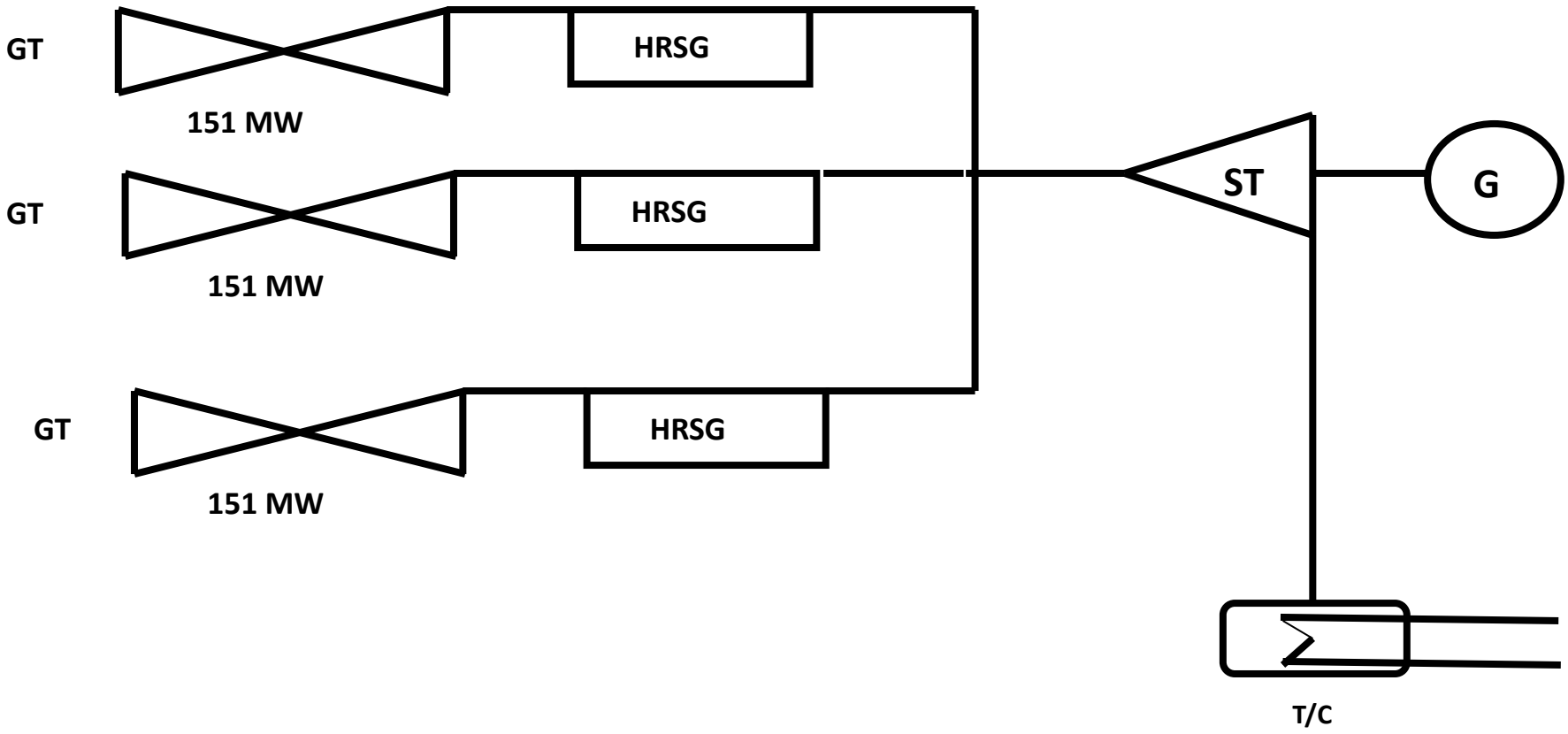
ACWA Ownership
20%

Marafiq / Jubail IWPP

Cogeneration Power & Water Block



Cogeneration Power Block



Rabigh IPP

Project cost
SR 9,397 million ~ $ 2,506 million

Power capacity
1,204 MW
ACWA Net 482MW

Contract type
20 year PPA based on BOO

Scheduled PCOD
April 2013

ACWA Ownership
40.0%

Present Desalination Practice in KSA

1. High Power Demand
2. High Water Demand
3. No Preferable Desalination Process

MSF, MED, RO

24MGD, 7.5MGD, Unlimited

	MSF	MED	RO
PR	9.5	9.5	4.6 KWhr/m^3
TBT	112	63	
Conf.	CT	TVC	Single & Double Pass
Size	24MGD	7.5 MGD	Unlimited

What is next?

Thermal Desalination Process

1- Implementation of solar energy.

2- Improve the performance ratio PR.

3- Develop high temperature antiscalant.

4- Reduce design fouling factor.

5- Improve the heat transfer coefficient.

Proposed improvement for Membrane Desalination

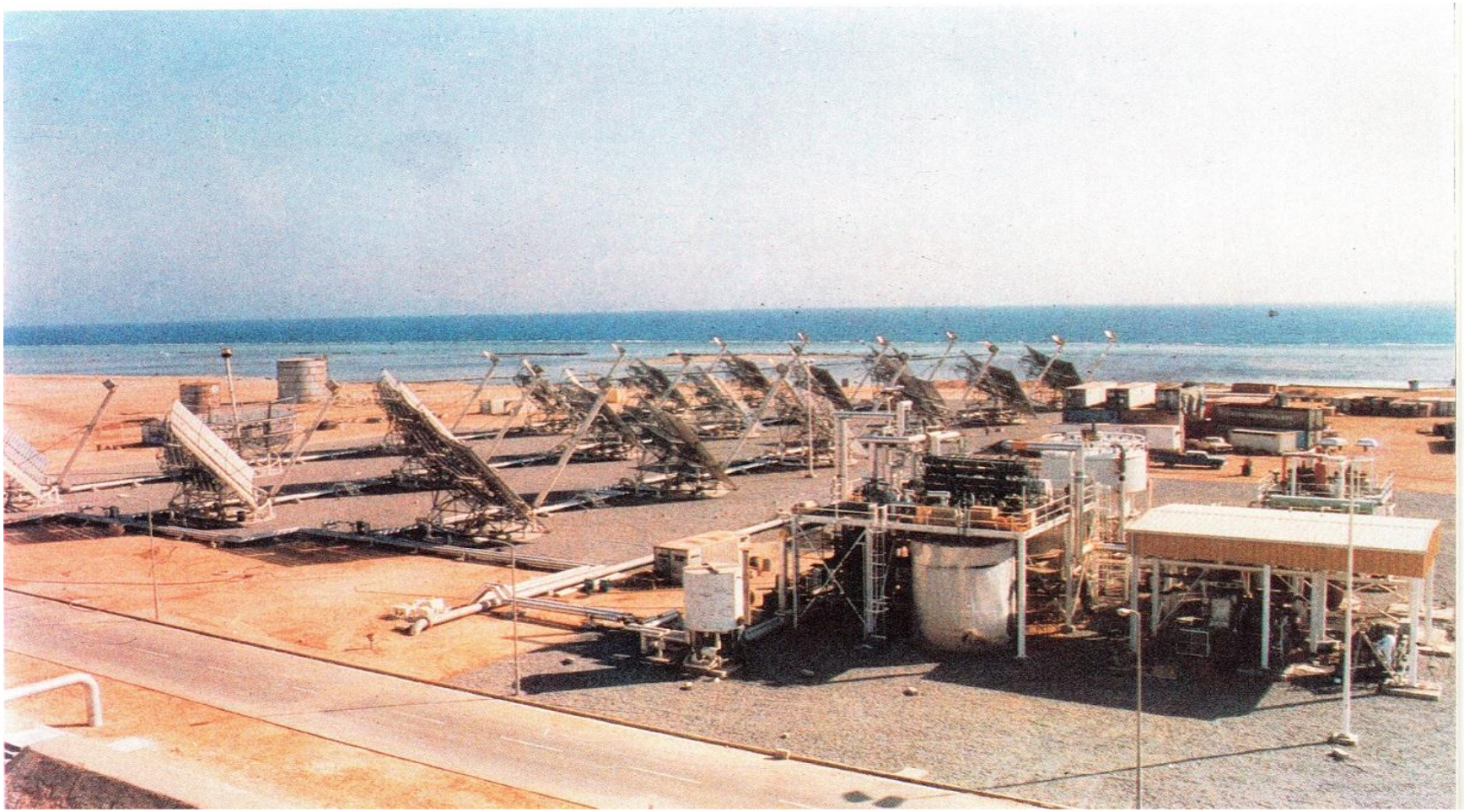
1- Improve the existing commercially viable membrane flux.

2- Improve salt rejection.

3- Resist organic fouling.

- **In 1977 an agreement between US Department of energy and KSA (KACST) was signed for the corporation in the field of solar energy to build freezing desalination plant using solar energy to produce 180 m3/d.**
- **The plant was built in 1985 and run for two years.**

Solar Energy Water Desalination Engineering Test Facility



Solar Panels

Freezing plant consist of:

1-Energy collection system, 18 solar panel with total surface area 1285 m2.The design was based on local solar radiation 8.3 kwhr/m2.

With Solar collector efficiency 65-68% steam temperature reached 389 C.

Peak solar energy during operation 5400 kwhr/day.

2- Energy storage system.

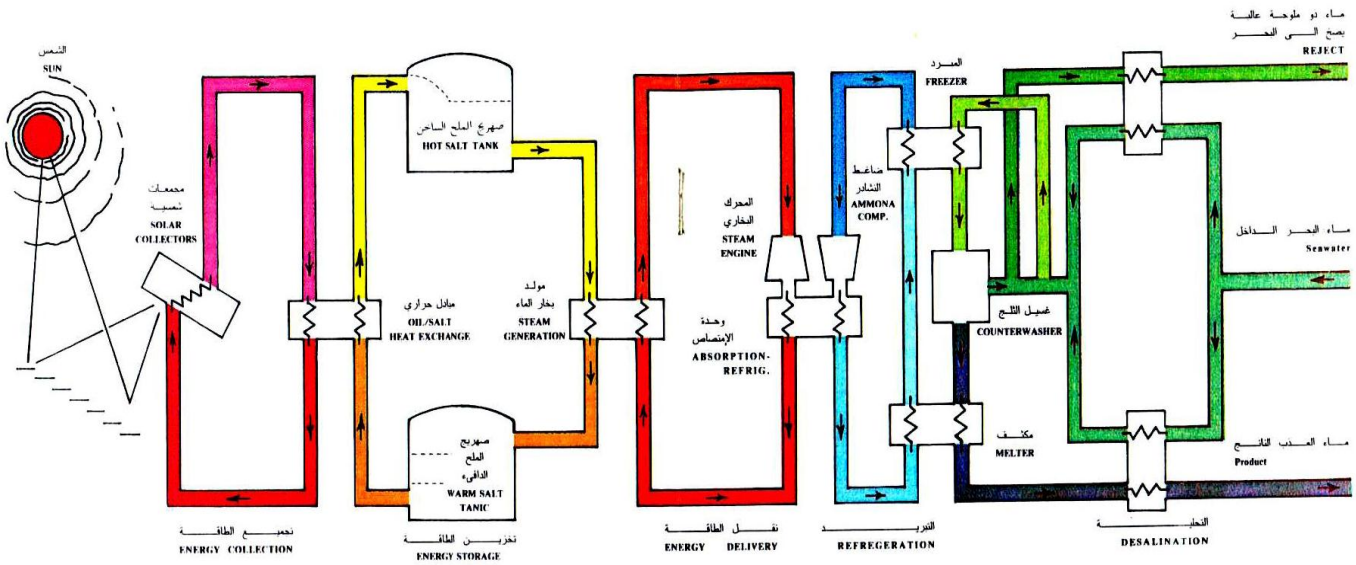
3- Energy delivery system.

4- Supplementary diesel firing system.

5- Desalination Plant design parameters:

- **Daily production 180 m3/ d.**
- **Sea water TDS 45000 ppm**
- **Sea water temperature 35 C.**
- **Product water TDS < 500 ppm.**

Freezing Plant Flow Diagram



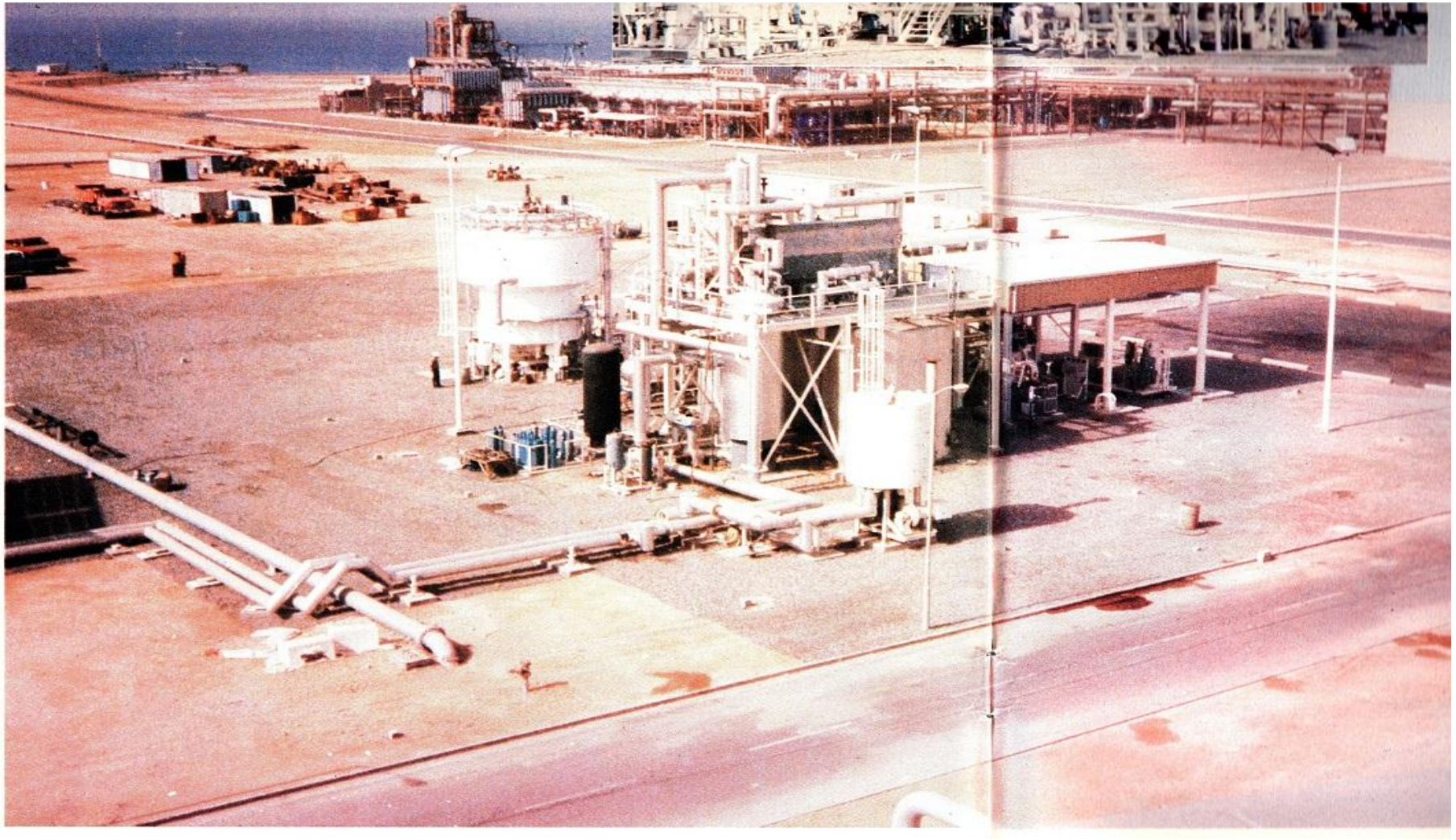
WARM "SYLTHERM" OIL
HOT "SYLTHERM" OIL
WARM "PARTHERM" SALT
HOT "PARTHERM" SALT
CONDENSATE
STEAM
FRESH WATER

AMMONIA VAPOR
TWO PHASE AMMONIA
AMMONIA LIQUID
SEAWATER
ICE BRINE SLURRY
CONCENTRATED SEAWATER, "BRINE"

بخار النشادر
سائل وبخار النشادر
سائل النشادر
ماء البحر
مستحلب ثلجين
ماء ذو ملوحه عاليه

زيت دافيء
زيت ساخن
ملح دافيء
ملح ساخن
ماء مكثف
بخار ماء
ماء عذب

Freezing Plant View



Forgotten Desalination Process

- **Freezing**
- **Advantages:**
- **1- Low latent heat, energy consumption is (1/7)of the MSF or MED.**
- **2- No corrosion.**
- **3- No antiscalant i.e. no pretreatment.**
- **4- Near atmospheric pressure.**
- **5- Direct heat transfer.**
- **6- High thermodynamic efficiency of refrigerant cycle.**
- **7- Consistent product water quality.**

Thank you