PROJECT DESCRIPTION OF

INTERNATIONAL ENERGY AGENCY (IEA)

SMALL SOLAR POWER SYSTEMS (SSPS)

CENTRAL RECEIVER SYSTEM (CRS)

BY

W. GRASSE AND M. BECKER

DFVLR, OPERATING AGENT

INTERNATIONAL WORKSHOP

ON THE DESIGN, CONSTRUCTION AND OPERATION

OF SOLAR CENTRAL RECEIVER PROJECTS

CLAREMONT, CALIFORNIA

OCTOBER 19-22, 1982.

SSPS/003/4000

IEA-SSPS
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1. INTRODUCTION

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DESIGN PHASE (STAGE 1)

- o 2×500 KW_E OF DISSIMILAR TECHNOLOGY (CRS/DCS) WHENEVER INSOLATION > 700 W/M^2 UTILIZING TO MAXIMUM EXTENT POSSIBLE OFF-THE-SHELF TECHNOLOGY

CONSTRUCTION PHASE (STAGE 2)

- o 2×500 KW_E (CRS/DCS) FOR EQUINOX NOON (920 W/M^2)
- o TEST + OPERATION FOR MINIMUM OF 2 YEARS WITH REGARD TO
  - VIABILITY OF TECHNOLOGY
  - INDIVIDUAL PLANT BEHAVIOUR
  - COMPARISON DCS/CRS (BREAK-EVEN POINT ?)
  - ECONOMICS OF OPERATIONS
  - ASSESSMENT OF FUTURE POTENTIAL
- o DISTRIBUTION OF DATA + EXPERIENCE TO ALL PARTICIPATING COUNTRIES

PARTICIPATING COUNTRY	CONTRACTING PARTY	ACTING ENTITY	FUNDING ENTITY	SHARE MIO DM	SHARE %
AUSTRIA	REPUBLIC OF AUSTRIA	AUSTRIAN SPACE & SOLAR AGENCY	FEDERAL CHANCELLERY	3.1	4
BELGIUM	GOVERNMENT OF BELGIUM	SERVICE DE LA PROGRAMMATION DE LA POLITIQUE SCIENTIFIQUE	MINISTERE DE LA POLITIQUE SCIENTIFIQUE	4.6	5.9
FEDERAL REPUBLIC OF GERMANY	GERMAN AEROSPACE RESEARCH ESTABLISHMENT (DFVLR)	IDEM	FED. MINISTRY OF RESEARCH AND TECHNOLOGY (BMFT)	32.0	40.9
GREECE	MINISTRY OF COORDINATION AND PLANNING	NATIONAL ENERGY COUNCIL	MINISTRY OF COORDINATION AND PLANNING	2.1	2.7
ITALY	CONSIGLIO NAZIONALE DELLE RICERCHE	IDEM	IDEM	1.8	2.3
SPAIN	MINISTRY OF INDUSTRY AND ENERGY	CENTRO DE ESTUDIOS DE LA ENERGIA	MINISTRY OF INDUSTRY AND ENERGY	12.8	16.3
SWEDEN	NATIONAL SWEDISH BOARD FOR ENERGY SOURCE DEVELOPMENT	IDEM	IDEM	2.6	3.3
SWITZERLAND	FEDERAL OFFICE OF ENERGY	FED. INSTITUTE FOR REACTOR RESEARCH	NATIONAL ENERGY RESEARCH FUND (NEFF)	4.1	5.2
UNITED KINGDOM *	DEPARTMENT OF ENERGY	IDEM	IDEM	0.2	0.2
USA	DEPARTMENT OF ENERGY	SANDIA NAT. LABS.	DOE	15.0	19.2
				78.3	100.0

* (PARTICIPATION ONLY IN DESIGN PHASE)

1.2 INTERNATIONAL PARTICIPATION

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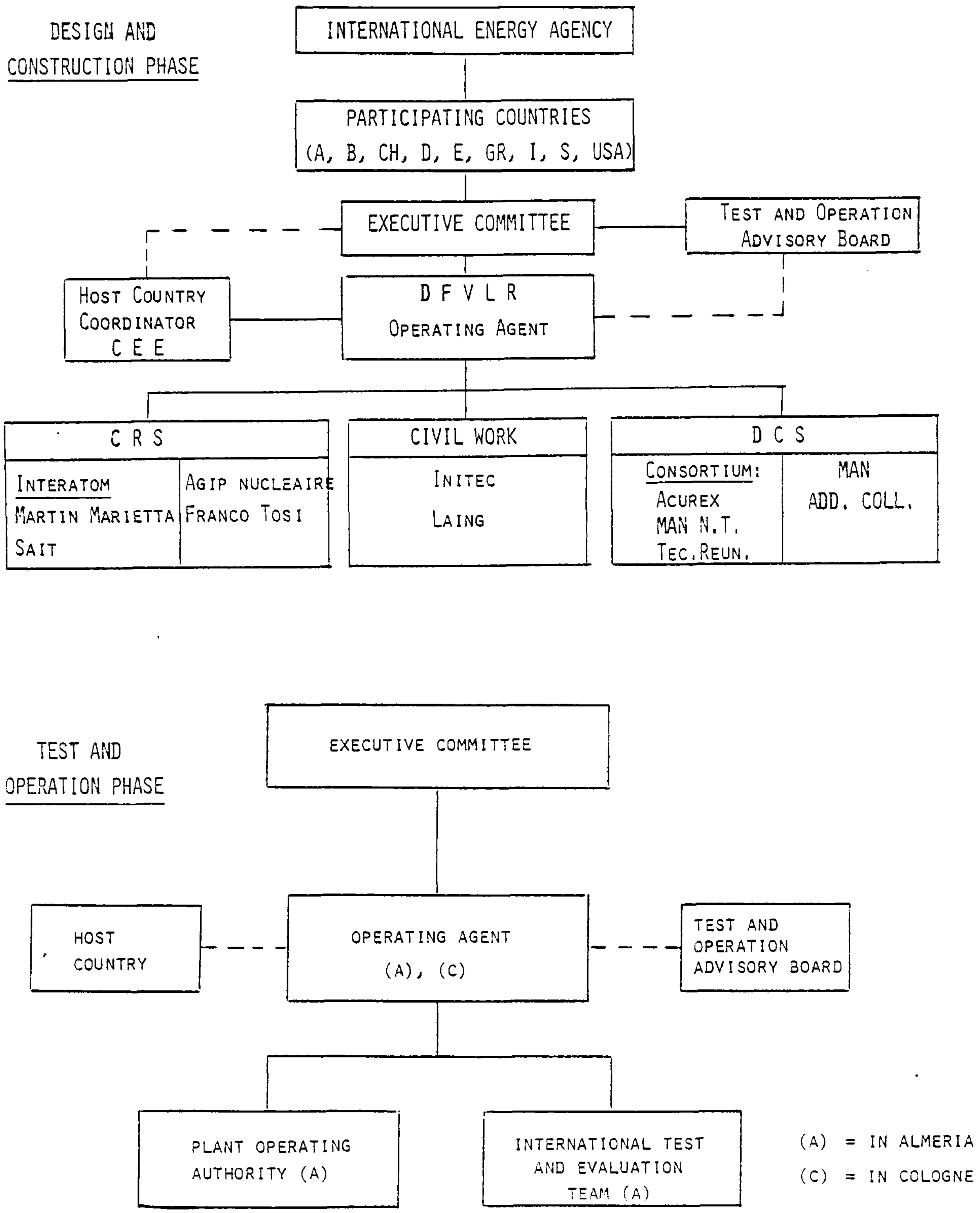

1.3 PROJECT ORGANIZATION

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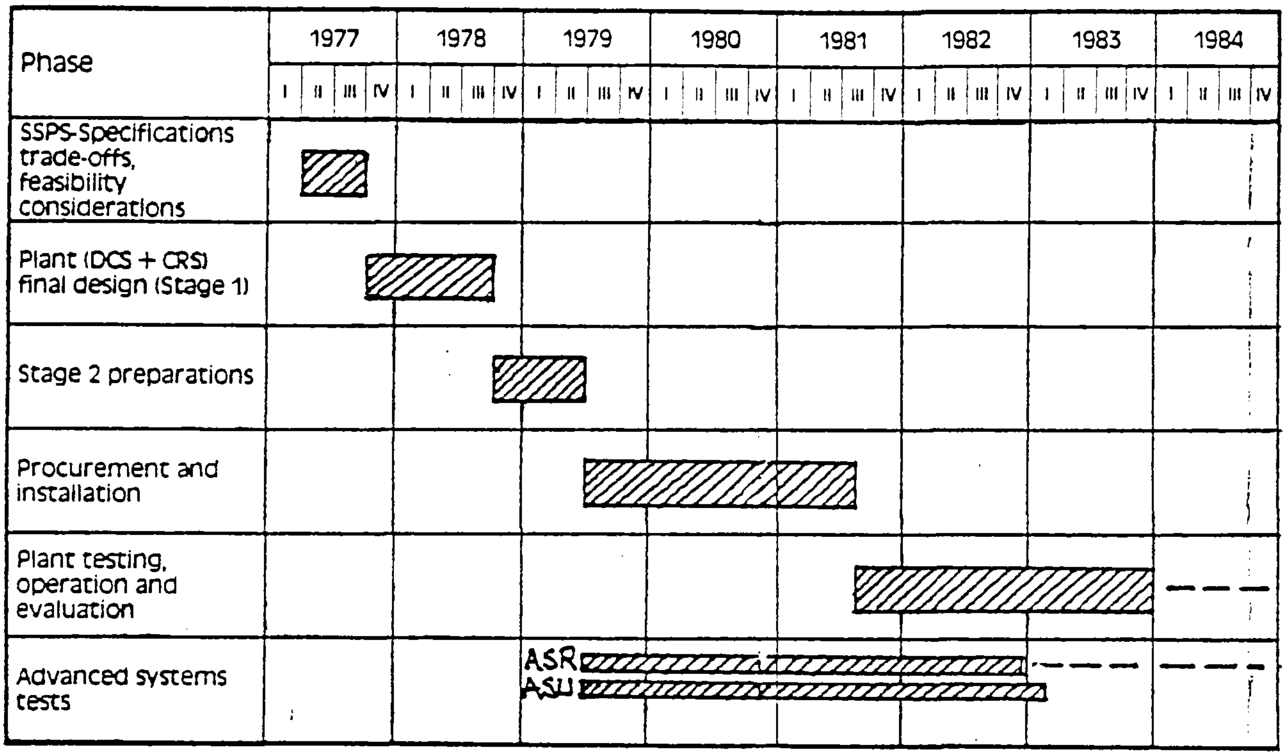

MILESTONES

FEB	'76	IEA WORKING PARTY
OCT	'77	STAGE 1 IMPLEMENTING AGREEMENT
MAY	'79	STAGE 2 SUPPLEMENT
JUN	'79	SUPPLY CONTRACT AWARDS
APR	'80	START OF ON-SITE CONSTRUCTION
APR	'81	START OF FUNCTIONAL TESTING
SEP	'81	INAUGURATION, PLANT OPTIMIZATION PHASE
JAN	'82	START OF ROUTINE OPERATION
JUN	'82	START OF STAGE 3 DISCUSSIONS
DEC	'83	END OF STAGE 2

LOCATION: SPANISH PLATAFORMA SOLAR WITH 4 PROJECTS, ALMERIA/SOUTHERN SPAIN

- CESA - 1 (1.0 MW_E CENTRAL RECEIVER SYSTEM)
- SSPS-CRS (0.5 MW_E CENTRAL RECEIVER SYSTEM)
- SSPS-DCS (0.5 MW_E DISTRIBUTED COLLECTORS)
- GAST (TECHNOLOGY PROGRAM DIRECTION TOWARDS 20 MWe CENTRAL RECEIVER SYSTEM)

ENVIRONMENT: 3000 HOURS $> 300\ W/M^2$, AVERAGE TEMPERATURE $17^{o}C$, ARID

INFRASTRUCTURE: ROADS, VIGILANCE, WORKSHOPS, OFFICES, CONFERENCE ROOMS, METEO-STATION, VISITORS SERVICES

PARTICIPATION: 9 COUNTRIES, LOCAL UTILITY (SEVILLANA)

TECHNOLOGY: HELIOSTATS FROM USA, GERMANY, SPAIN (1ST AND 2ND GENERATION)
PARABOLIC COLLECTORS FROM USA + GERMANY (THICK+THIN GLASS, 1-AXIS, 2-AXES)

HEAT TRANSFER MEDIA:	OIL, SODIUM, WATER, AIR
STORAGE MEDIA:	OIL, SODIUM, HITEC
PRIME MOVERS:	STEAM TURBINES, STEAM MOTOR
TEMPERATURE RANGE:	$295^{o}C$ ... $800^{o}C$
COOLING SYSTEMS:	WET, DRY

1.5 SITE CHARACTERISTICS

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2. DESIGN

2. DESIGN

GEOGRAPHICAL DATA FOR TABERNAS SITE

LATITUDE	37^{o} 06' N
LONGITUDE	02^{o} 23 W
ALTITUDE	500 M
SUN-SHINE HOURS	2900 TO 3000

DESIGN POINT SPECIFICATION

TIME	EQUINOX 12:00 H
DIRECT RADIATION	920 W/M^2
NET OUTPUT	500 KW
PARASITE LOAD	100 KW

HELIOSTAT FIELD

TYPE OF FIELD	NORTH
NUMBER OF HELIOSTATS	93
HELIOSTAT REFLECTIVE SURFACE	39.3 M^2

(US IN-KIND-CONTRIBUTION FROM
BARSTOW PROCUREMENT)

HEAT TRANSFER CYCLE

MEDIUM	SODIUM
RECEIVER TYPE	CAVITY
CENTER POINT HEIGHT	43.25 M
MAXIMUM TEMPERATURE	530° C
MAXIMUM PRESSURE	8 BAR
HEAT STORAGE	TWO VESSELS OF 70 M^3

POWER CONVERSION CYCLE

TYPE	RANKINE
LIVE STEAM	500° C; 100 BAR

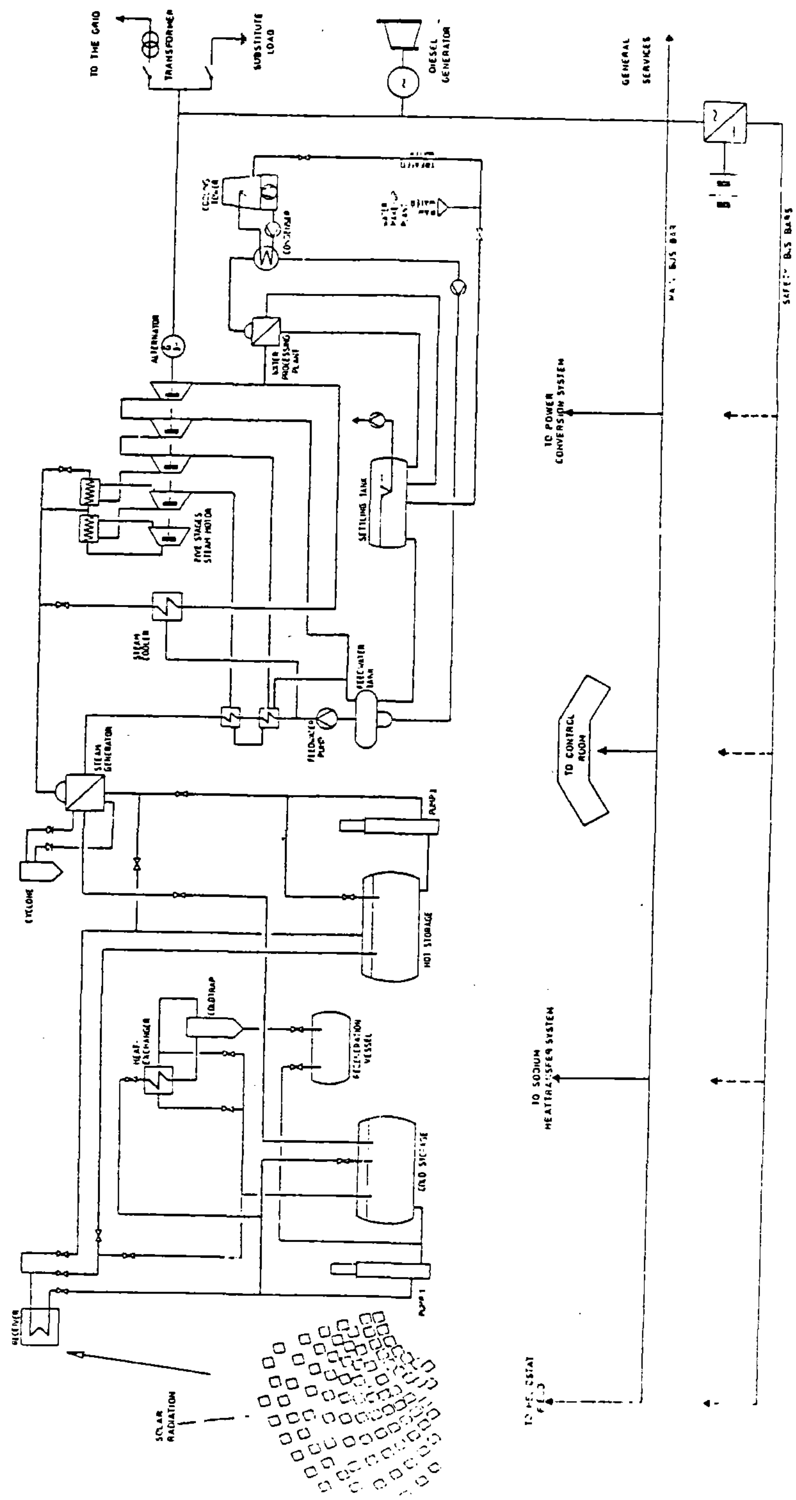
GENERAL

LIFE TIME	10 YEARS
PRICE TYPE -	FIRM FIXED ,
PROVISIONS	12 MONTHS
PERFORMANCE	ELECTRICAL OUTPUT
PENALTY/INCENTIVE	90 % / 100 %

POWER INPUT	2.8 MW TO RECEIVER AT DESIGN CONDITIONS
ENERGY STORAGE	EQUIVALENT TO ABOUT 1 MW_E AVAILABLE UP TO 24 H AFTER FULLY CHARGED, TO BE LOADED UNDER FULL, PARTIAL AND ZERO ELECTRICAL OUTPUT
LAND USE FACTOR	HIGHER THAN 20 %
COOLING	EVAPORATIVE WATER
OPERATIONAL MODES	INSOLATION ONLY INSOLATION AND STORAGE STORAGE ONLY
POWER DELIVERY	UTILITY GRID SUBSTITUTE LOAD

OPERABILITY		FULL	REDUCED (50 %)	SURVIVAL
INSOLATION	W/M^2	1100		
WIND	KM/H	13	50	144
EARTHQUAKE	M/S^2	0.3	0.3	0.6
HAIL SIZE	MM			19
AT SPEED	M/S			20

SAFETY PRECAUTIONS	EMERGENCY POWER DEFOCUSSING DEVICES INDEPENDENT SAFETY INSTRUMENTATION ALARM AND PROTECTION SYSTEMS



2.3 FACILITY SCHEMATIC

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3. CONSTRUCTION

3. CONSTRUCTION

3.1 PROCUREMENT PRINCIPLES

3.2 INDUSTRIAL PARTICIPATION

3.3 CHECKOUT / ACCEPTANCE

3.4 COSTS

- SSPS PROCUREMENT REGULATIONS
- CONTRIBUTIONS AND PAYMENTS IN DM
- FIXED SCALE OF CONTRIBUTIONS
- FIXED SCHEDULE OF CONTRIBUTIONS
- FIXED PRICE CONTRACTS
  - 60 % OF 70 MDM FIRM FIXED
- CONTRACTS IN THE NAME OF DFLVR
- STAGE I COMPETITIVE PROCUREMENT

  REDUCED COMPETITION IN STAGE II
  - CRS : 3 MAIN CONTRACTORS, DFVLR INTEGRATION
  - DCS : CONSORTIUM OF 3 COMPANIES
- EXTENSIVE WARRANTY - GUARANTEE PROVISIONS

COUNTRY		NUMBER OF FIRMS INVOLVED	TOTAL VALUE MIO. DM	REFLOW %
AUSTRIA	(A)	5	1.9	63
BELGIUM	(B)	7	3.0	66
SWITZERLAND	(CH)	4	3.4	85
GERMANY	(D)	14	24.9	79
SPAIN	(E)	16	20.7	165
GREECE	(GR)	2	0.25	12
ITALY	(I)	1	0.6	37
SWEDEN	(S)	1	2.7	108
USA		3	12.8	88
OTHER		4	1.0	--
		57	71.25	

3.2 INDUSTRIAL PARTICIPATION AND REFLOW
(1979 - 1981)

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FUNCTIONAL TESTS — WITHOUT SOLAR ENERGY
AT AMBIENT TEMPERATURE AND WITHOUT HEAT TRANSFER MEDIA
FOR ALL SUBSYSTEMS FROM HFS TO DAS

FUNCTIONAL TESTS — WITHOUT SOLAR ENERGY
AT ELEVATED TEMPERATURES AND WITH HEAT TRANSFER MEDIA
FOR SHTS, PCS, AND CES

FUNCTIONAL TESTS — WITH SOLAR ENERGY
- o INTEGRATIONS HFS/SHTS, SHTS/PCS
- o COMPONENT TESTS FROM SHTS TO CES

ACCEPTANCE TESTS — PLANT START-UP
- o CAPABILITY OF HFS/SHTS; SHTS/PCS; STORAGE
- o START-UPS HFS/SHTS; SHTS/PCS
- o SHUT-DOWNS HFS/SHTS; SHTS/PCS

ACCEPTANCE TESTS — PLANT EMERGENCY
- o POWER SUPPLY FAILURE
- o PUMP FAILURES (SODIUM; FEEDWATER)
- o STEAM MOTOR FAILURE

PLAN : MAY 1979	MDM		STATUS : APRIL 1982	MDM	
CENTRAL RECEIVER SYSTEM	33.5		CENTRAL RECEIVER SYSTEM	36.3	5)
DISTRIBUTED COLLECTOR SYS.	22.5		DISTRIBUTED COLLECTOR SYS.	30.2	
TEST + OPERATION	6.0	1)	TEST + OPERATION	10.1	3) 4)
I T E T	-		I T E T	0.2	
OPERATING AGENT	4.0	1)	OPERATING AGENT	5.9	4)
GENERAL EXPENDITURE	-		GENERAL EXPENDITURE	0.5	
CONTINGENCY	8.5		CONTINGENCY	3.2	
T O T A L :	74.5	2)	T O T A L :	86.4	

1) UNTIL MARCH 1983
2) WITHOUT ITALIAN IN-KIND CONTRIBUTIONS

REMARK :
- ALL FIGURES NOT SPECIFIED FOR DCS OR CRS ARE FOR TWO PLANTS
- ITET = INTERNATIONAL TEST AND EVALUATION TEAM

3) INCLUDING CRS/DCS OPERATION OPTIMIZATION (3.4)
4) INCLUDING 9 MONTHS EXTENSION TILL END 1983
5) BREAKDOWN (APPROXIMATELY ONLY)

HELIOSTAT FIELD	7
SODIUM SYSTEM + ELECTRICAL SYSTEM + CONTROL SYSTEM	23
POWER CONVERSION	3
DATA ACQUISITION SYSTEM	1
BUILDING + INFRASTRUCTURE (50 % OF TOTAL)	2.3
	36.3

3.4 FACILITY COSTS

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4. CHARACTERISTICS

4. CHARACTERISTICS

o INTERFACES OF IMPORTANCE

- RADIATION / POWER STATION
  (HELIOSTATS)
- HELIOSTAT FIELD / SODIUM CIRCUIT
  (RECEIVER)
- SODIUM CIRCUIT / STEAM CIRCUIT
  (STEAM GENERATOR)
- POWER STATION / GRID
  (ALTERNATOR)

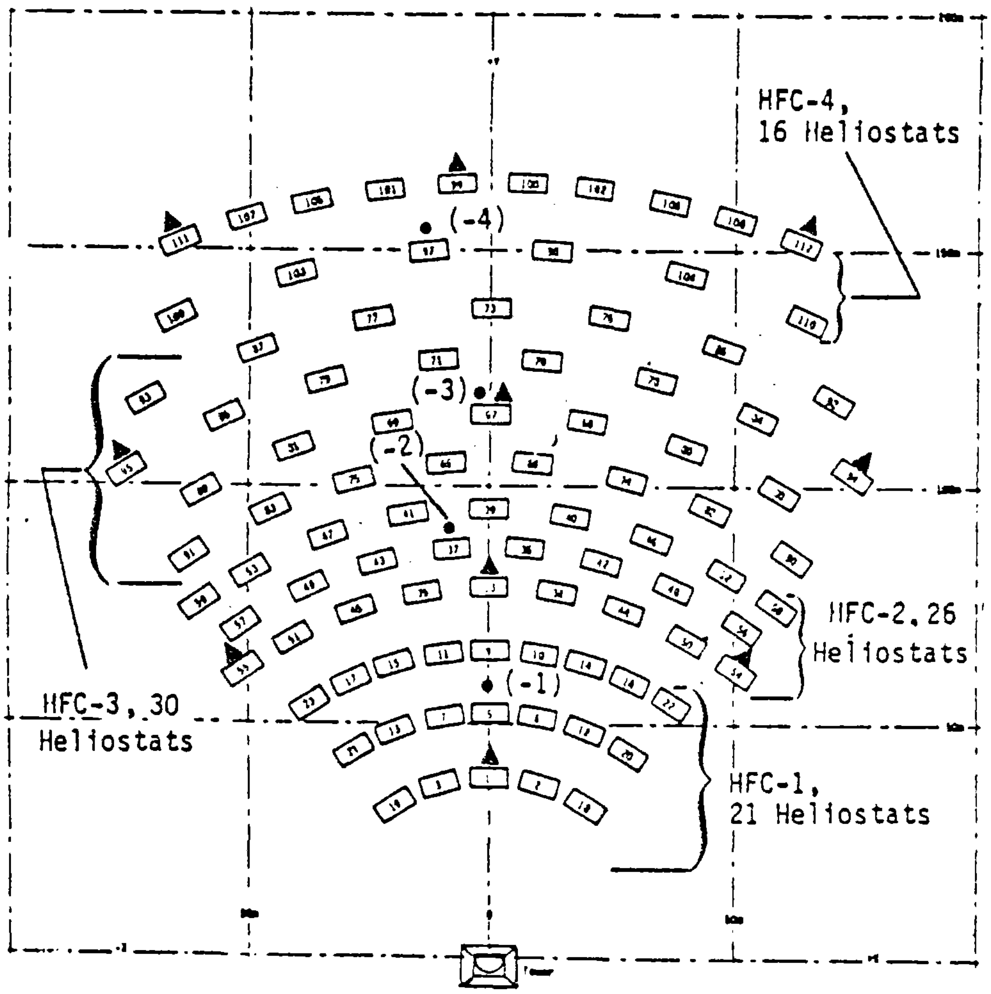
o RECEIVER AS SOLAR SPECIFIC INTERFACE

- TRANSFER OF SOLAR RADIATION INTO THERMAL ENERGY
- HELIOSTAT FIELD CONCENTRATION PRODUCES DISTRIBUTION OF HEAT FLUX DENSITIES ON ABSORPTION PLANE
- SPILLAGE PROBLEM ON RECEIVER APERTURE EDGES AS SAFETY CRITERION AND DESIGN PARAMETER
- ENERGY BALANCE AT RECEIVER
  ABSORPTION ON TUBES :
  RADIATION, RERADIATION, REFLECTION,
  CONDUCTION, CONVECTION
- REACTIONS OF THERMAL CYCLE ON
  RADIATION FLUCTUATIONS, CLOUD INTERMISSIONS,
  STARTS AND SHUT DOWNS

- o HIGH REFLECTIVITY PRE-FOCUSED HELIOSTATS
- o COORDINATION OF TOTAL HELIOSTAT FIELD WITH PURPOSE OF CONCENTRATION
- o DIRECTION TO THERMAL RECEIVER WITH OCTOGONAL APERTURE AREA ON TOP OF TOWER
- o CONTROL ON THREE LEVELS
  - SINGLE HELIOSTAT (HC)
  - HELIOSTAT GROUPS (HFC)
  - TOTAL FIELD (HAC)

TABLE OF MAIN DATA

NUMBER OF HELIOSTATS	93
TOTAL REFLECTIVE AREA	3655 M^2
APERTURE AREA	9.7 M^2
AIM POINT IN APERTURE PLANE ABOVE GROUND	43.2 M
POWER INTO CAVITY AT DESIGN CONDITIONS	2840 KW



- ● Location of Heliostat Field Controllers (4 ea)
- ▲ Location of Sun-Presence Sensors (10 ea)

	4.2 HELIOSTAT FIELD PLOT PLAN (MMC, USA)	**IEA-SSPS** OPERATING AGENT **DFVLR**

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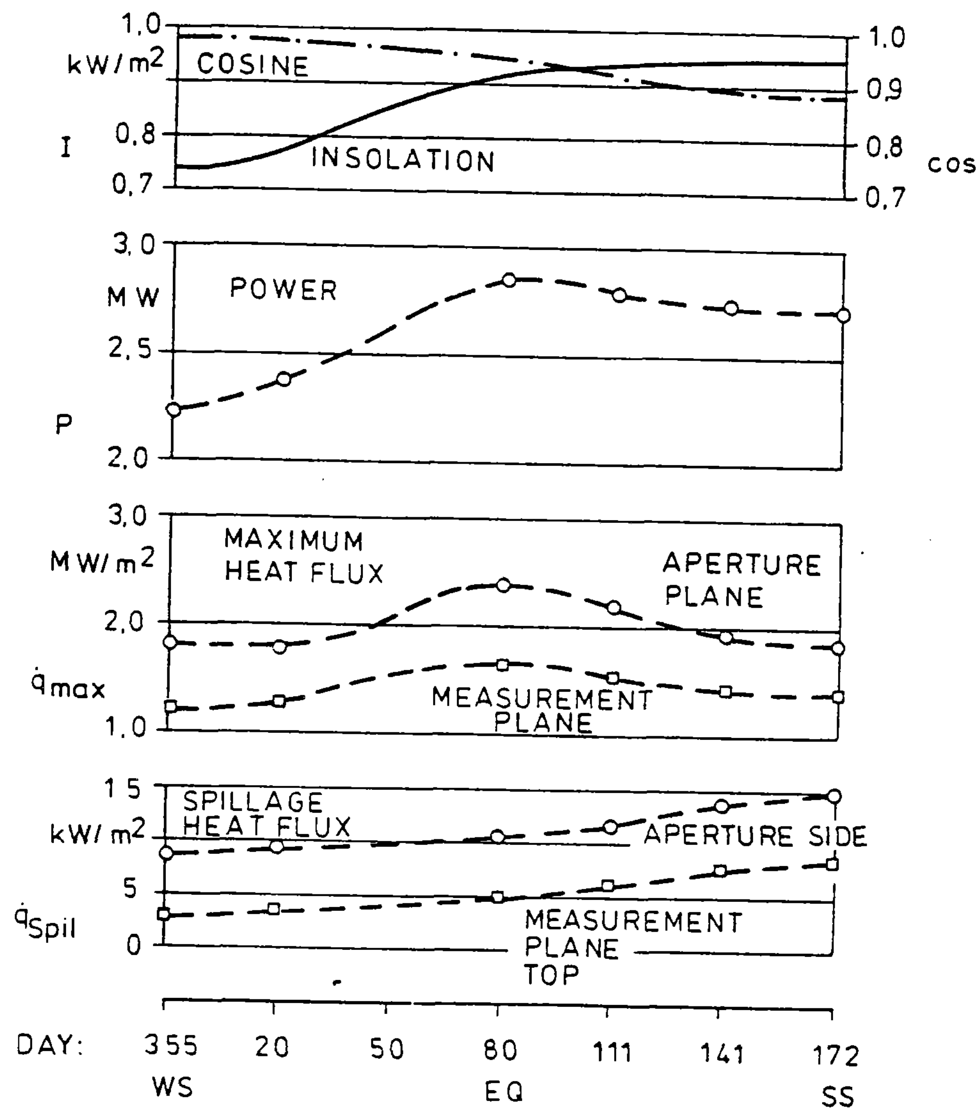

4.2 HELIOSTAT FIELD
INSOLATION, COSINE AND
CALCULATED POWER FLUX

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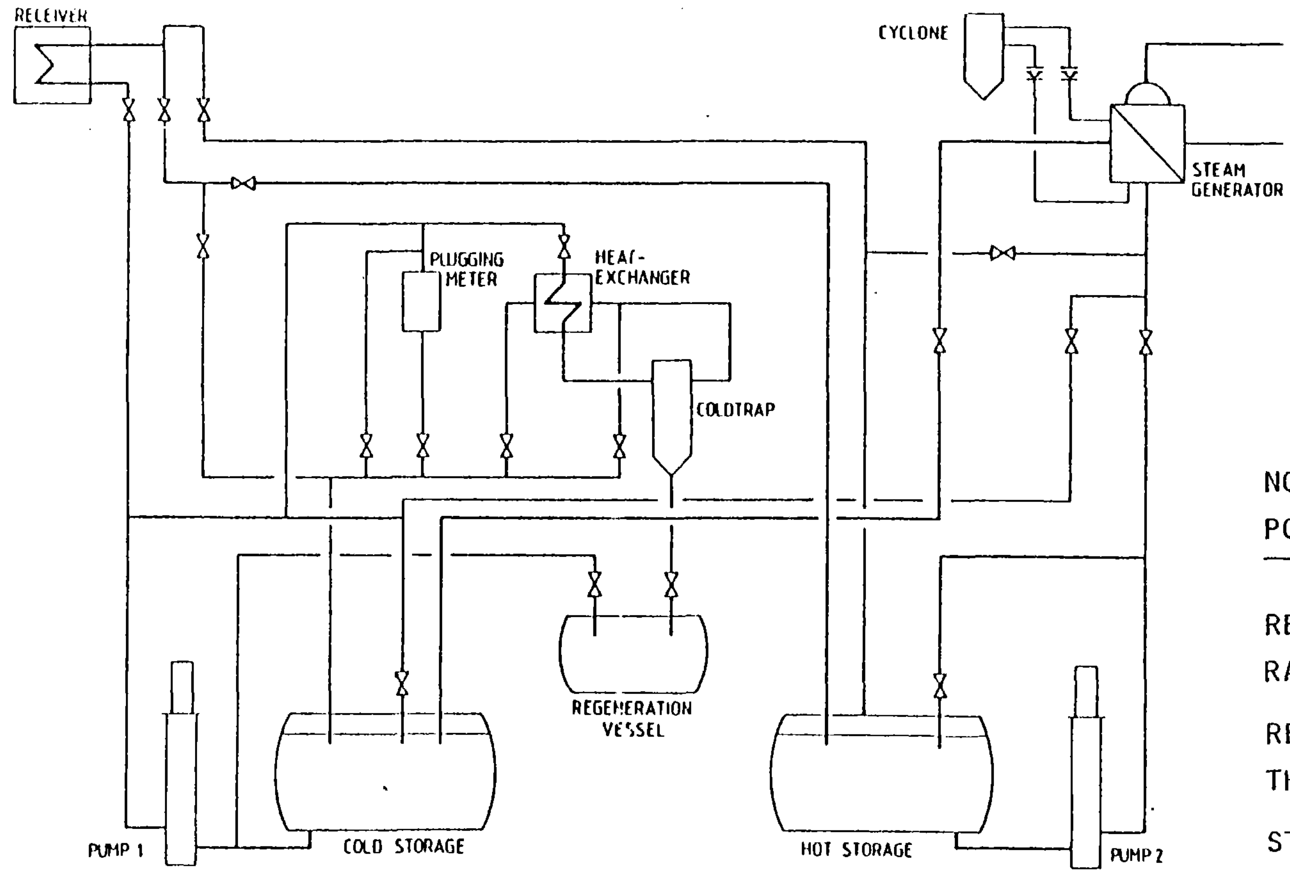

NOMINAL (DESIGN) POWER CONDITIONS [KW]

RECEIVER RADIATIVE INPUT	2840
RECEIVER THERMAL INPUT	2508
STEAM GENERATOR THERMAL INPUT	2203

4.3 SODIUM HEAT TRANSFER CYCLE (INTERATOM, GERMANY)

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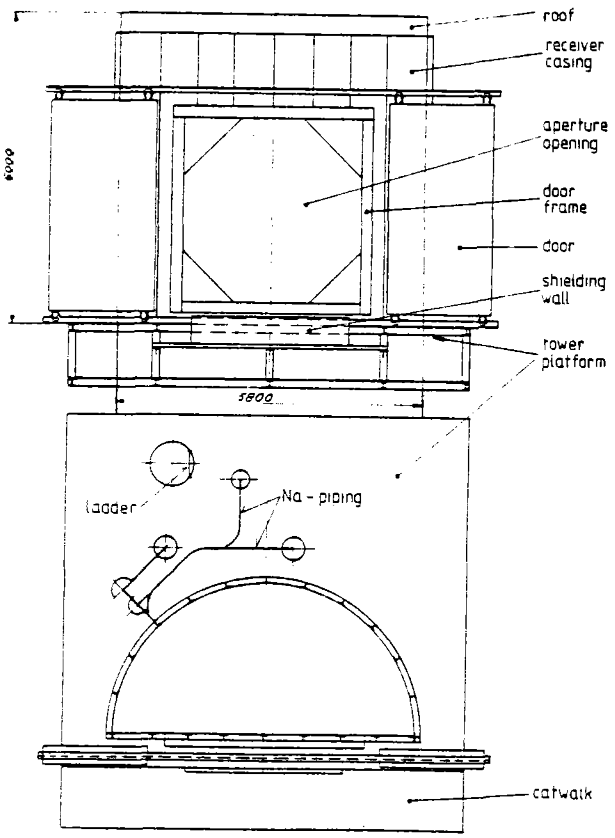
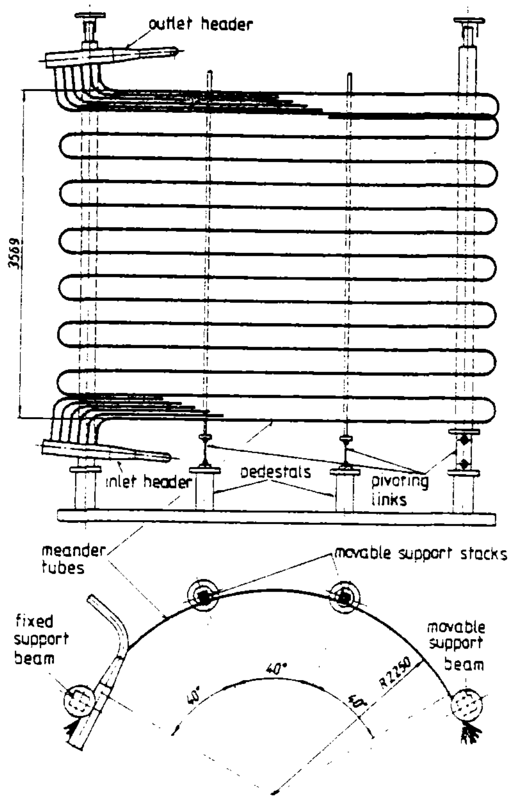
- o CAVITY RECEIVER WITH NORTH ORIENTED OCTOGONAL SHAPED (3.4 M AND 3.5 M MAIN DIMENSION) APERTURE OF 9.7 M^2
- o CENTER LOCATED 43.25 M ABOVE GROUND
- o ABSORBING SURFACE 17 M^2
  6 PARALLEL SODIUM CARRYING TUBES DIRECTED IN A SERPENTINE WAY FROM BOTTOM TO TOP WITH 14 TURNS
  PEAK FLUX DENSITY 600 KW/M^2
  ABSORPTIVITY OF TUBES 0.95
  DESIGN EFFICIENCY 0.883
- o CERAMIC BACK WALL ENABLES SHORT TIME HEAT STORAGE





4.3 SODIUM HEAT TRANSFER RECEIVER (SULZER, SWITZERLAND)

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DESIGN ITEMS

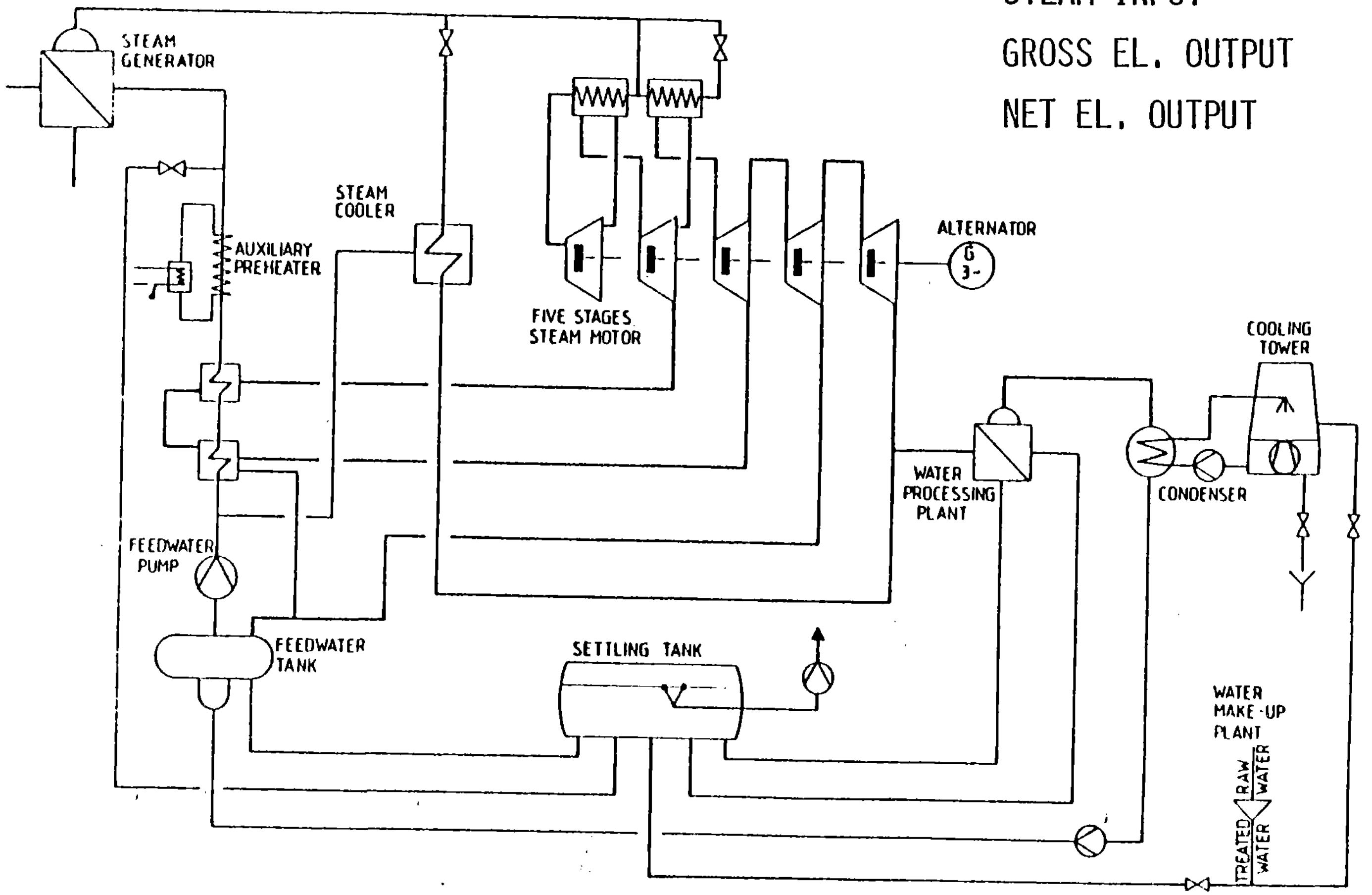
- o HELICAL TUBE / ONCE TROUGH
- o COILED AROUND CENTRAL DISPLACEMENT TUBE
- o SODIUM FLOW DOWNWARDS BETWEEN SHELL AND DISPLACEMENT AROUND THE HEATING TUBES
- o WATER FLOW UPWARDS
- o TWO RUPTURE DISCS CONNECTED WITH CYCLONE

DATA

HEAT TRANSFER AREA	14.7 M^2
FEED WATER TEMPERATURE	193^0 C
OUTLET STEAM TEMPERATURE	500 TO 525^0 C
OUTLET PRESSURE	105 BAR
STEAM MASS FLOW	0.86 KG/S
SODIUM INLET TEMPERATURE	525^0 C
SODIUM OUTLET TEMPERATURE	275^0 C
MAXIMUM SODIUM PRESSURE	8 BAR
SODIUM MASS FLOW	6.9 KG/S

NOMINAL (DESIGN)
POWER CONDITIONS [KW]

STEAM INPUT	2203
GROSS EL. OUTPUT	599
NET EL. OUTPUT	500



4.4 POWER CONVERSION
(SPILLING, GERMANY/SWITZERLAND)

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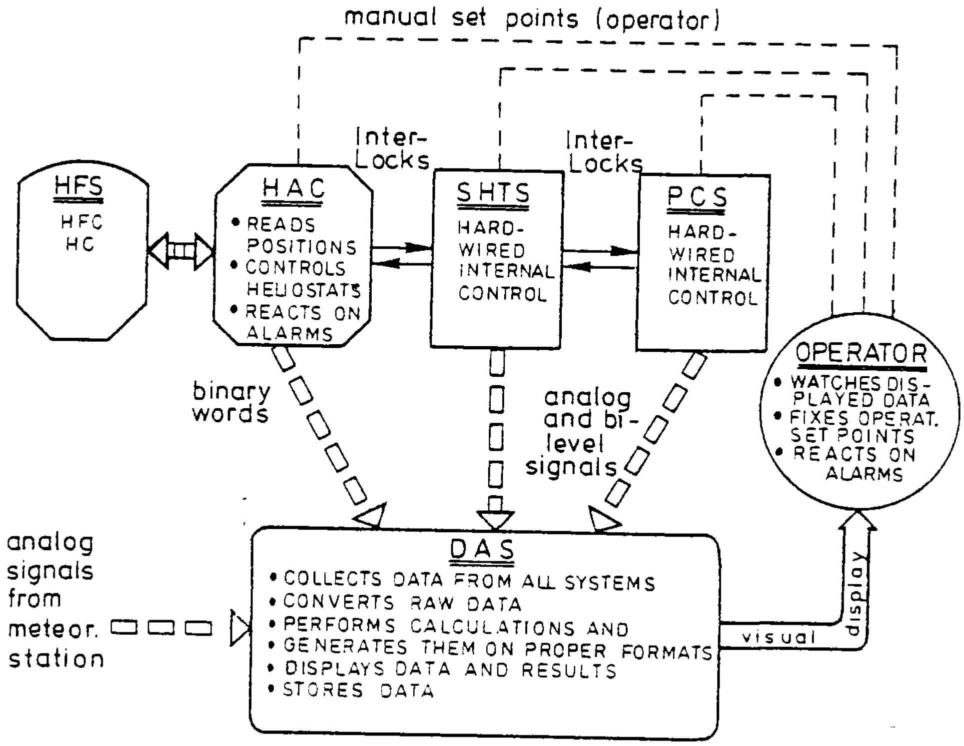
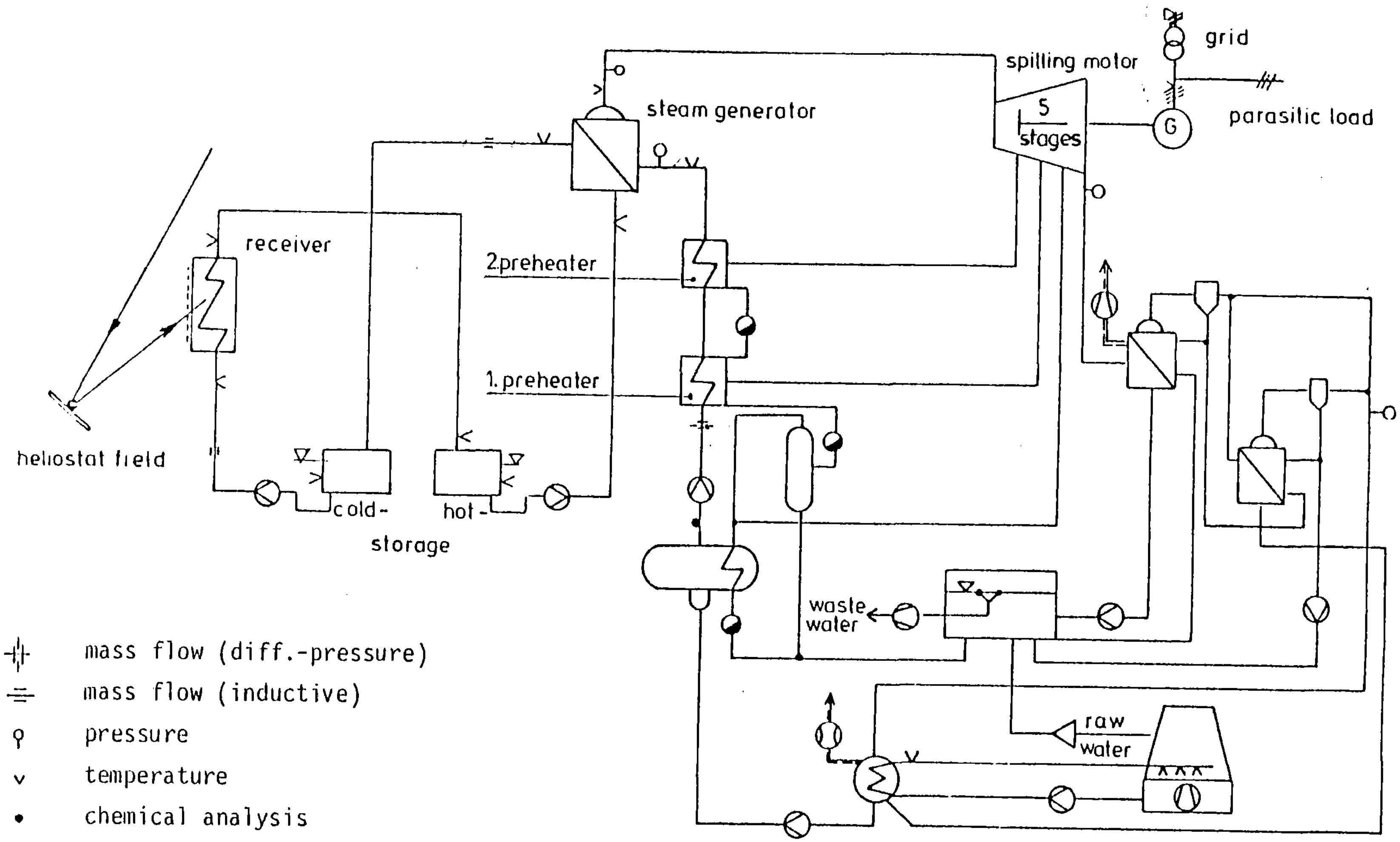
Main Functions of CRS

Control and Data Acquisition System



HFS	Heliostat Field System
HFC	Heliostat Field Control
HAC	Heliostat Array Control
HC	Heliostat Control
SHTS	Sodium Heat Transfer System
PCS	Power Conversion System
DAS	Data Acquisition System



- mass flow (diff.-pressure)
- mass flow (inductive)
- pressure
- temperature
- chemical analysis
- electrical variables
- level
- meteorological data

4.6 INSTRUMENTATION

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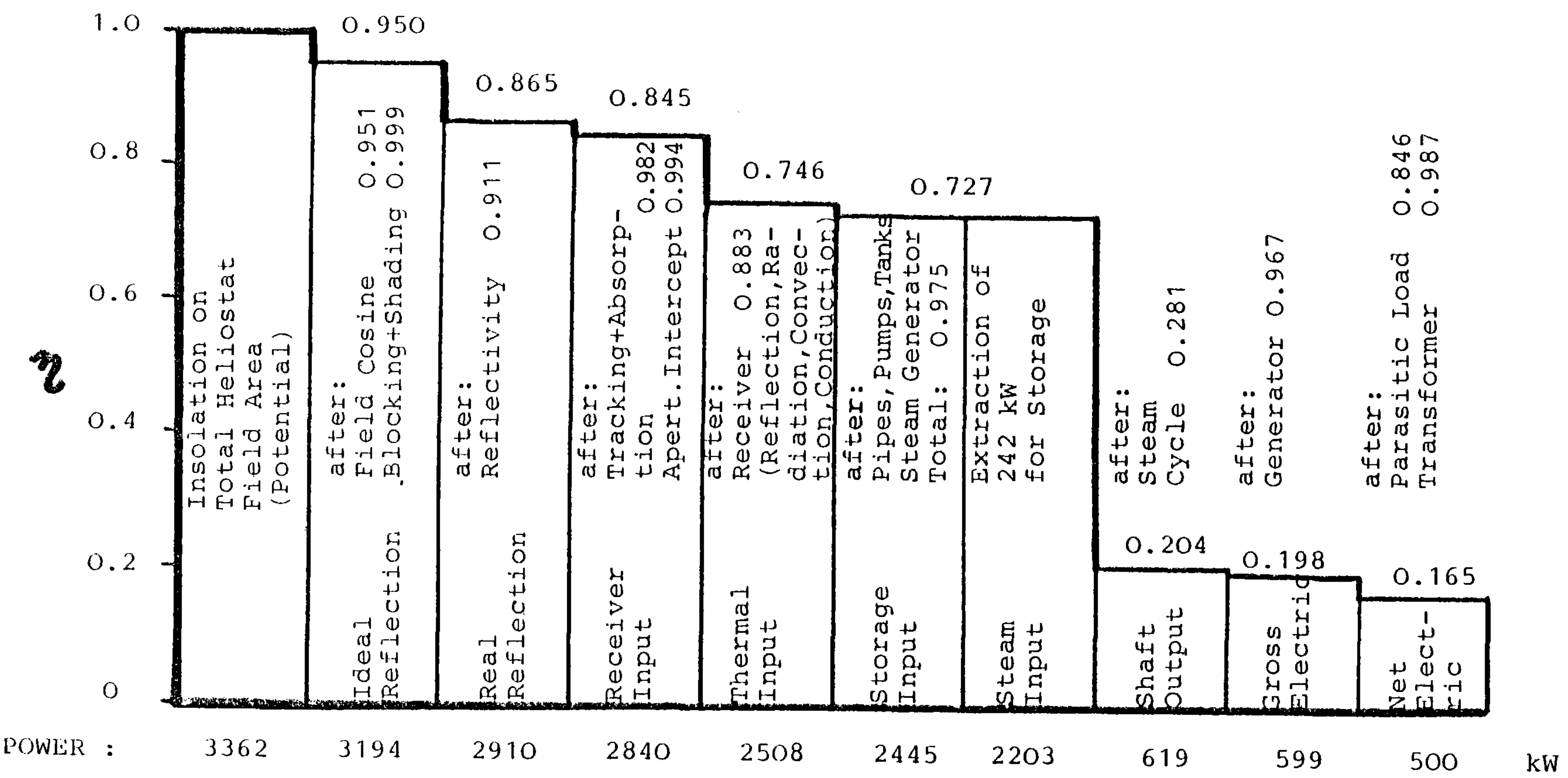
DESIGN CONDITION

Day 80 Time: 12:00
Insolation 0.92 kW/m^2
Heliostat Field Area 3655 m^2



4.7 POWER STAIR STEP
CALCULATED FOR DESIGN CONDITION

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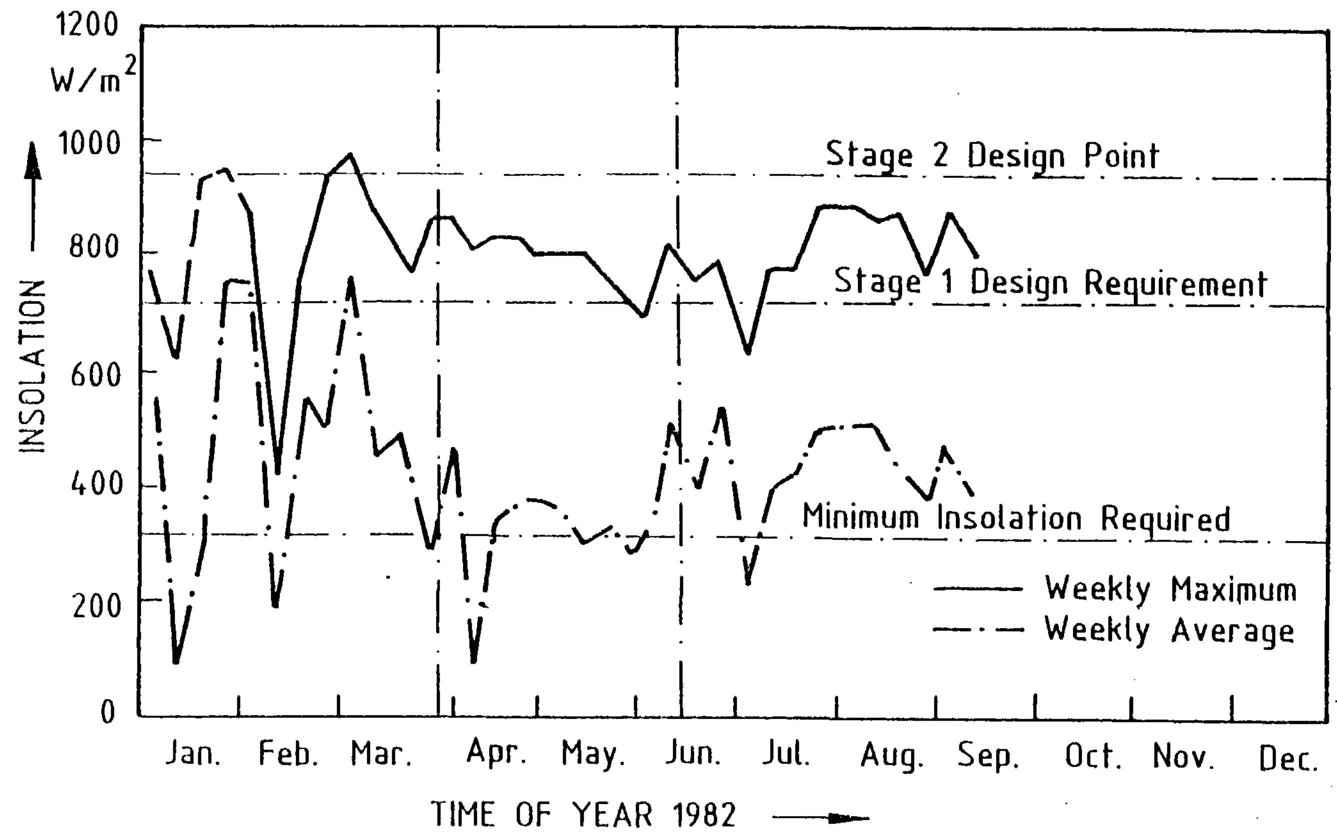
5. PERFORMANCES

5. PERFORMANCE



5.1 METEO DATA

DIRECT INSOLATION

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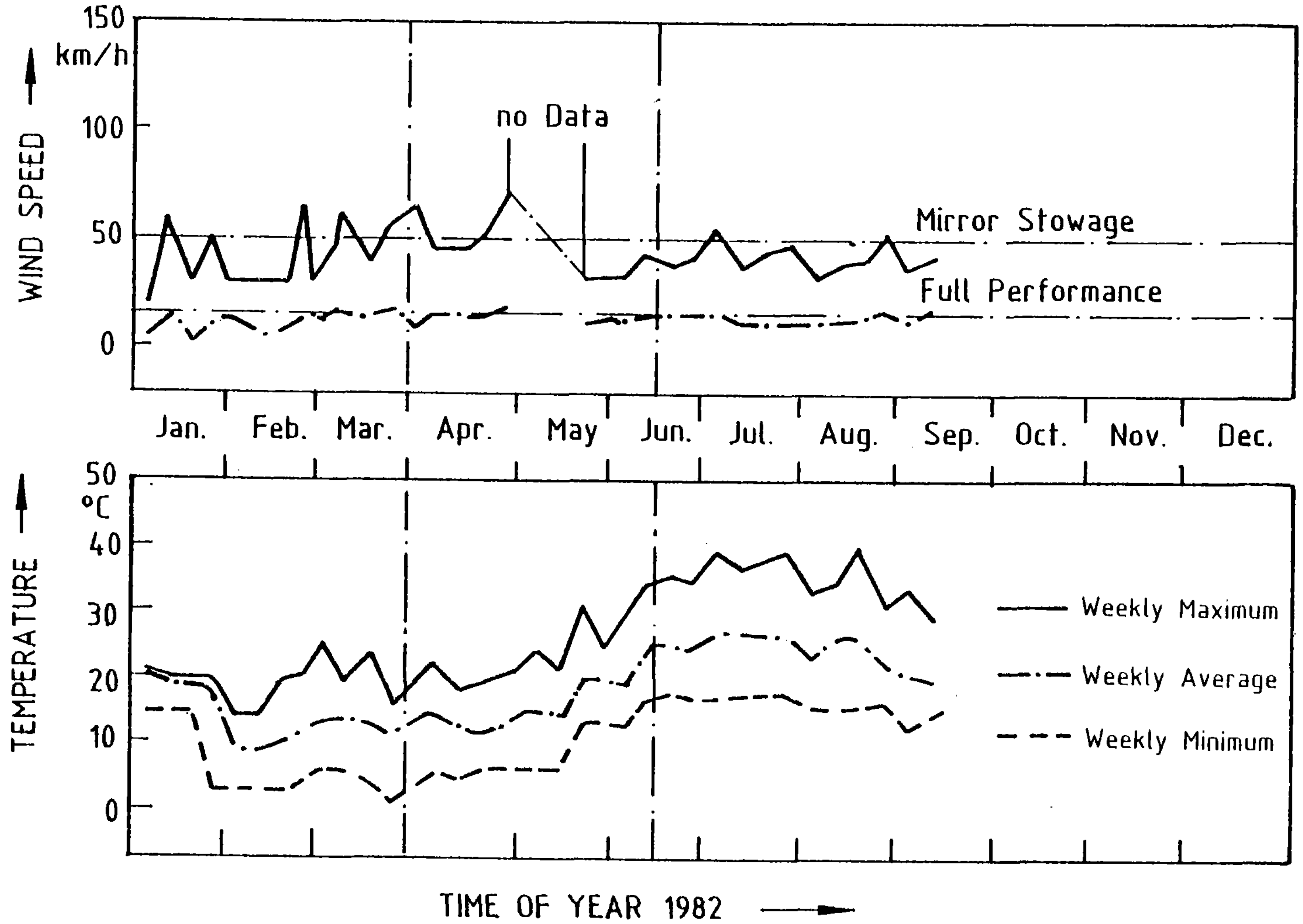

5.1 METEO DATA

WIND SPEED AND TEMPERATURE

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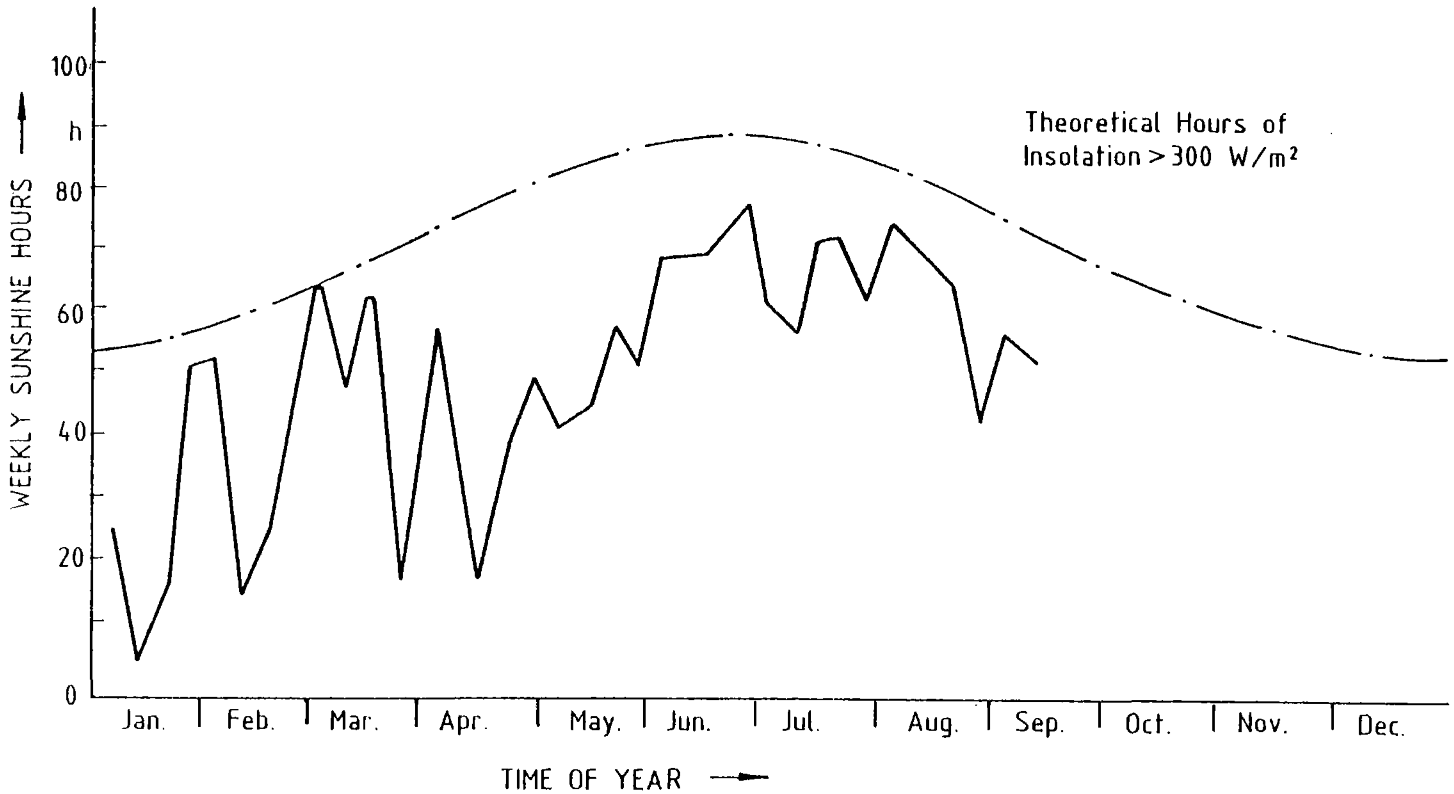

5.1 METEO DATA
COMPARISON OF REAL WITH CLEAR SKY
CALCULATED SUN SHINE HOURS FOR 1982

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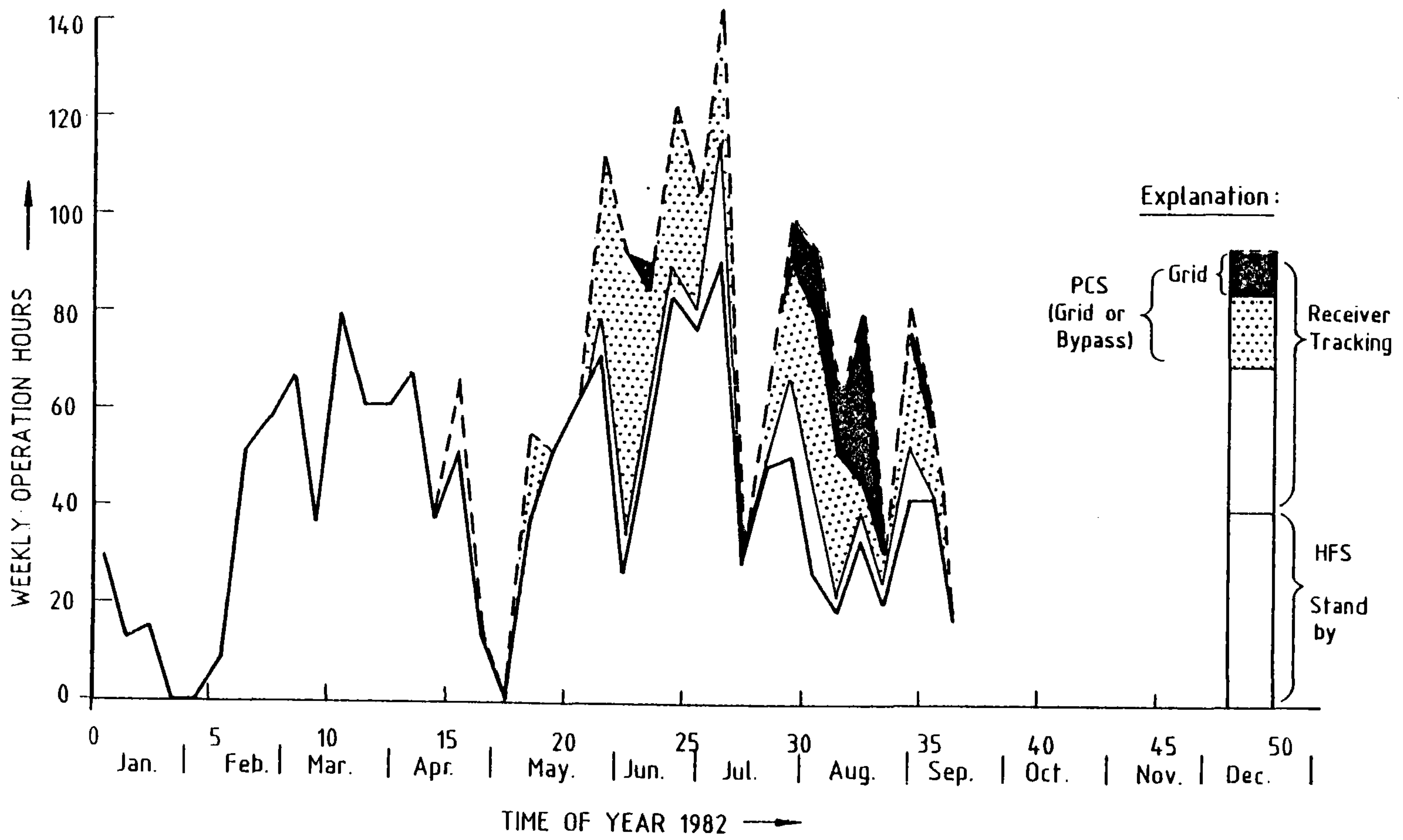
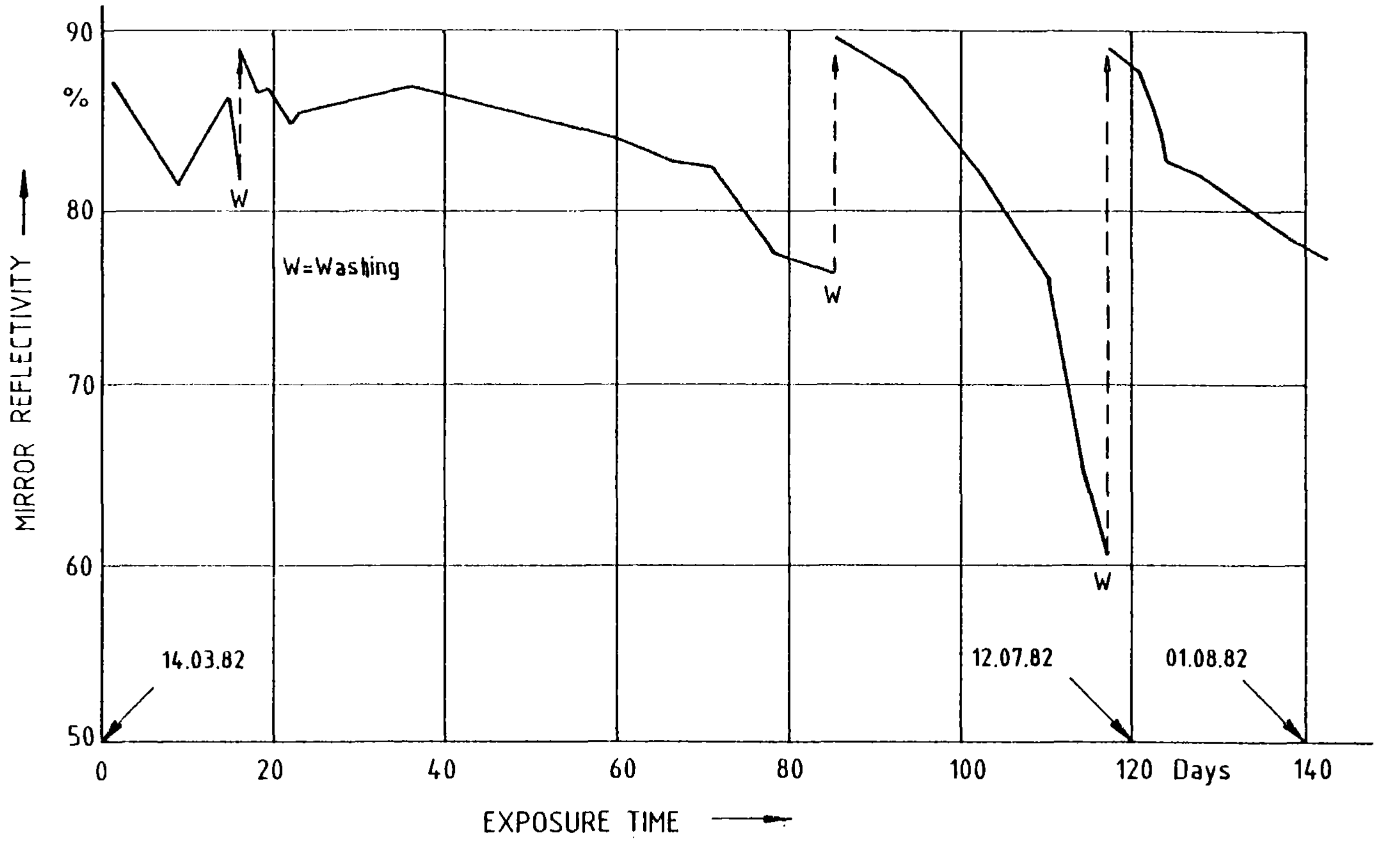


	5.2 PLANT OPERATION DATA 1982	IEA-SSPS OPERATING AGENT DFVLR



5.3 HELIOSTAT FIELD
AVERAGED REFLECTIVITIES IN 1982

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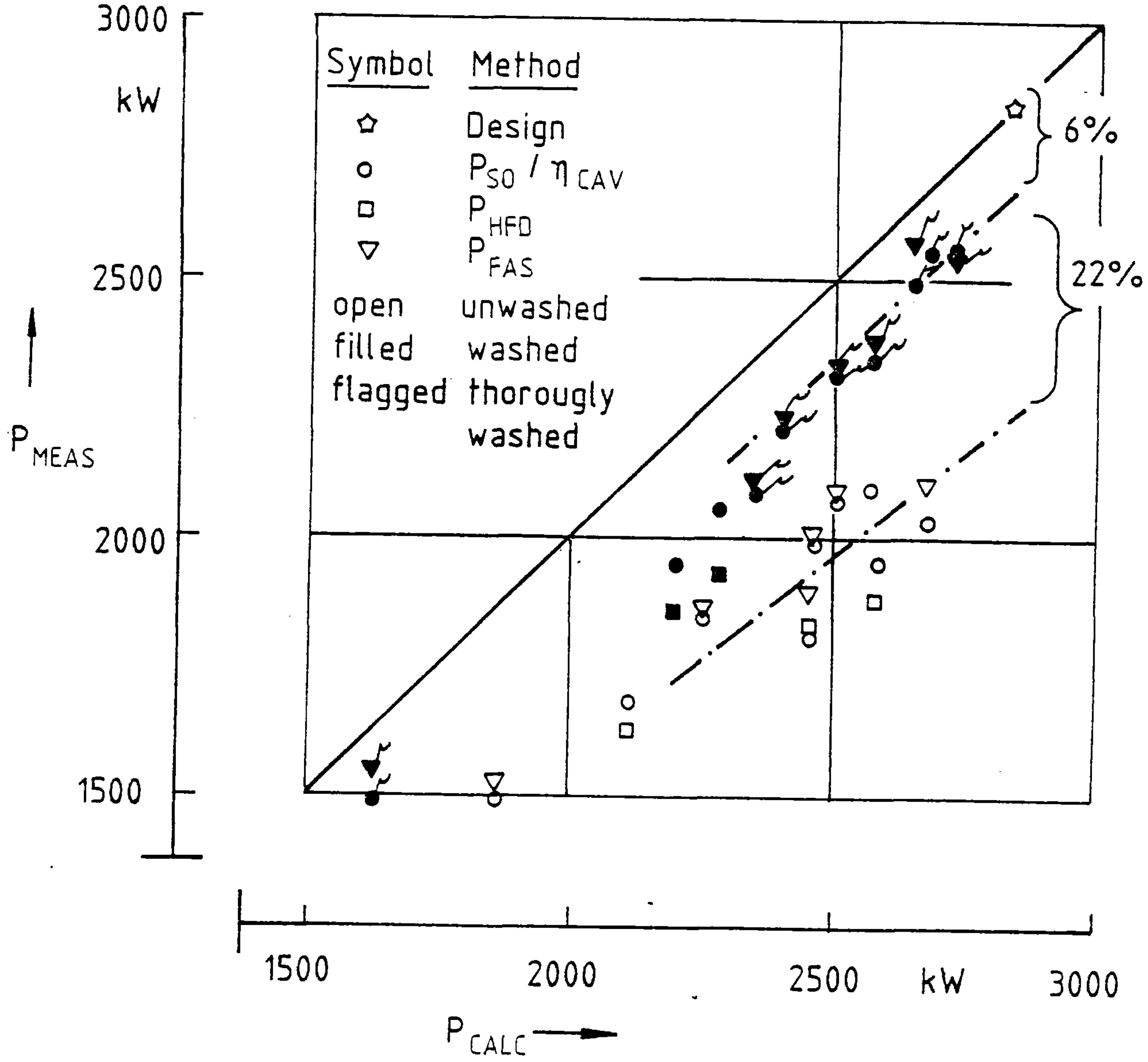
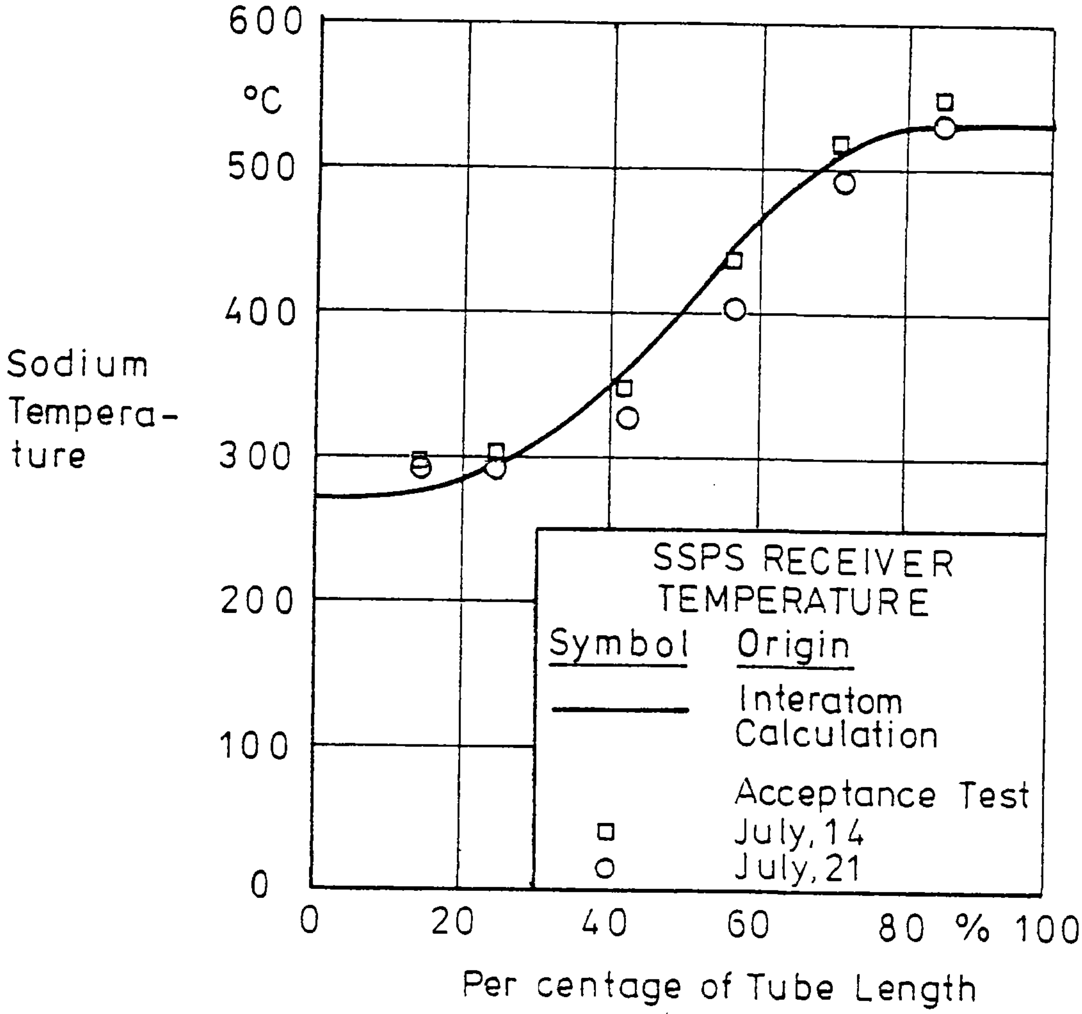
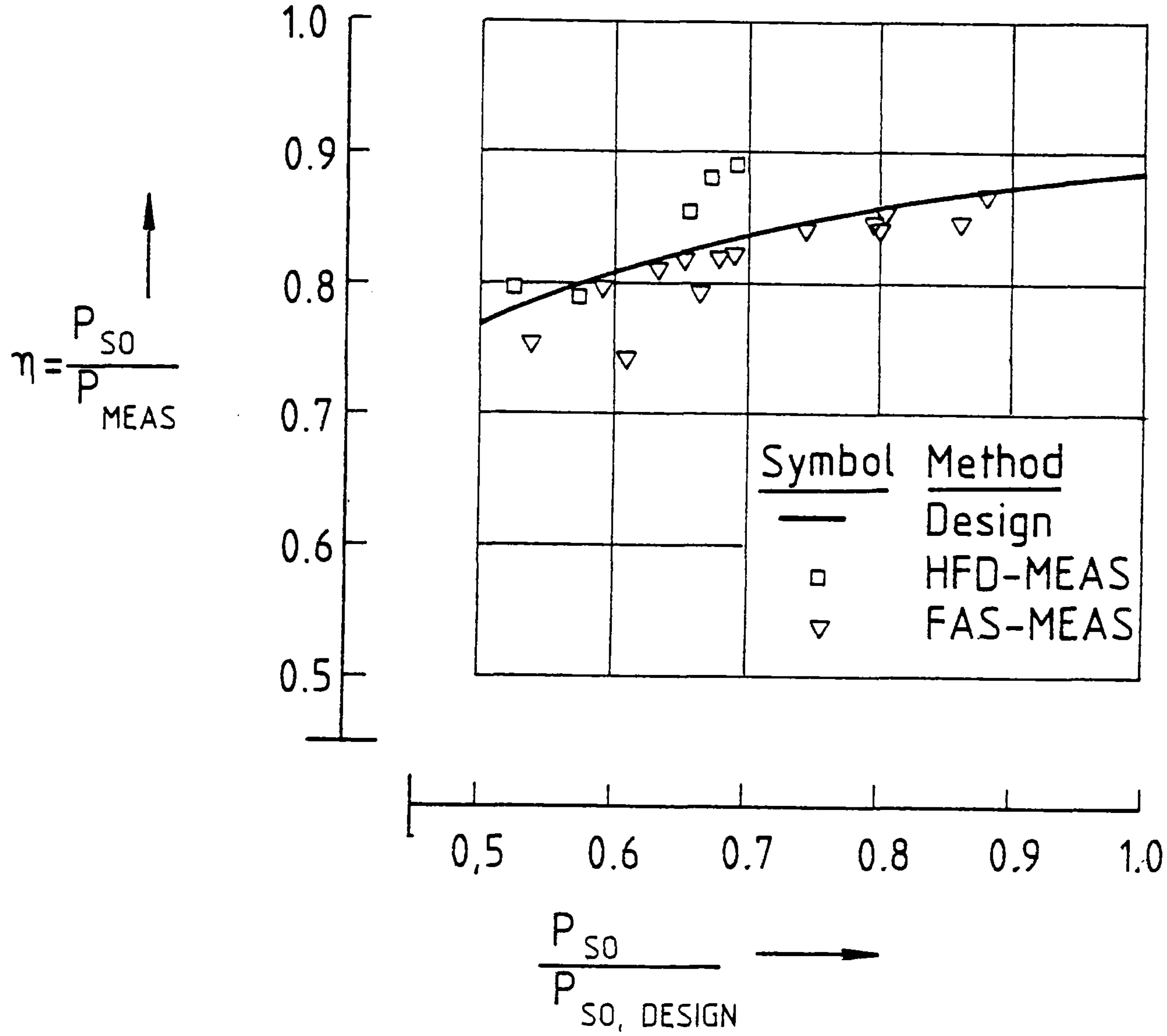


	5.3 HELIOSTAT FIELD POWER IN APERTURE PLANE	**IEA-SSPS** OPERATING AGENT **DFVLR**


600
°C
500
400
Sodium
Tempera-
ture
300
200
100
0
0
20
40
60
80 % 100
Per centage of Tube Length
SSPS RECEIVER
TEMPERATURE
Symbol
Origin
Interatom
Calculation
Acceptance Test
July, 14
July, 21



5.4 SODIUM HEAT TRANSFER RECEIVER EFFICIENCY

RESULTS OF 1982

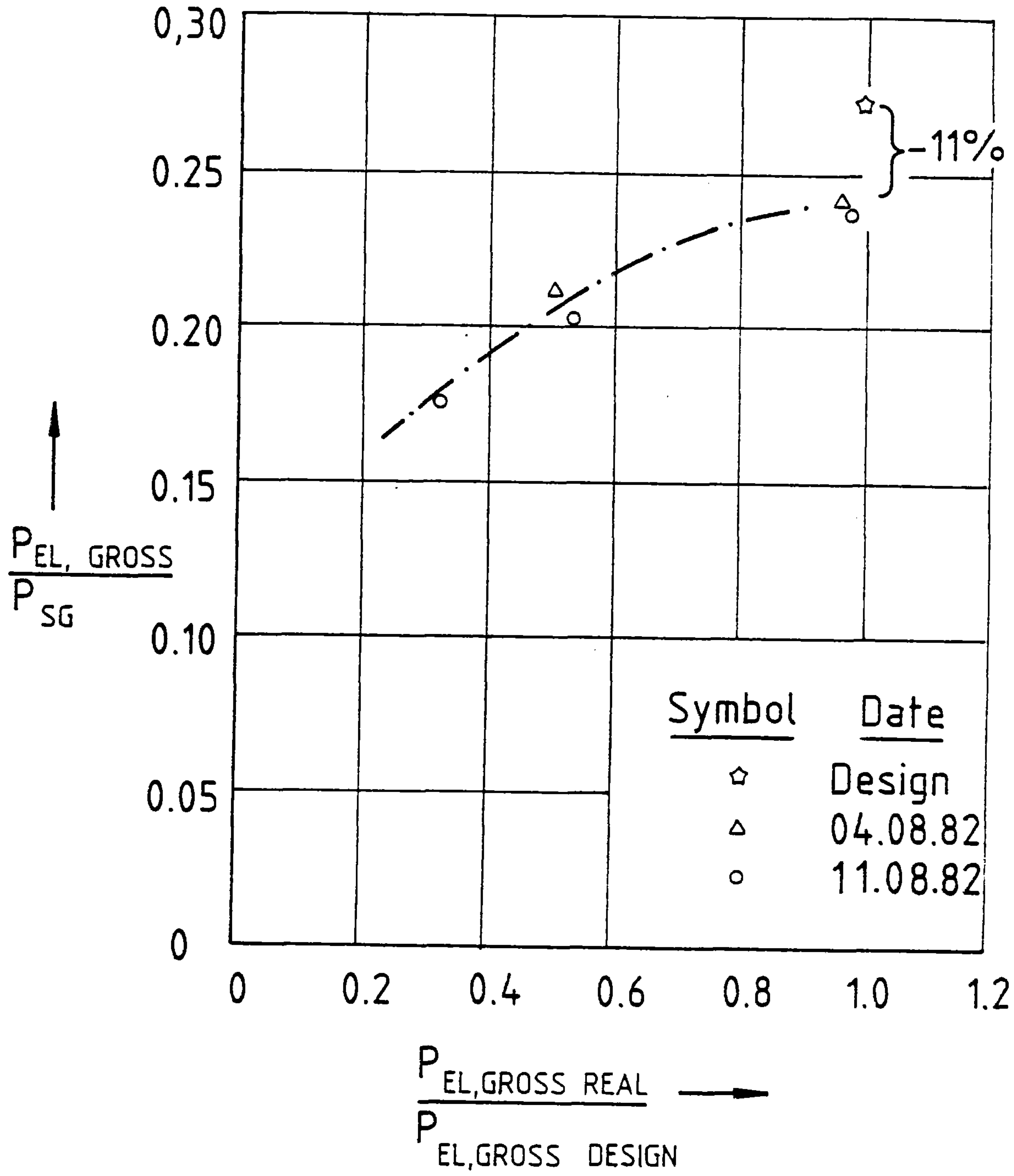
JANUARY - MAY	FIRST STAGE STEAM MOTOR REPAIR
JUNE - JULY	FUNCTIONAL TESTS
JULY - AUGUST	TEN-DAY-TEST
SEPTEMBER	OPERATION

TEN-DAY-EXPERIENCE-TEST

- o DEMONSTRATION OF PERFORMANCE CAPACITY IN REQUIRED POWER RANGE
- o MAINTENANCE REQUIREMENTS DUE TO UNSATISFACTORY RELIABILITY

STEAM ENGINE PERFORMANCE DATA

	AVERAGE LOAD KW	TOTAL ENERGY KWH	GRID TIME H
TO END OF JULY	166	8730	52:34
10-DAY-TEST	259	6855	26:25
POST 10-DAY-TEST TO SEPT. 27, 1982	371	7055	19:01
SUM	233	22640	98:00



5.5 POWER CONVERSION EFFICIENCY

1979	JULY	STAGE 2 CONTRACT
	OCTOBER	CRITICAL DESIGN REVIEW
	DECEMBER	HELIOSTAT PROCUREMENT
1980	APRIL	START OF SITE ACTIVITIES
	DECEMBER	RECEIVER ON TOWER
1981	JANUARY	START OF HELIOSTAT INSTALLATION
	FEBRUARY	FIRST SODIUM FILLING
	APRIL	DAS ACCEPTANCE
	MAY	HFS ACCEPTANCE
		START OF SOLAR TESTS
	JUNE	PROVISIONAL PLANT ACCEPTANCE
	JULY	HFD ACCEPTANCE / FAS OPERATIONAL
		STEAM MOTOR RUN (NO LOAD)
	SEPTEMBER	FIRST POWER TO GRID
		INAUGURATION
	OCTOBER	PLANT OPTIMIZATION
	DECEMBER	PLANT ACCEPTANCE AND
		REPAIR AGREEMENT
1982	JANUARY	ROUTINE OPERATION START AND
		COLD SODIUM TANK GENERAL REPAIR
		FIRST STAGE STEAM MOTOR REPAIR
	MAY	COLD SODIUM TANK OPERATIONAL
	JULY	EC-DECISION TO SUBSTITUTE
		STEAM ENGINE BY TURBINE
	SEPTEMBER	MEASUREMENT CAMPAIGN

1980	SEPTEMBER	FLOODING OF SITE
1981	MARCH	SODIUM FIRE AT TRANSPORT CONTAINER
	APRIL	MIRROR ATTACHMENTS FAILED
		HELIOSTAT COMMUNICATION PROBLEMS
		SODIUM PUMP LK02 BLOCKAGE (CONTAMINATION)
	JUNE	SODIUM PUMP LK02 BLOCKAGE
	JULY	SODIUM LEAKAGE AT COLD STORAGE TANK LOWER PART
	AUGUST	CONCENTRATED IMAGE EASTWARD WALK DUE TO POWER FAILURE AND LACK OF RESTAURATION
	SEPTEMBER	SODIUM LEAKAGE AT CAP WELDING OF COLD STORAGE TANK MAN HOLE
		STEAM ENGINE FIRST STAGE WATER HAMMER
	NOVEMBER	CRANE DAMAGE FROM ONE HELIOSTAT
		DAS MEMORY ERROR, BLOCKAGE OF SYSTEM
1982	JANUARY	HFS INOPERABLE (HAC)
	APRIL	HFS UNSOLICITED INTERRUPTS
		HFS DAMAGES (HC, HAC AND HFC/HAC INTERFACE) DUE TO LIGHTNING
	MAY	SODIUM PUMP LK02 OIL LEAK
	JULY	SODIUM PUMP LK02 OIL LEAK
	SEPTEMBER	COLD SODIUM TANK LEAKAGE
	OCTOBER	COLD SODIUM TANK LEAKAGE

OBJECTIVES

- o CONCENTRATION EFFICIENCY OF HELIOSTAT FIELD
- o CAVITY LOSSES OF RECEIVER
- o POWER STAIR STEP; ENERGY PRODUCTION

GOALS

- o BETTER RECOGNITION OF SOLAR SPECIFIC ELEMENTS
- o INCREASED UNDERSTANDING OF CONTEXTS
- o PROPOSALS FOR IMPROVEMENTS OF PLANT, TECHNIQUES AND PROCEDURES
- o PREPARATION FOR FUTURE DESIGNS

MEASUREMENT TECHNIQUES

GAGES, PYRHELIOMETERS (METEO, SUN SHAPE)
REFLECTOMETERS
DUST ANALYSES
RADIOMETERS / TRAVERSES (VISIBLE; IR)
CAMERAS FOR REFLECTED LIGHT/TRAVERSES (VISIBLE; IR)
THERMOCOUPLES (RECEIVER)

OTHER

PLANT POWER STAIR STEP
(EXPERIMENTALLY AND FOR COMPARISON
OPTICAL PART ALSO CALCULATED)

6. OPERATION AND MAINTENANCE

6. OPERATION AND MAINTENANCE (O + M)

6.1 REQUIREMENTS

6.2 STAFFING

6.3 EXPERIENCES

6.4 COSTS

<u>OPERATION</u>

- 7 DAYS WITH 2 SHIFT + OVERNIGHT VIGILANCE
- MAXIMIZATION OF YEARLY ENERGY OUTPUT
- MINIMIZATION OF PLANT OUTAGES
- OPTIONALLY GRID CONNECTION AND STAND ALONE OPERATION
- FLEXIBILITY FOR PARALLEL TESTS AND EXPERIMENTS
- RECCORDING OF O + M COSTS ON SUBSYSTEM LEVEL

<u>MAINTENANCE</u>

- ROUTINE / PREVENTIVE MAINTENANCE
- MAINTENANCE AND REPAIR/MODIFICATION OF MACHINERY AND INSTALLATIONS
- SUPPLY OF ENERGY, WATER, GASES, ETC.
- STORE-HOUSE AND SPARE PART SUPPLY
- COST CONTROL (PERSONNEL AND MATERIALS)
- SUPPORTING MAINTENANCE CONTRACTS

SHIFT PERSONNEL 7 DAYS/WEEK
7:00/15:00; 15:00/23:00; 23:00/7:00

2	SYSTEM ENGINEERS
4	OPERATION DEPUTIES
10	OPERATORS
10	WATCHERS
26	
13	FOR DCS
13	FOR CRS

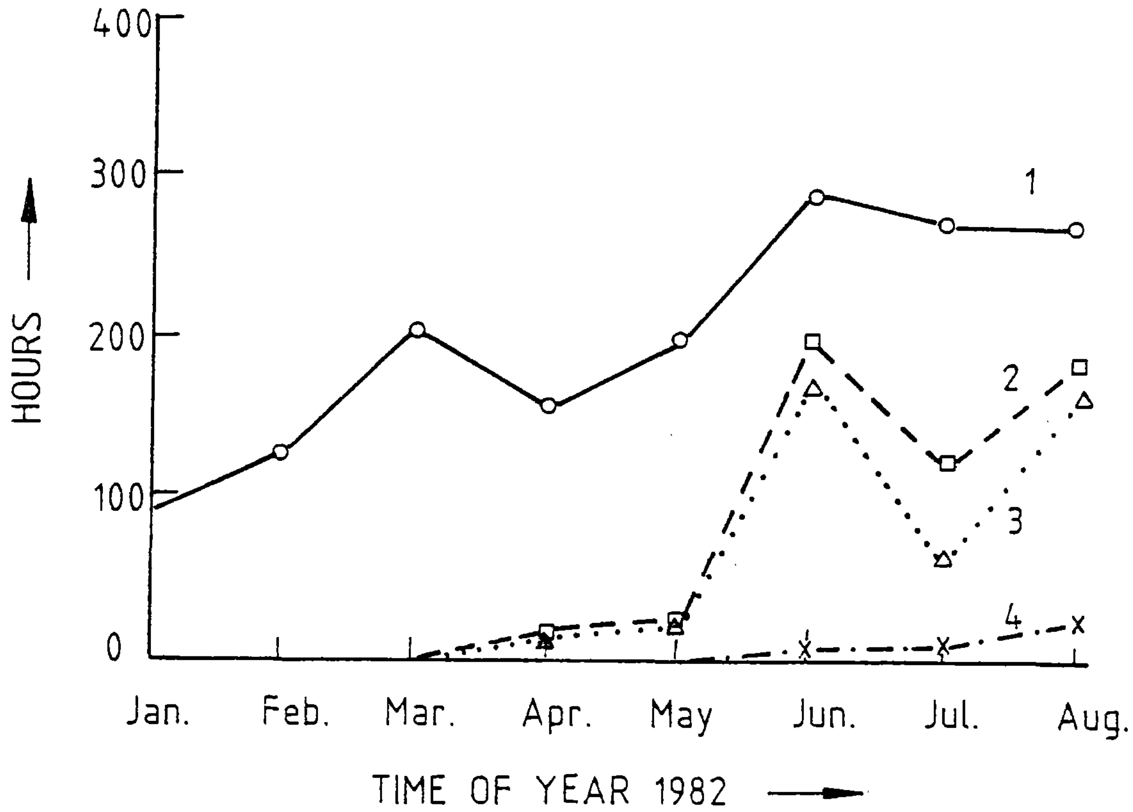
NON SHIFT PERSONNEL 5 DAYS/WEEK
8:30/17:30

1	PLANT OPERATION MANAGER
1	ADMINISTRATOR
1	SECRETARY
1	TELEPHONIST
1	MAINTENANCE SUPERVISOR
8	SPECIALIZED WORKERS
13	(50 % EACH FOR CRS + DCS)

JOB SHARING WITH CESA-1 PLANT (5 DAYS/WEEK)

0.5	SAFETY ENGINEER
0.5	MEDICAL ASSISTANT
0.5	CHEMIST
1.5	(50 % EACH FOR CRS + DCS)

6.2 STAFFING



			H
1	———	HOURS OF INSOLATION 300 W/M^2	1605
2	------	HOURS OF ENERGY COLLECTION	543
3	······	HOURS OF PCS-OPERATION	429
4	-·-·-	HOURS OF ELECTRICITY PRODUCTION	40

GROSS ELECTRIC ENERGY : 11 800 KWH

6.3 EXPERIENCES
OPERATION HOURS
(JAN. TO AUG. 1982)

IEA-SSPS
OPERATING AGENT
DFVLR

SSPS/003/4000

1982	HOURS OPER.*	NON-OPER.	TRACK	STAND-BY	STOW	REASON FOR NON-OPERATION	OUT OF SERVICE (MONTHLY)
JANUARY	106	638	0	52	54	1-SHIFT OPERATION (597) HAC-FAILURE (41)	3
FEBRUARY	442	230	0	115	327	HAC-FAILURE (230)	3
MARCH	718	26	0	265	453	HAC-FAILURE (26)	2
APRIL	592	128	19	206	367	HAC-FAILURE (97) MAINTENANCE (31)	11
MAY	503	241	24	161	318	HAC-FAILURE (216) MAINTENANCE (25)	31
JUNE	709	11	197	270	242	MAINTENANCE (11)	3
JULY	731	13	119	246	366	MAINTENANCE (13)	6
AUGUST	736	8	184	121	431	MAINTENANCE (8)	7
TOTAL	4537	1295	543	1436	2558		-
% of 5832 H	(78 %)		(1 %)	(25 %)	(43 %)		

* MAX. 24 HOURS PER DAY

6.3 EXPERIENCES
HELIOSTAT FIELD OPERATION HOURS
(JAN. TO AUG. 1982)

IEA-SSPS
OPERATING AGENT
DFVLR

TOTAL MAINTENANCE MANHOURS

1982	HFS	SHTS	PCS	ES	DAS	TOTAL
JAN	10.75	-	-	0.25	-	11
FEB	63.50	30	-	8	-	101.5
MAR	29	16.5	1	10	-	56.5
APR	43.50	16	173	-	1	233.5
MAY	169	152	-	40	-	361
JUN	79	28	6	2	2	117
JUL	392	345.5	3	0.5	2	743
AUG	211.5	76	19.5	189	-	496
TOTAL	998.25	664.0	202.5	249.75	5	2119.5

MIRROR WASHING MANHOURS

1982	H F S		A C U R E X		M A N		
MONTH	TIME	MAN-HOUR	TIME	MAN-HOUR	TIME	MAN-HOUR	TOTAL
JAN	-	-	6.75	13.5	7	14	27.5
FEB	13	26	7	14	4	8	48
MAR	19.75	39.5	-	-	-	-	39.5
APR	4.25	8.5	7	14	10.5	21	43.5
MAY	-	-	8	16	-	-	16
JUN	24.5	49	9	18	10.5	21	88
JUL	13.5	27	9.5	19	17.75	35.5	81.5
AUG	35.5	71	9.5	19	10	20	110
TOTAL	110.5	221	56.75	113.5	59.75	119.5	454

6.3 EXPERIENCES
MANHOURS
(JAN. TO AUG. 1982)

IEA-SSPS
OPERATING AGENT
DFVLR

SSPS/003/4000

C O N C E P T	COSTS (DM)
* ADMINISTRATION	9.500
* PERSONNEL	1.007.000
* GENERAL MAINTENANCE	4.500
SPECIAL MAINTENANCE	50.000
* DEVELOPMENT WORKS AND MAINTENANCE OF GENERAL SERVICES	17.200
* ELECTRICITY	82.000
CRS CONSUMABLES	13.500
CRS/HFS SPARES	79.150
CRS/SHTS SPARES	500
CRS/PCS SPARES	—
CRS/ES SPARES	12.000
CRS/DAS SPARES	29.000
CRS DEVELOPMENT WORKS	9.800
	1.314.150

* TOTAL COSTS FOR SSPS PLANTS ONLY 50 % FOR CRS.

7. SUMMARY

SYSTEM OR COMPONENT	PROBLEM	SOLUTION
HELIOSTAT FIELD	- FOCAL LENGTH	11 16 VARIOUS
	- MIRROR ATTACHMENT	RIVETING
	- TRACKING INTERRUPT	NEW HC
	- DUST, SOIL	WASHING
	- COMPUTER MAINTENANCE	STILL OPEN
	- EARTHING, LIGHTNING, DAMAGES, OVERVOLTAGES	STILL OPEN
	- SOLAR MULTIPLE	MORE HELIOSTATS
RECEIVER	- APERTURE FLUX	MEASUREMENTS
	- CONVECTION	SPEC. ACTIVITIES
SODIUM HEAT TRANSFER	- COLD VESSEL LEAKAGE	OPEN
	- VALVE LEAKAGE	REPAIR
	- PUMP	REPAIR AND INCREASED MAINTENANCE
	- BYPASS FOR COLD VESSEL	OPEN
STEAM GENERATOR	NONE	
POWER CONVERSION	- STEAM MOTOR PERFORMANCE	REPLACEMENT BY TURBINE
	- FEED WATER REGENERATION	SUPPLY FROM DCS
ELECTRICAL SYS.	- GRID OVERVOLTAGES	GRID IMPROVEMENT
PLANT	- METEO	NONE
	- DUST	NONE
	- START UP AT 300 W/M^2	WAIT
OPERATION	- LACKING ROUTINE EXPERIENCE	EXTENSION OF STAGE 2
MAINTENANCE	- ONLY ONE SHIFT	OPEN
	- LACKING DOCUMENTATION FOR HFS	OPEN

7. SUMMARY
PROBLEMS AND SOLUTIONS

IEA-SSPS
OPERATING AGENT
DFVLR

SSPS/003/4000

8. FUTURE PLANS

- EXTENSION OF T + 0 PHASE (ORIGINALLY 2 YEARS) FOR
  - INCREASE OF OPERATIONAL EXPERIENCE AND DEVELOPMENT AND OPTIMIZATION OF OPERATIONAL STRATEGIES
  - COMPLETION OF DATA EVALUATION
  - EXPLORATION OF OPERATIONAL LIMITS FOR SODIUM AS HEAT TRANSFER MEDIUM
  - IMPROVEMENTS OF HARDWARE (STORAGE VESSEL; PRIME MOVER)
  - CONTINUATION OF MEASUREMENT CAMPAIGNS

- ADDITION OF HELIOSTATS FOR BETTER OPERATIONAL FLEXIBILITY (SOLAR MULTIPLE FROM 1.1 TO 1.6)

- TESTING OF HIGH FLUX SODIUM RECEIVER

- EXCHANGE OF EXPERIENCE AND DATA IN PARTICULAR WITH RESPECT TO HITEC APPLICATION AT RECEIVER, STORAGE, STEAM GENERATOR