GL008666

M-X/RES PROJECT BRIEFINGS

23-24 SEPTEMBER 1980

M-X/RES PROJECT BRIEFINGS/DISCUSSIONS

TUESDAY, 23 SEPTEMBER 1980

0900 Hours - Insolation and Wind Resources Assessment Briefing

1300 Hours - Geothermal Briefing and Discussions

1500 Hours - M-X/RES Data Base Content/Schedule Discussions

WEDNESDAY, 24 SEPTEMBER 1980

0900 Hours - Evaluation Criteria and Methodology Briefing

1430 Hours - Storage Discussions

THRUSDAY, 25 SEPTEMBER 1980

0900 Hours - Project Office Briefing

1430 Hours - General Discussions

- Systems Integration Contract Draft
- Proposal Evaluation Criteria
- System Development Contracts Schedule of Events
- Development Hardware

M-X/RES INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

BRIEFING TO M-X/RES PROJECT OFFICE

ON

23 SEPTEMBER 1980

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

BRIEFING FORMAT

• INTRODUCTORY COMMENTS	AEROSPACE
• PROGRAM OVERVIEW	AEROSPACE
• INSOLATION ASSESSMENT	SERI
• WIND ASSESSMENT	PNL
• MEASUREMENT STATIONS	PNL
• SUMMARY	AEROSPACE

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

ACCOMPLISHMENTS TO DATE

- ESTABLISHED JOINT INSOLATION AND WIND PROGRAM
  - o MANAGEMENT PLAN
    - OBJECTIVES
    - ROLES AND RESPONSIBILITIES
    - POINTS OF CONTACT
    - SCHEDULES
  - o FY80 and FY81 FUNDING
- DEFINED METEOROLOGICAL STATIONS
  - o CONFIGURATIONS
    - RATIONALE
    - COST ESTIMATES
    - DATA RECOVERY/ANALYSIS
  - o DEPLOYMENT
  - o SCHEDULES
  - o RFP PREPARATION
- ESTABLISHED PLAN FOR MEASUREMENT SITES CLEARANCES/PERMITS
- PNL AND SERI AGREED TO CONTINUE SUPPORT OF M-X/RES DATA BASE PREPARATION

BENEFITS OF AN M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

- CORRELATION OF INSOLATION AND WIND MEASUREMENTS FACILITATED
- COMMON DATA FORMAT AND PROCESSING YIELDS IMPROVED ACCURACY
- QUANTITY BUYS OF EQUIPMENT AT REDUCED UNIT COST
- DUPLICATE MEASUREMENT STATION INSTALLATION, MAINTENANCE, AND OPERATING COSTS ELIMINATED
- DUPLICATE TM GROUND STATIONS, DATA PROCESSING AND SECURITY SYSTEMS ELIMINATED
- FEWER CONTRACTS - LESS LIKELIHOOD OF A PROCUREMENT DELAY

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

OBJECTIVES

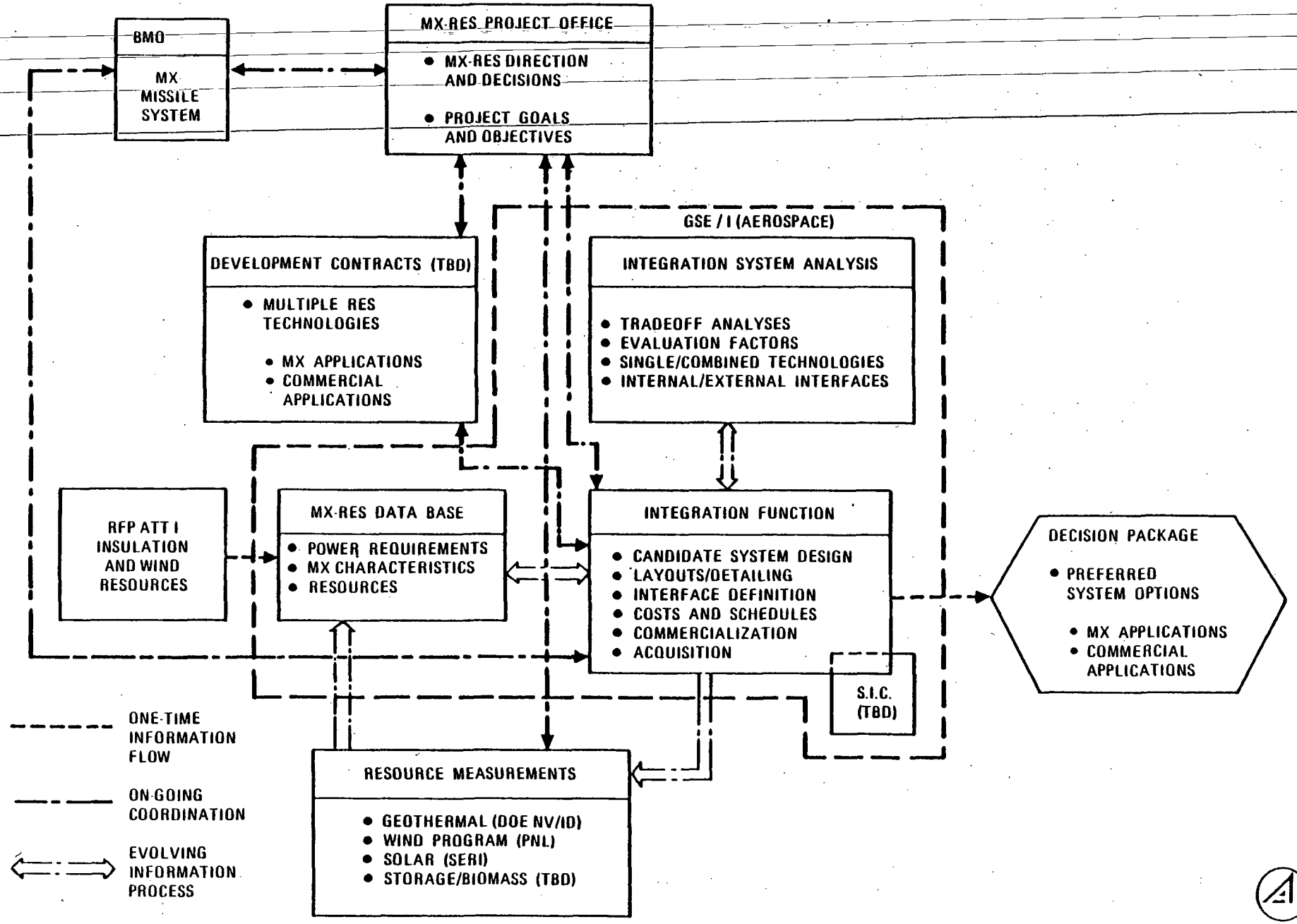
- CHARACTERIZE INSOLATION AND WIND RESOURCES IN THE M-X DEPLOYMENT REGION
  - o SUPPORT RES DESIGN EFFORTS
  - o ENHANCE COMMERCIALIZATION IN REGION
- DETERMINE THE VIABILITY OF WIND AS A POWER SOURCE FOR THE INTEGRATED M-X RENEWABLE ENERGY SYSTEM

MEASUREMENT ACTIVITIES

- FOCUS ACTIVITIES TO DETERMINE THE
  - o EXTENT OF INSOLATION AND WIND RESOURCES IN THE NEVADA/UTAH AREA
  - o TEMPORAL (DIURNAL, SEASONAL) AND SPATIAL (SITE-TO-SITE) VARIABILITY
  - o CORRELATION OF INSOLATION AND WIND RESOURCES MEASUREMENTS
  - o LOCATION OF POTENTIAL SITES FOR WECS APPLICATION
- SCHEDULE
  - o PHASE A - JULY 1980 TO JUNE 1982 (DECISION PACKAGE DATE)
  - o PHASE B - JULY 1982 TO 1 OCTOBER 1983
  - o PHASE C - TBD

MX-RES Roles and Responsibilities

INTEGRATION RELATIONSHIPS



PACIFIC NORTHWEST LABORATORY'S

ROLE AND RESPONSIBILITIES

- PROCUREMENT, INSTALLATION, OPERATION, AND MAINTENANCE OF ALL METEOROLOGICAL STATIONS, EXCEPT FOR INSOLATION INSTRUMENTATION

- COLLECTING/TRANSMITTING, EDITING AND REPORTING DATA FROM ALL STATIONS

- ASSESSMENT AND **INTERPRETATION OF ALL WIND RESOURCE DATA**

- SITING OF THE TYPE I AND IIa STATIONS (SERI COORDINATION)

SOLAR ENERGY RESEARCH INSTITUTE'S

ROLE AND RESPONSIBILITIES

- PROCUREMENT OF PYRANOMETERS AND THEIR MOUNTINGS FOR ALL STATIONS
- PROCUREMENT, INSTALLATION, AND MAINTENANCE OF THE TRACKING PYRHELIOMETERS AND CIRCUMSOLAR TELESCOPE
- ASSESSMENT AND INTERPRETATION OF ALL INSOLATION RESOURCE DATA
- SITING OF THE TYPE IIb, III AND IV STATIONS (PNL COORDINATION)

M-X/RES JOINT INSOLATION AND WINDS RESOURCES ASSESSMENT PROGRAM

KEY POINTS OF CONTACT

- PACIFIC NORTHWEST LABORATORY

  PRIMARY CONTACT: W. R. BARCHET (509) 376-4621
  ALTERNATE CONTACT: WILLIAM CLIFF (SITE SELECTION) (509) 375-2024
  PHILIP EKSTROM (MEASUREMENT PROGRAM) (509) 376-7301

- SOLAR ENERGY RESEARCH INSTITUTE

  PRIMARY CONTACT: ROLAND HULSTROM (303) 231-1220
  ALTERNATE CONTACT: ROBERT RADER (303) 231-1815

- THE AEROSPACE CORPORATION

  PRIMARY CONTACT: CHARLES HOULT (213) 648-7366
  ALTERNATE CONTACT: FRANK AUGUSTINE (WINDS) (213) 648-5331
  CHARLES RANDALL (INSOLATION) (213) 648-5997

- FUGRO NATIONAL, INC.

  PRIMARY CONTACT: JAMES R. MILLER (213) 595-6611
  ALTERNATE CONTACT: KENNETH L. WILSON (213) 595-6611

MX/RES JOINT INSOLATION AND WIND RESOURCE ASSESSMENT PROGRAM

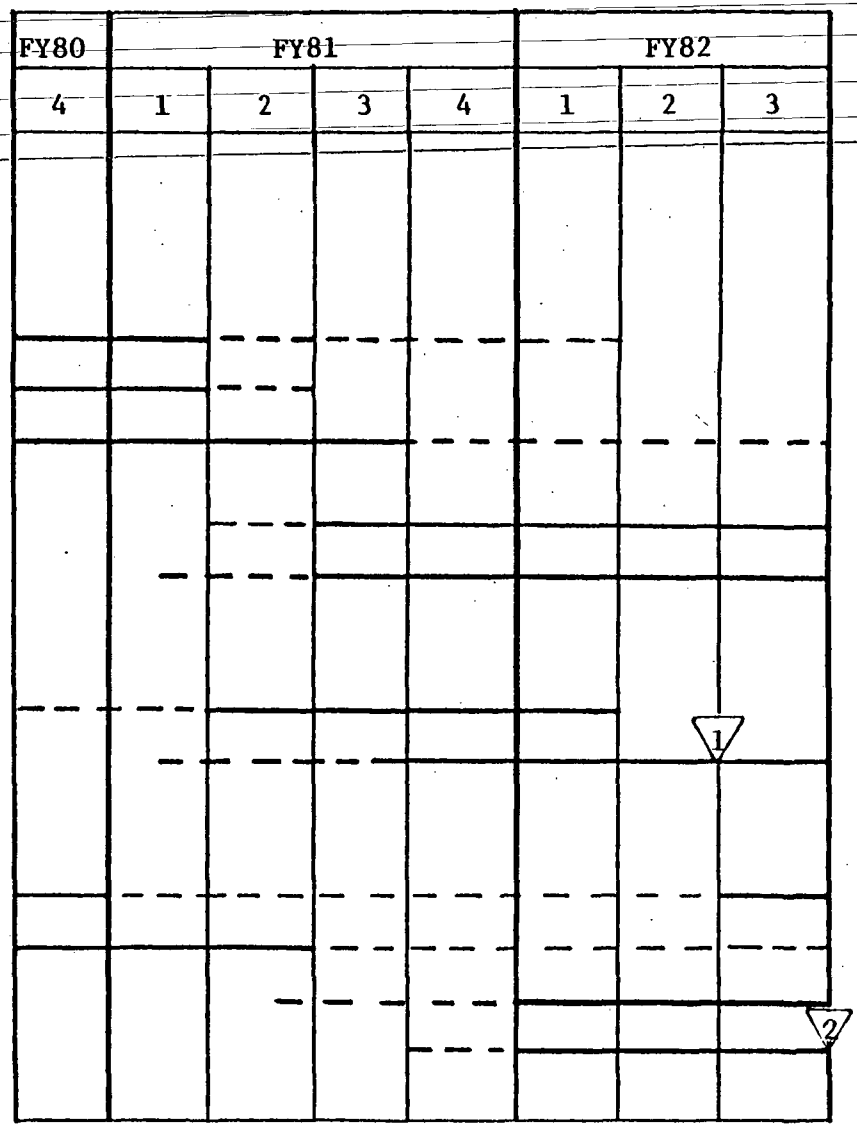
SCHEDULE

RESOURCES ASSESSMENT TASKS (PNL AND SERI)

- MEASUREMENT ACTIVITIES
  - o SITE SELECTION
  - o MEASUREMENT SYSTEM DEFINITION
  - o EQUIPMENT PROCUREMENT, INSTALLATION AND CALIBRATION
  - o MEASUREMENTS AND DATA GATHERING
  - o DATA PROCESSING, EDITING AND REPORTING
- ANALYSES ACTIVITIES
  - o HISTORICAL DATA
  - o POST-MEASUREMENT

SYSTEMS INTEGRATION ACTIVITY (AEROSPACE)

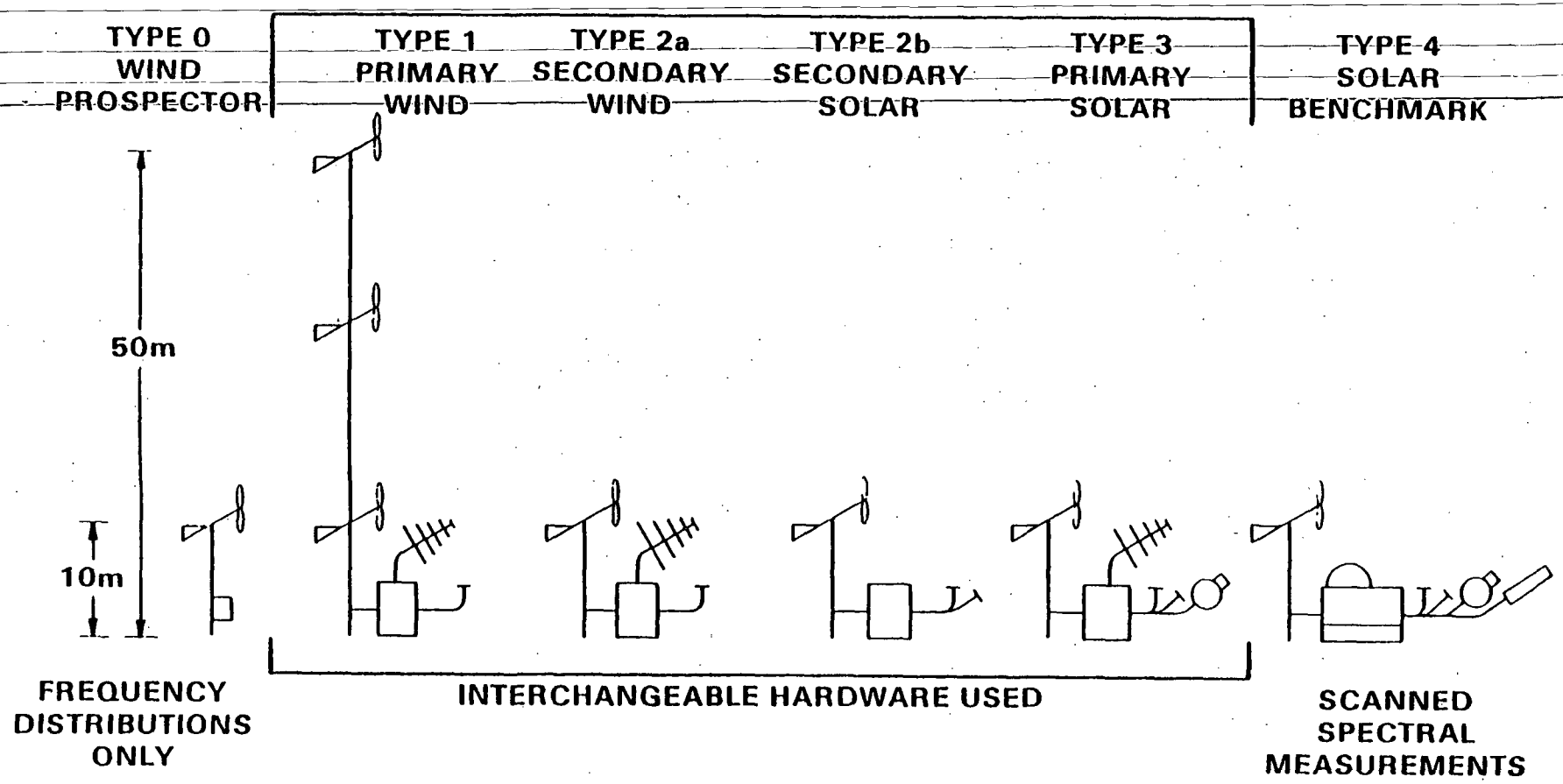
- RESOURCE REQUIREMENTS DEFINITION
- INTERACTION WITH RESOURCES ASSESSMENT AGENCIES
- APPLICATION ANALYSES
- INTEGRATED RES ANALYSES



1 INPUTS TO DECISION PACKAGE

2 DECISION PACKAGE

MEASUREMENT STATIONS



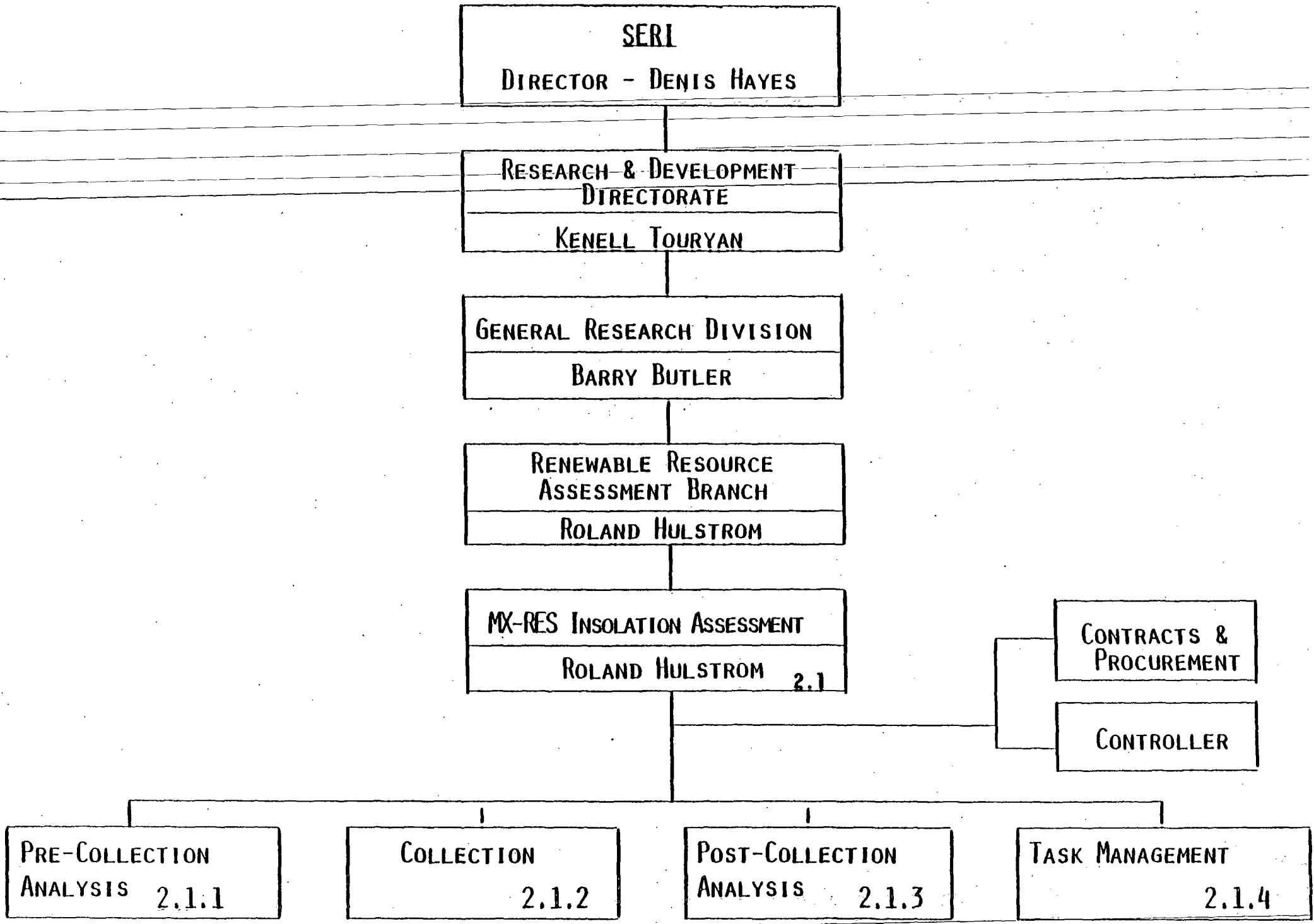
PHASE A WIND DATA NEEDS TO MEET PROGRAM OBJECTIVES

OBJECTIVE	DATA NEEDED	STATION TYPES MEETING NEED					
		0	I	IIa	IIb	III	IV
• WECS SITE SELECTION	o Cumulative Wind Speed Distribution Function	X	X	X	X	X	X
	o Wind Rose	X	X	X	X	X	X
	o Temperature (synoptic climatology)		X	X	X	X	X
	o Global Insolation (Synoptic climatology)		X	X	X	X	X
• WECS SELECTION	o Cumulative Wind Speed Distribution Function	X	X	X	X	X	X
	o Wind Speed vs Height		X				
• DEFINITION OF OPERATING ENVIRONMENT	o Icing		X			X	X
	o Temperature	X	X	X	X	X	X
	o Humidity		X			X	X
• INTEGRATION OF WECS INTO SYSTEM	o Diurnal Wind Speed and Direction Variation		X	X	X	X	X
	o Monthly/Seasonal Wind Speed Variation		X	X	X	X	X
	o Correlation of Wind Speed with Other Sites and Modes		X	X	X	X	X
	o Duration of Calms		X	X	X	X	X

PHASE A INSOLATION DATA NEEDS TO MEET PROGRAM OBJECTIVES

OBJECTIVE	DATA NEEDED	STATION TYPES MEETING NEED					
		0	I	IIa	IIb	III	IV
• FLAT PLATE PHOTOVOLTAIC SYSTEM SELECTION	o Horizontal Global Insolation		X	X	X	X	X
	o Tilted Surface Insolation				X	X	X
	o Spectral Data & Solar Aureole						X
• CONCENTRATING PHOTO-VOLTAIC SYSTEM SELECTION	o Horizontal Global Insolation		X	X	X	X	X
	o Tilted Surface Insolation				X	X	X
	o Direct Insolation					X	X
	o Spectral Data & Solar Aureole						X
• SOLAR THERMAL SYSTEM SELECTION	o Horizontal Global Insolation		X	X	X	X	X
	o Tilted Surface Insolation				X	X	X
	o Direct Insolation					X	X
	o Spectral Data and Solar Aureole						X
	o Wind Speed	X	X	X	X	X	X
	o Temperature	X	X	X	X	X	X
• SOLAR HEATING AND COOLING OF BUILDINGS	o Horizontal Global Insolation		X	X	X	X	X
	o Tilted Surface Insolation				X	X	X
	o Wind Speed	X	X	X	X	X	X
	o Temperature	X	X	X	X	X	X
	o Humidity		X			X	X
• DEFINITION OF OPERATING ENVIRONMENT	o Icing		X			X	X
	o Temperature	X	X	X	X	X	X
	o Humidity		X			X	X
• INTEGRATION OF SOLAR DEVICES INTO SYSTEM	o Seasonal Variations		X	X	X	X	X
	o Correlation of Insolation with Other Sites & Modes		X	X	X	X	X
	o Duration of Sunny Periods		X	X	X	X	X

M-X/RES INSOLATION RESOURCE ASSESSMENT PROJECT MANAGEMENT



OBJECTIVES OF M-X/RES INSOLATION RESOURCE MEASUREMENTS

- OBTAIN DATA TO DETERMINE THE AMOUNT OF SOLAR ENERGY FOR USE BY M-X/RES
  - o EVALUATE BASELINE INSOLATION DATA ASSUMPTIONS
  - o DETERMINE VARIABILITY OVER THE M-X DEPLOYMENT REGION
  - o ASSESS INSOLATION-WIND CORRELATIONS
  - o PROVIDE DESIGN DATA TO SUPPORT SYSTEM DESIGN
- ADVANCE THE STATE-OF-THE-ART OF
  - o TILTED SURFACE ALGORITHMS
  - o AUTOMATIC DIRECT INSOLATION MEASUREMENT
  - o INSOLATION DATA BASE

SERI M-X/RES INSOLATION RESOURCE ASSESSMENT PROJECT

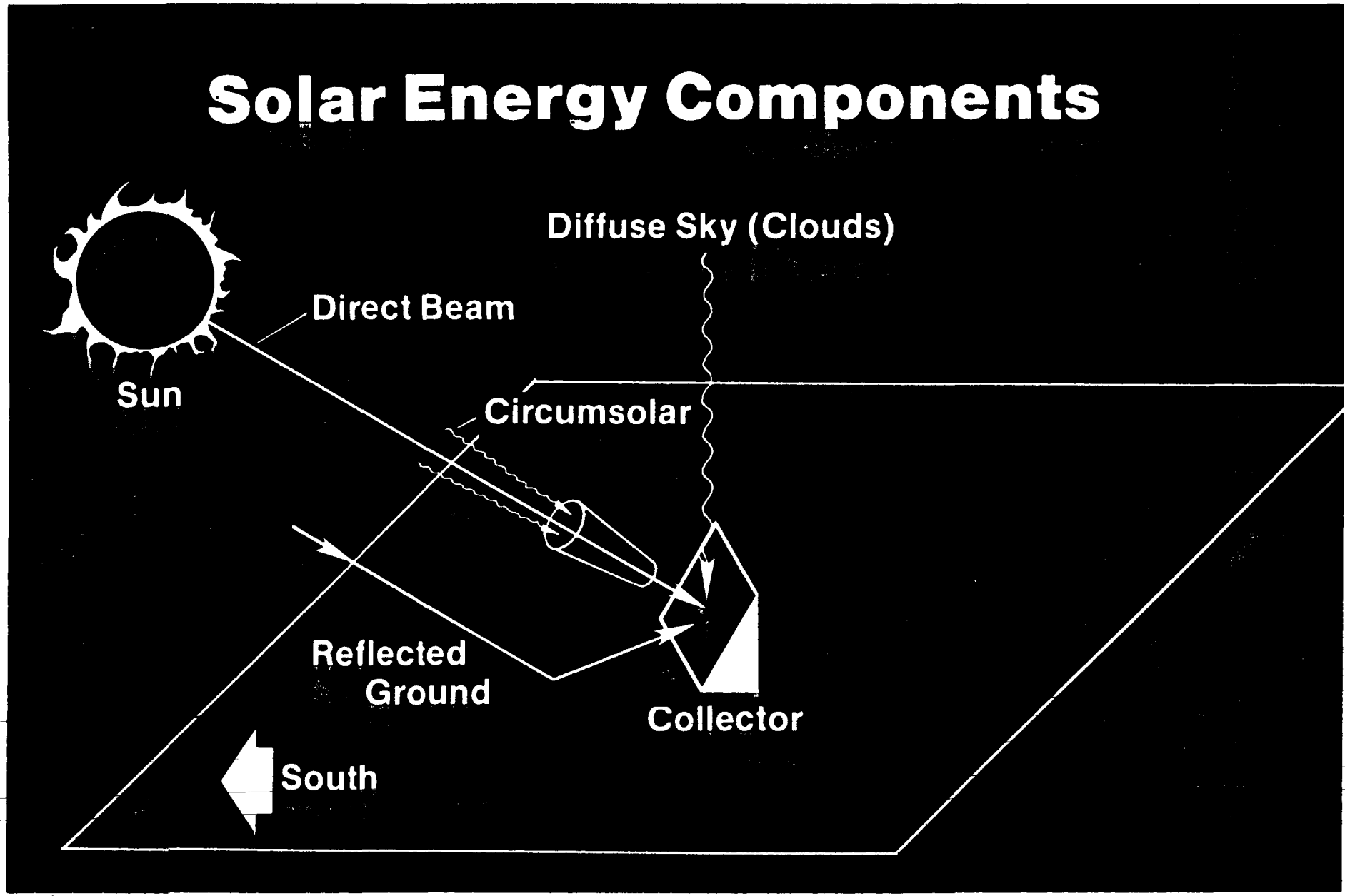
- MANAGEMENT SCHEDULE - MILESTONES: FY80

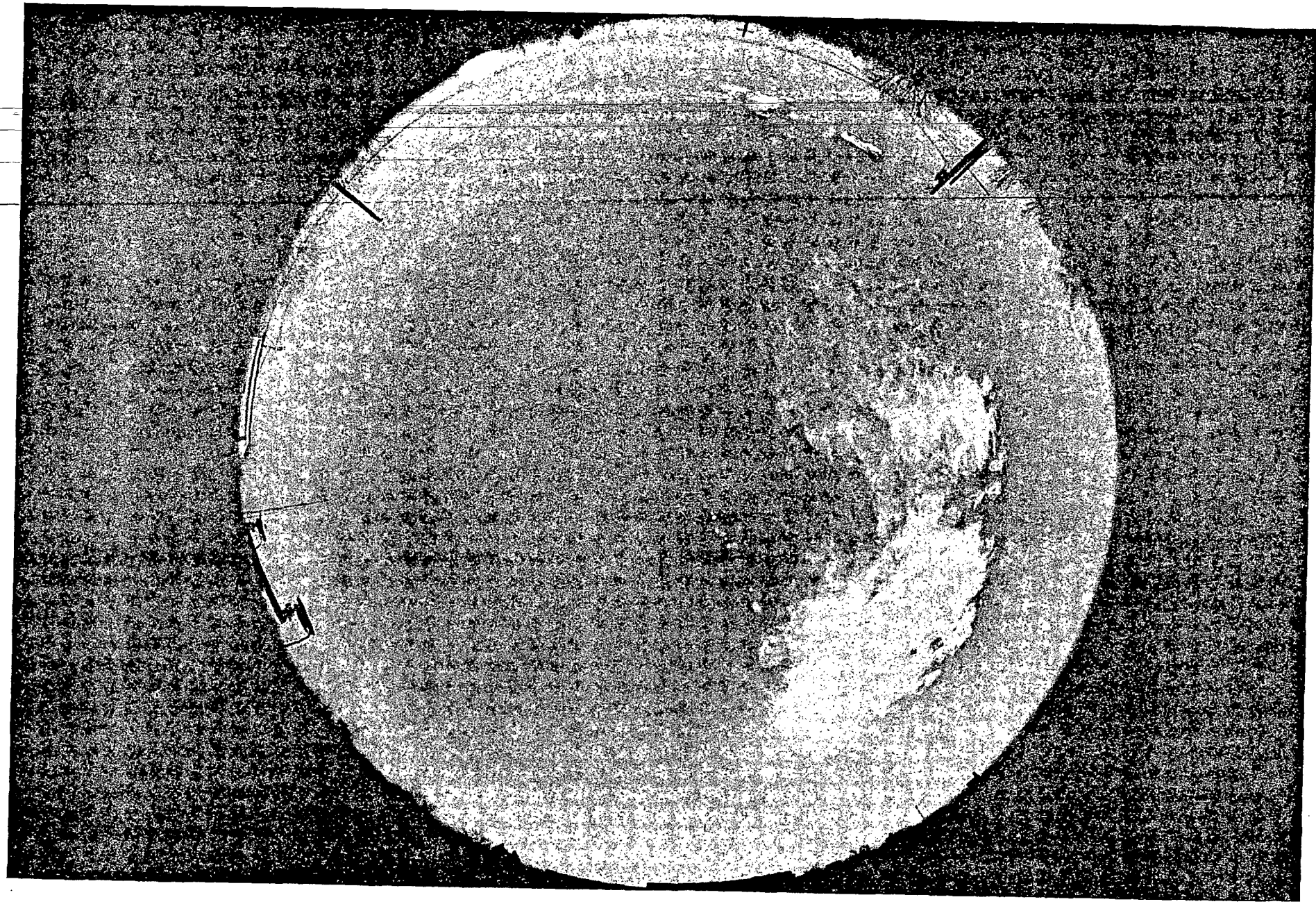
	ITEM	DATE
1.	HULSTROM-TO-HAYES MEMO-MX REQUEST FOR SERI INVOLVEMENT	JANUARY 31, 1980
2.	DOWTY (HAYES, SERI POLICY COUNCIL)-TO-HULSTROM MEMO-APPROVAL OF MX INVOLVEMENT	MARCH 19, 1980
3.	FY80 PROJECT PLAN SUBMITTED TO PROJECT OFFICE	JULY 8, 1980
4.	FY80 WPA SUBMITTED TO PROJECT OFFICE	JULY 11, 1980
5.	PROJECT OFFICE APPROVAL (UNOFFICIAL) OF FY80 WPA, AT $50,000	JULY 15, 1980
6.	1ST AREOSPACE/SERI MEETING (AT SERI)	JULY 23, 1980
7.	1ST AEROSPACE/SERI/PNL MEETING (AT AEROSPACE)	AUGUST 6-7, 1980
8.	REVISED PROJECT OFFICE APPROVAL (OFFICIAL) OF SERI WPA, AT $50,000	AUGUST 12, 1980
9.	PROJECT OFFICE EXTENSION OF SERI WPA TO $75,000 AND DECEMBER 31, 1980. FY81 GUIDANCE OF $500,000 FOR DECEMBER 31, 1980 TO SEPTEMBER 30, 1981	AUGUST 13, 1980

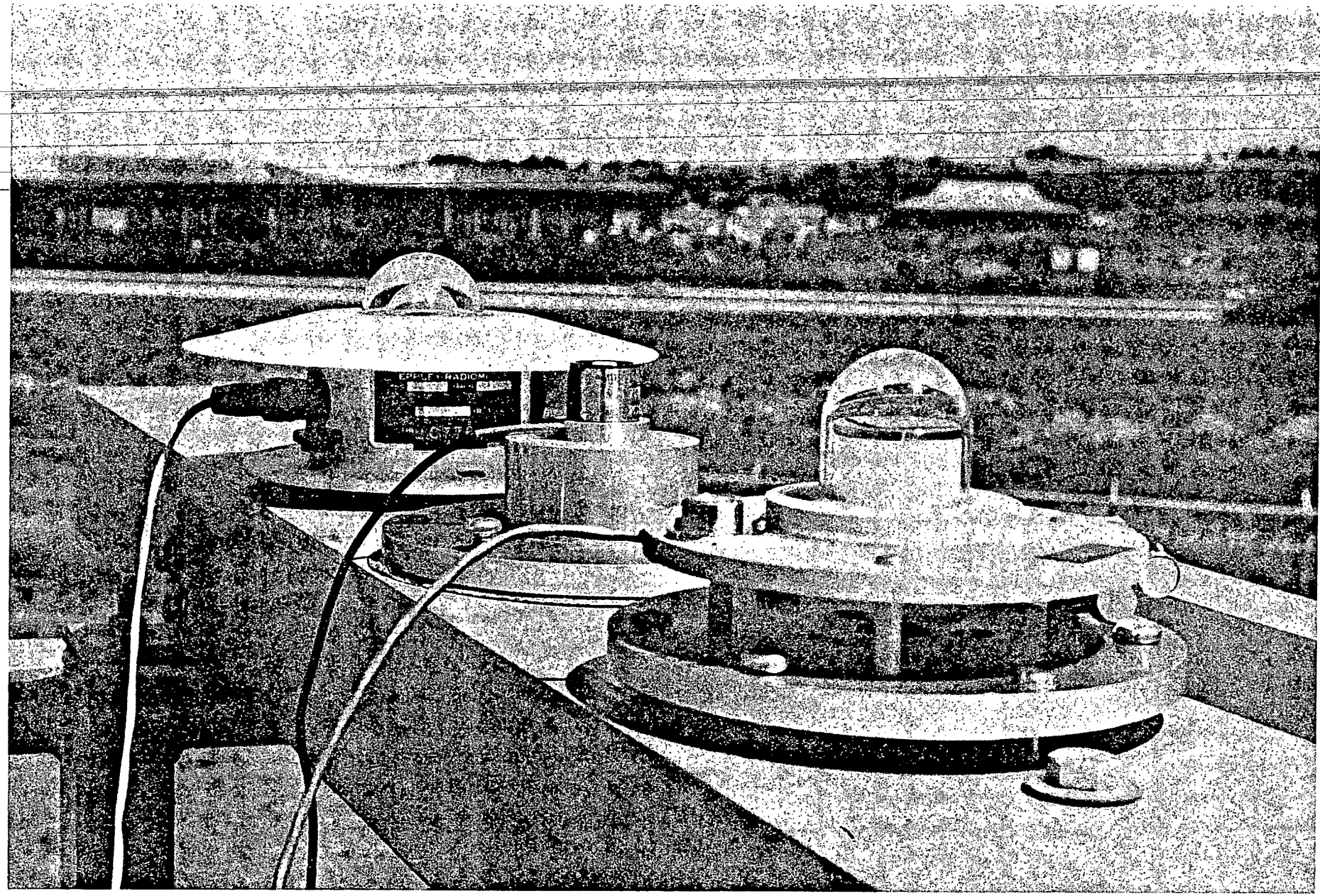
SERI M-X/RES INSOLATION RESOURCE ASSESSMENT PROJECT

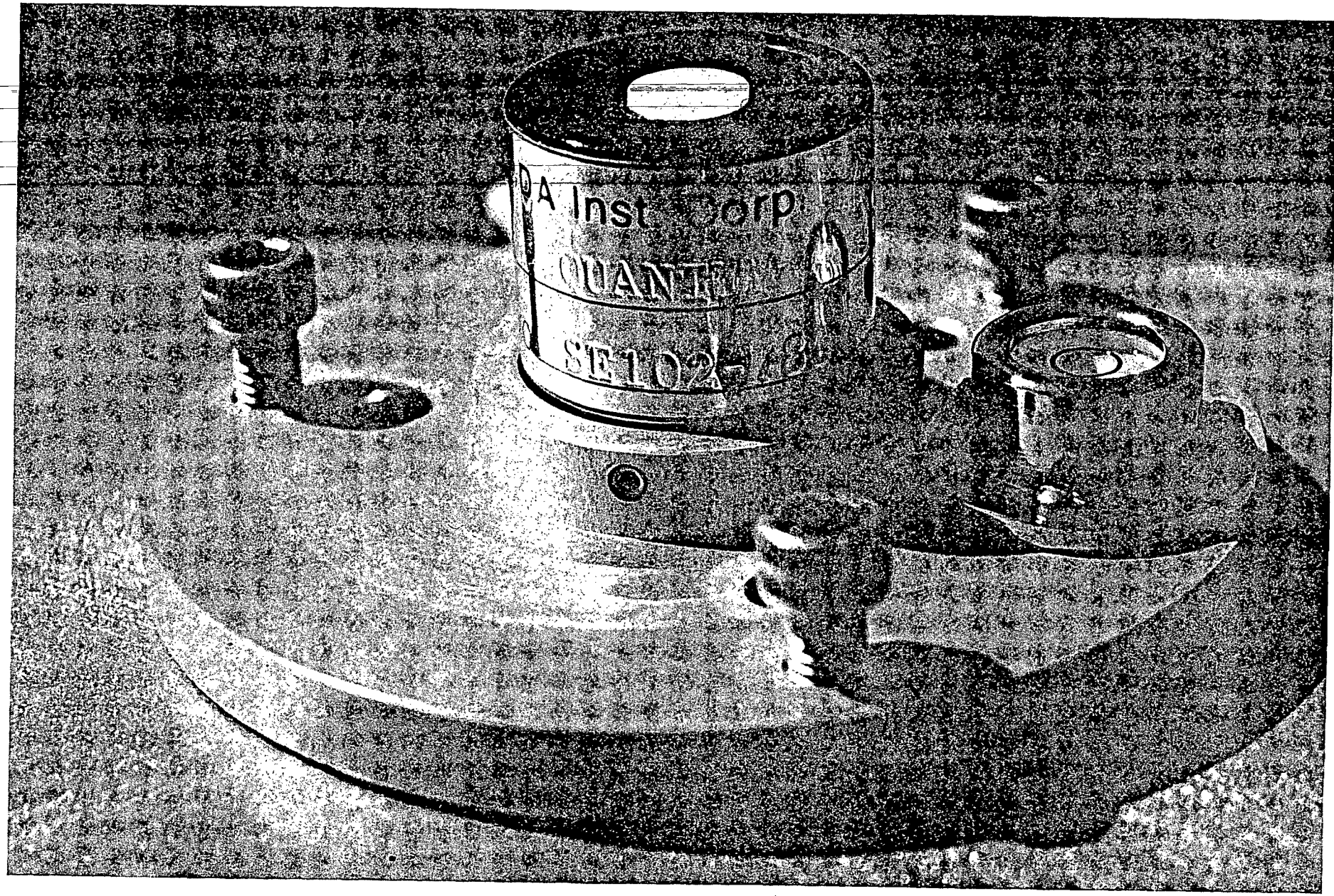
- MANAGEMENT SCHEDULE - MILESTONES: FY80 (CONTINUED)

	ITEM	DATE
10.	2ND AEROSPACE/SERI/PNL MEETING (AT SERI)	AUGUST 28, 1980
11.	DOE SITE OFFICE-SERI OFFICIAL TURN-ON OF TASK NUMBER/CHARGES	SEPTEMBER 3, 1980 (ORIGINALLY ANTICIPATED 7/25/80)
12.	M-X/RES INSOLATION RESOURCE ASSESSMENT FY80/FY81 PROJECT SCHEDULE	SEPTEMBER 10, 1980
13.	3RD AEROSPACE/SERI/PNL MEETING (AT AEROSPACE)	SEPTEMBER 11, 1980
14.	1ST PROJECT OFFICE/SERI/AEROSPACE/PNL PROGRAM REVIEW, AT WASHINGTON, DC	SEPTEMBER 23, 1980
15.	FY81 PROJECT PLAN W.P.A. TO PROJECT OFFICE	SEPTEMBER 30, 1980 (ORIGINAL-WPA-9/15/80)


Solar Energy Components
Diffuse Sky (Clouds)
Direct Beam
Sun
Circumsolar
Reflected
Ground
Collector
South



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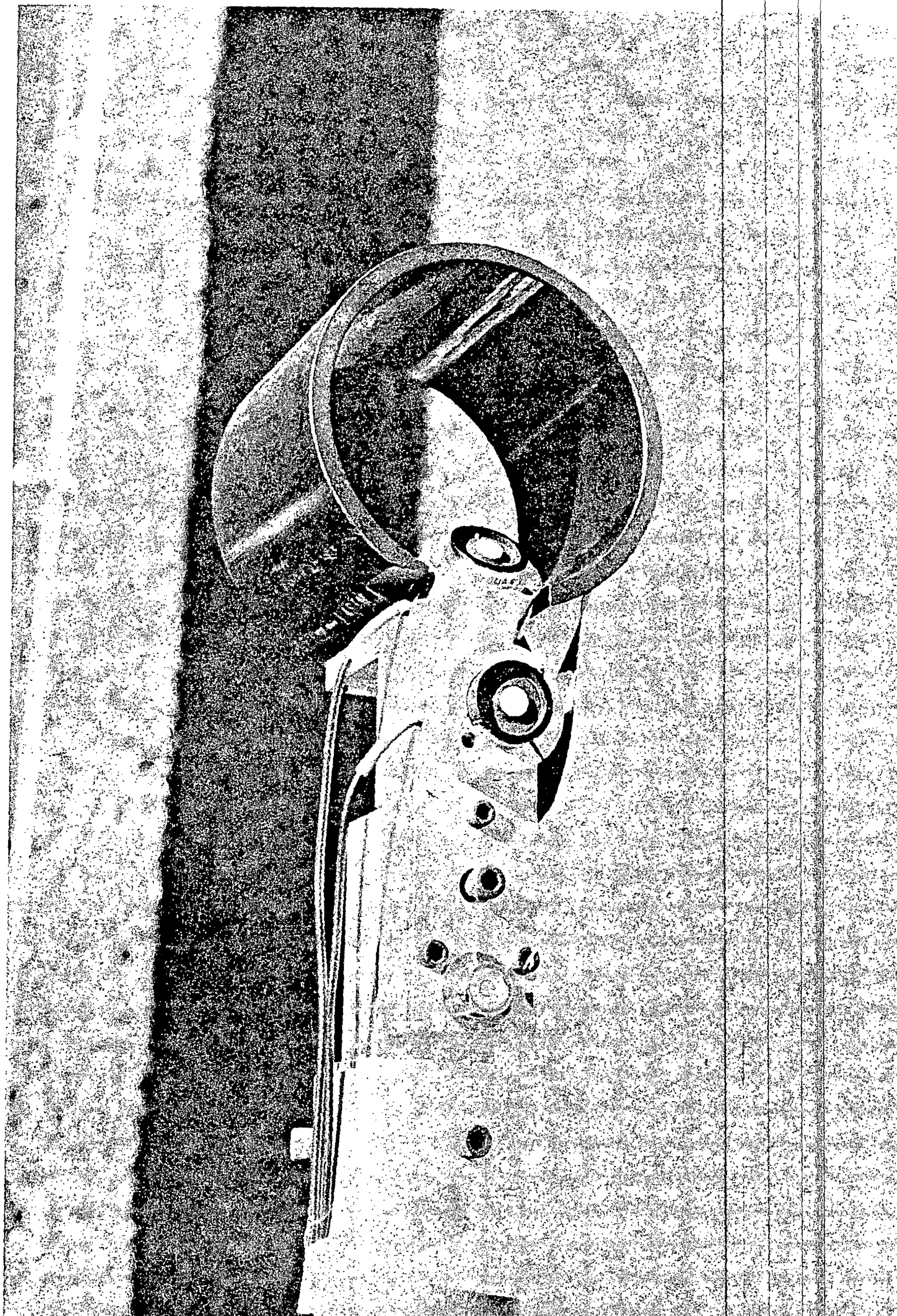
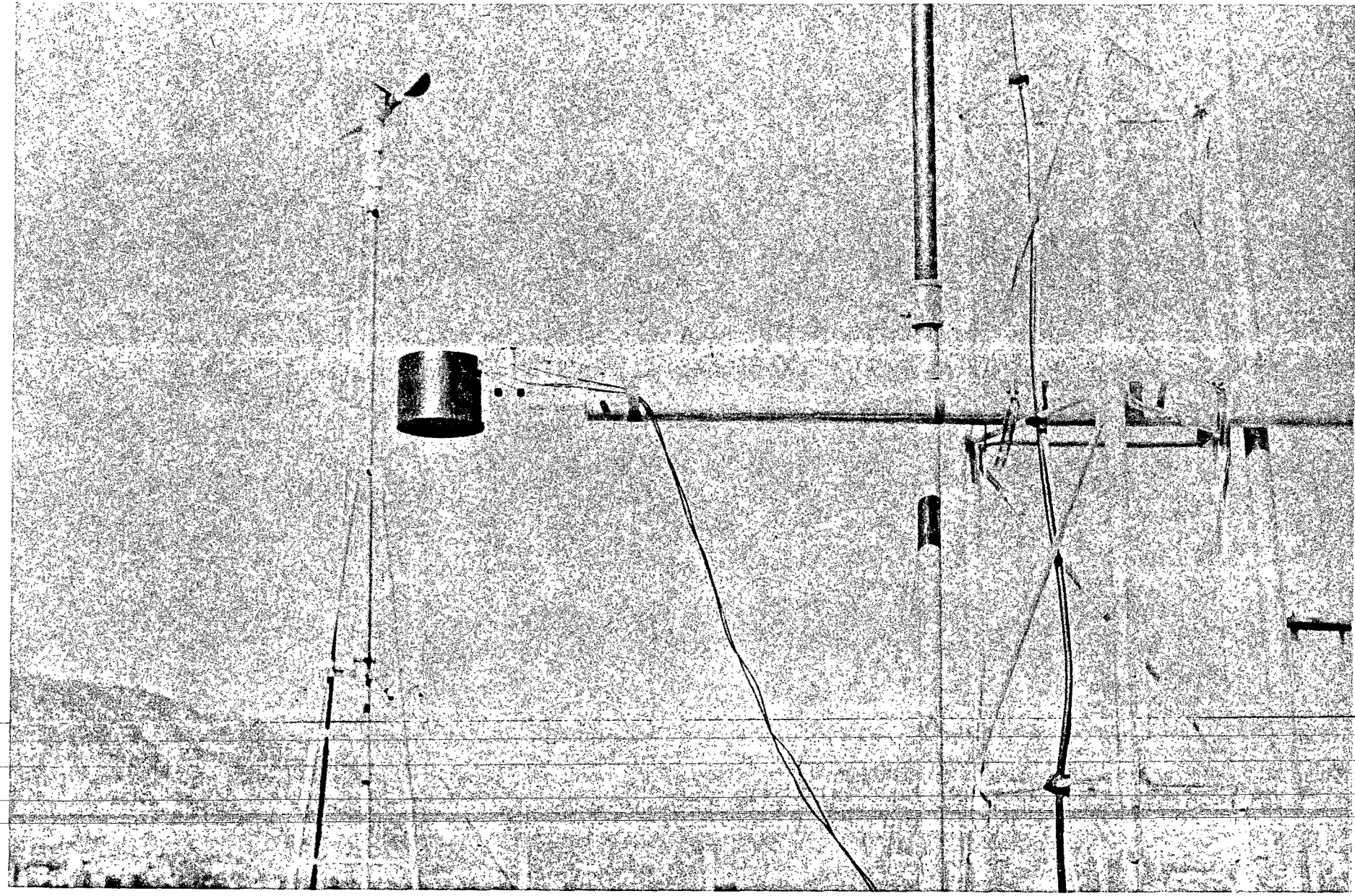
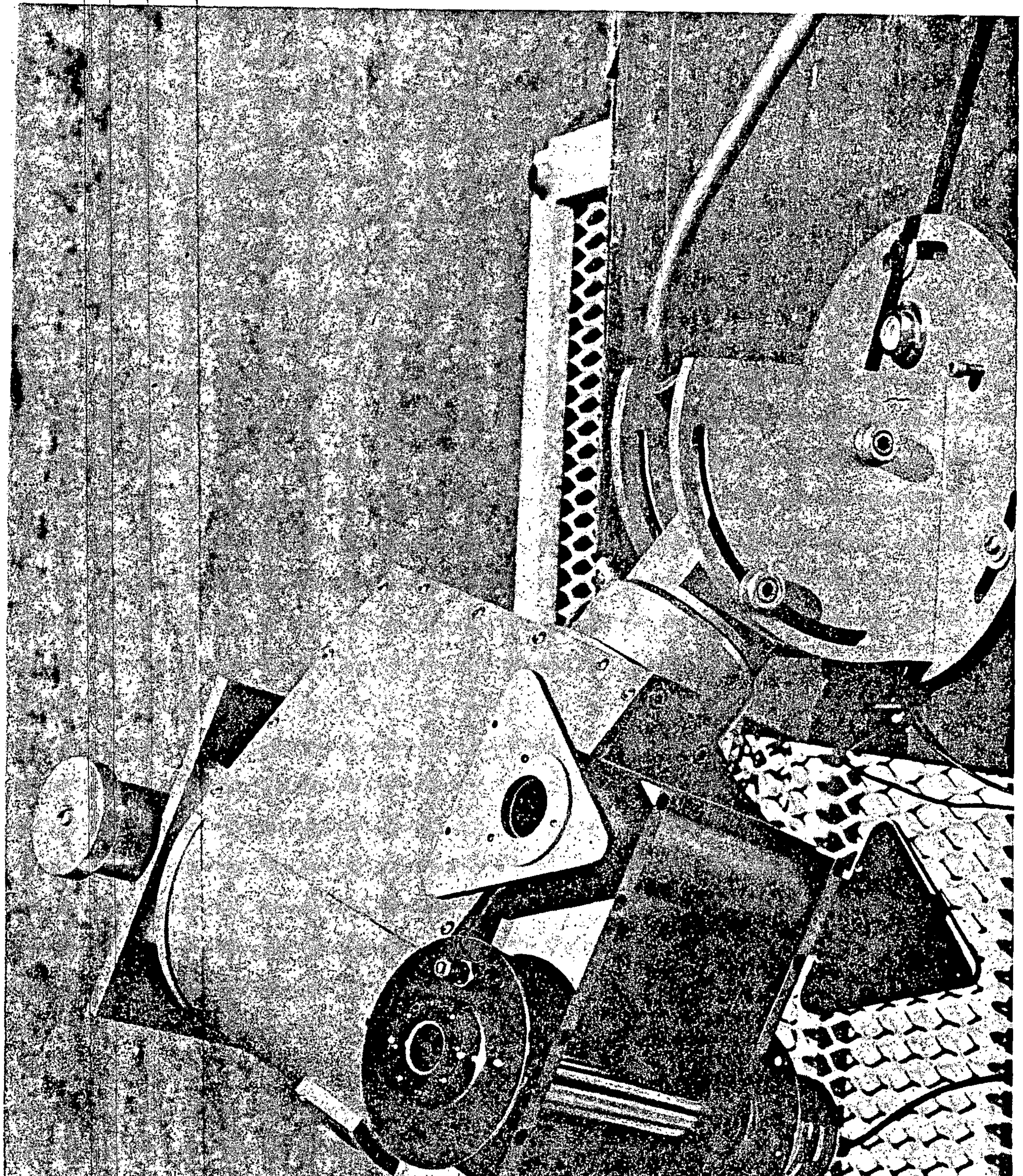
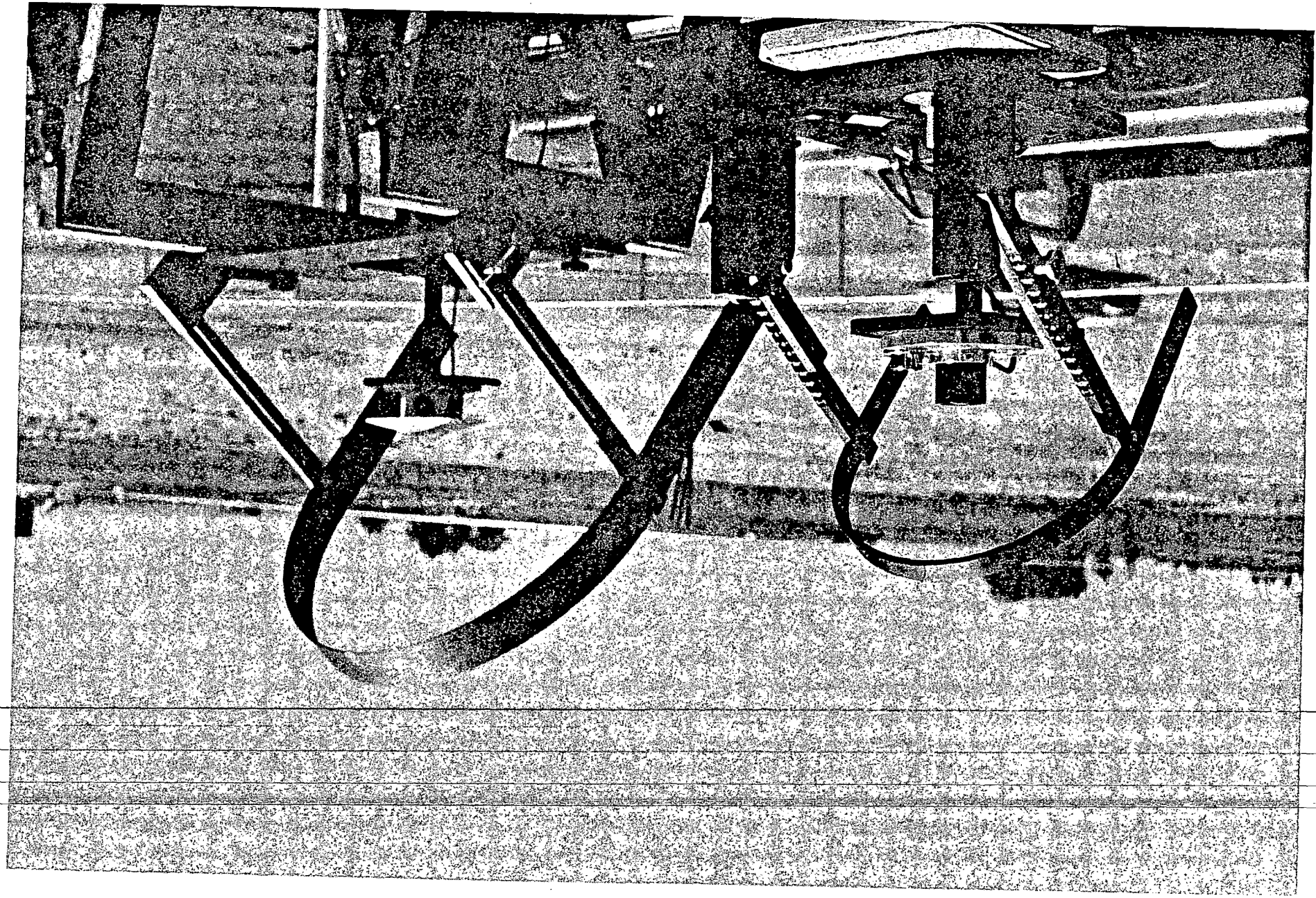
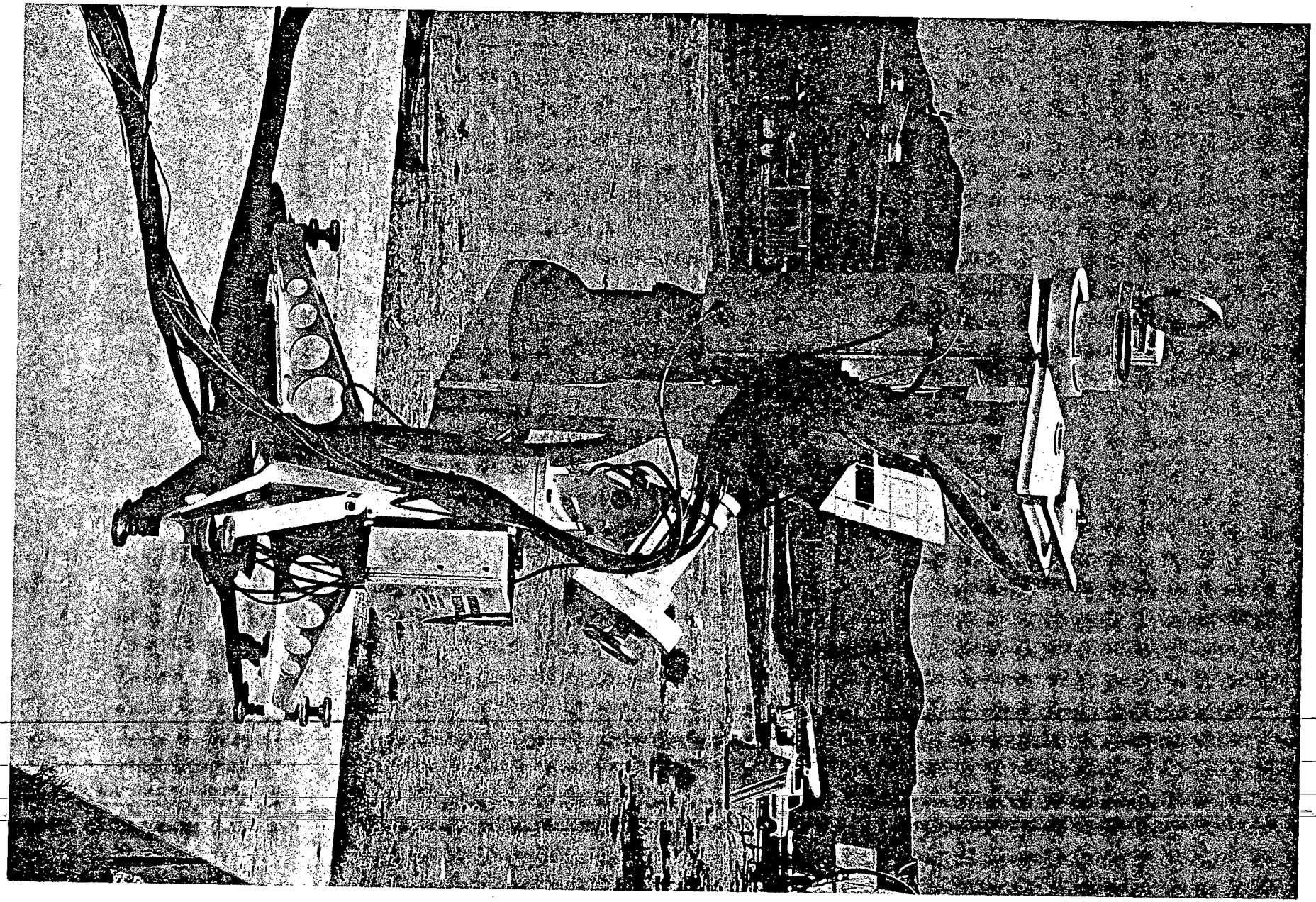
SF102-18











INSOLATION MEASUREMENTS AND SITING - IDEAL

- PURPOSE
  - o TOTALLY CHARACTERIZE ALL INSOLATION COMPONENTS (DIRECT, GLOBAL, DIFFUSE), PERTINENT TO RESOURCE ASSESSMENT AND SYSTEM DESIGN, ON A TEMPORAL AND SPATIAL BASIS SUCH THAT ALL VARIATIONS ARE ESTABLISHED.

- TYPES OF MEASUREMENTS
  - o DETERMINED BY SOLAR CONVERSION METHODS/SYSTEMS USED
    - CONCENTRATORS - DIRECT BEAM AND CIRCUMSOLAR
    - FLAT PLATE - GLOBAL (DIRECT & DIFFUSE) ON TILTED SURFACES
    - PASSIVE - GLOBAL ON VERTICAL WALLS
    - PHOTOVOLTAIC - SPECTRAL DATA FOR DIRECT, CIRCUMSOLAR, DIFFUSE, AND GLOBAL ON TILTED SURFACES.

- TEMPORAL
  - o DETERMINED BY SOLAR CONVERSION METHODS/SYSTEMS USED AND CHARACTERISITC CLIMATE OF SPECIFIC GEOGRAPHICAL AREA OF INTEREST
    - SYSTEM TRANSIENTS (CLOUDS) - 1 MINUTE (OR LESS)
    - ASSESSMENT OF POWER ABOVE THRESHOLDS - 5 MINUTES (OR LESS)
    - DIURNAL VARIATIONS, LOAD - 1 HOUR (OR LESS)
      (MATCHING, STORAGE, COLLECTOR ORIENTATION, SYSTEM SIZING AND DETAILED DESIGN)

INSOLATION MEASUREMENTS AND SITING - IDEAL (CONTINUED)

- WEATHER (CLEAR DAYS, CLOUDY DAYS) PERSISTENCE, - DAILY (STORAGE, LOAD MATCHING, SPATIAL VARIATIONS)
- SEASONAL VARIATIONS - MONTHLY, YEARLY (1 YEAR MINIMUM, 5 YEARS NOMINAL)
- CLIMATIC VARIATIONS - 30 YEARS OR LONGER (TYPICAL DESIGN YEAR)

- SPATIAL
  - DETERMINED BY SIZE OF GEOGRAPHICAL AREA OF INTEREST AND METEOROLOGICAL VARIATIONS WITHIN THAT AREA
    - MICROSCALE: (MINIMAL CLOUD COVER AND INSOLATION VARIATION)
      - . HORIZONTAL - 100 METERS OR LESS
      - . VERTICAL - LESS THAN 10 METERS
      - . TIME - .5 TO 5 MINUTES
    - *MESOSCALE: (SIGNIFICANT CLOUD COVER AND INSOLATION VARIATIONS)
      - . HORIZONTAL - 10 TO 100 KM
      - . VERTICAL - 1 TO 10 KM
      - . TIME - 1 TO 10 HOURS
    - *MACROSCALE: (SYNOPTIC PERTURBATIONS)
      - . HORIZONTAL - 500 TO 2,000 KM
      - . VERTICAL - 10 KM
      - . TIME - 7 DAYS

* SIGNIFICANT TO INSOLATION ASSESSMENT

MX-RES INSOLATION SITING STRATEGY

- SITE AND AREA SPECIFIC STATIONS
  - o UTILIZE EXISTING DEPLOYMENT MAPS OF MX SHELTERS, CLUSTERS, AND OPERATING BASES TO DETERMINE MOST PROBABLE SITES/AREAS OF SOLAR SYSTEM DEPLOYMENT.
  - o UTILIZE FULL COMPLEMENT OF MEASUREMENTS/SENSORS AT MOST PROBABLE SITES.
  - o SELECT LOCATIONS TO BE REPRESENTATIVE OF MESOSCALE OF DEPLOYMENT SITES (SHELTERS, CLUSTERS, OPERATING BASES).

- MESOSCALE VARIATIONS/SOLAR PROSPECTING
  - o UTILIZE SATELLITE (GOES) INSOLATION MAPPING, 5 x 5 KM
  - o UTILIZE SIMPLE, ECONOMICAL, GLOBAL HORIZONTAL INSOLATION SENSORS ON ALL INSOLATION AND WIND MONITORING STATIONS

- BENCHMARK STATION
  - o UTILIZE A FULL COMPLEMENT STATION AT ELY, NEVADA, TO RELATE NEW DATA TO LONG TERM AVERAGE (SOLMET & ERSATZ)

MX-RES INSOLATION MEASUREMENT/SENSOR STRATEGY

- GENERAL MEASUREMENTS
  - o SOLAR CONCENTRATING SYSTEMS
    - DIRECT SOLAR BEAM, FIRST CHOICE
    - GLOBAL HORIZONTAL (AND MODEL), SECOND CHOICE
    - CIRCUMSOLAR RADIATION, THIRD CHOICE
    - SPECTRAL DATA, FOURTH CHOICE
  - o FLAT PLATE SYSTEM
    - GLOBAL ON TILTED (AT LATITUDE) SURFACE, FIRST CHOICE
    - DIRECT BEAM & GLOBAL HORIZONTAL, SECOND CHOICE
    - GLOBAL HORIZONTAL, THIRD CHOICE
  - o ACCURACY GOAL
    - $\pm$ 5 % HOURLY TOTALS

- GENERAL SENSORS
  - o DIRECT SOLAR BEAM
    - THERMOPILE PYRHELIOMETER, 5.7° F.O.V., $\pm$ 1 % ACCURACY
  - o GLOBAL (TILTED SURFACE AND HORIZONTAL)
    - SI CELL PYRANOMETER, 180° F.O.V., $\pm$ 5 % ACCURACY, HAS SIMILAR RESPONSE TO PHOTOVOLTAIC SOLAR SYSTEMS

MX-RES INSOLATION MEASUREMENT/SENSOR STRATEGY (CONTINUED)

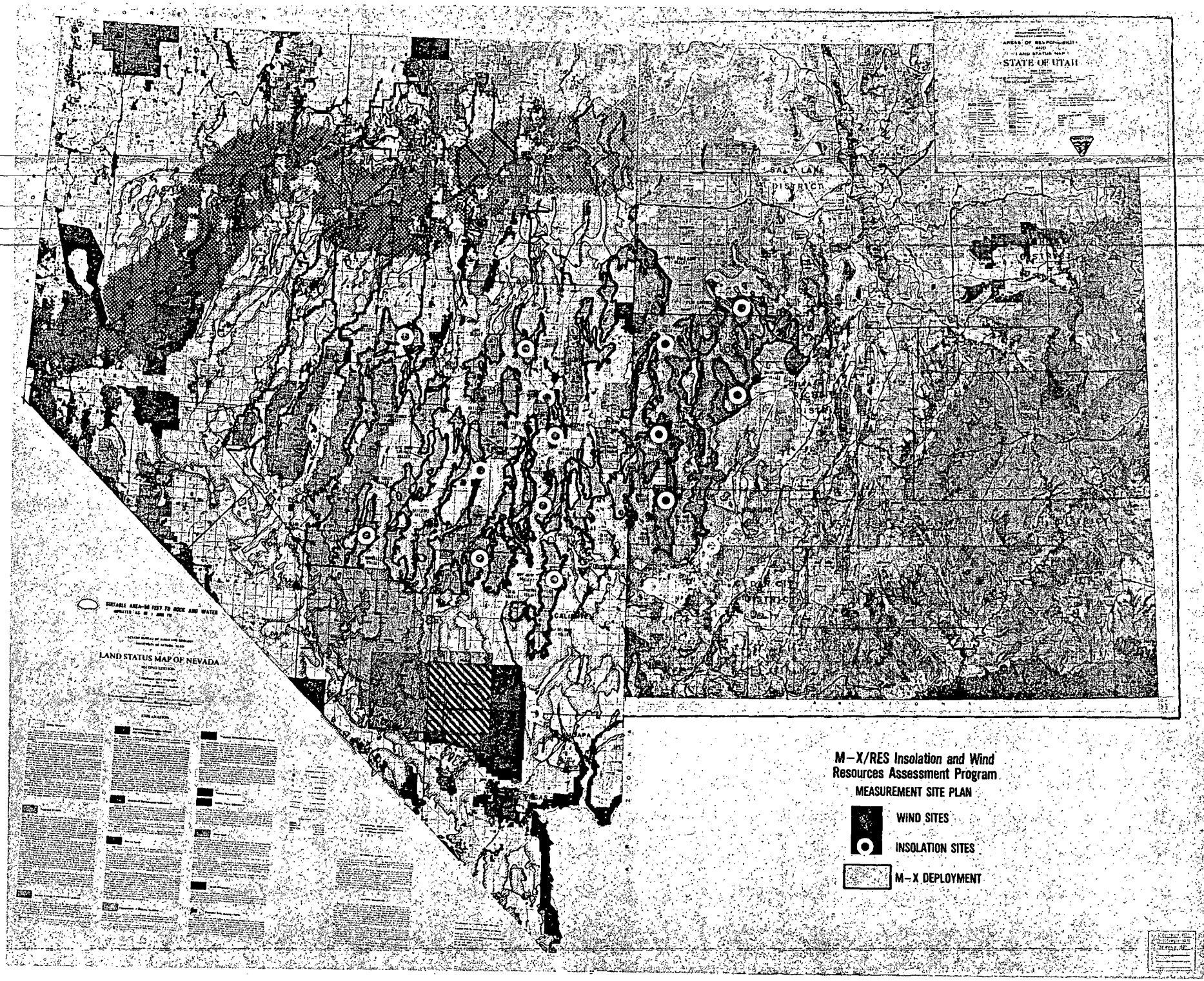
- o COSTS
  - USE SI CELL SENSORS/PYRANOMETERS AS APPOSED TO THERMOPILES ($200.00 EACH VS $1200.00 EACH)
  - MINIMIZE DIRECT BEAM MEASUREMENTS/SENSORS BECAUSE OF TRACKER COSTS ($14,400.00)
  - MAXIMIZE SAMPLING/AVERAGING TIME BECAUSE OF DATA LOGGING AND PROCESSING EXPENSES.

- o SAMPLING TIME
  - UTILIZE 5 MINUTE AVERAGE BECAUSE OF REQUIREMENTS FOR DETERMINING POWER ABOVE GIVEN INSOLATION THRESHOLDS, AND OTHER DESIGN REQUIREMENTS
  - 5 MINUTE AVERAGE IS COMMENSURATE WITH 10 MINUTE REQUIREMENTS FOR WIND MEASUREMENTS

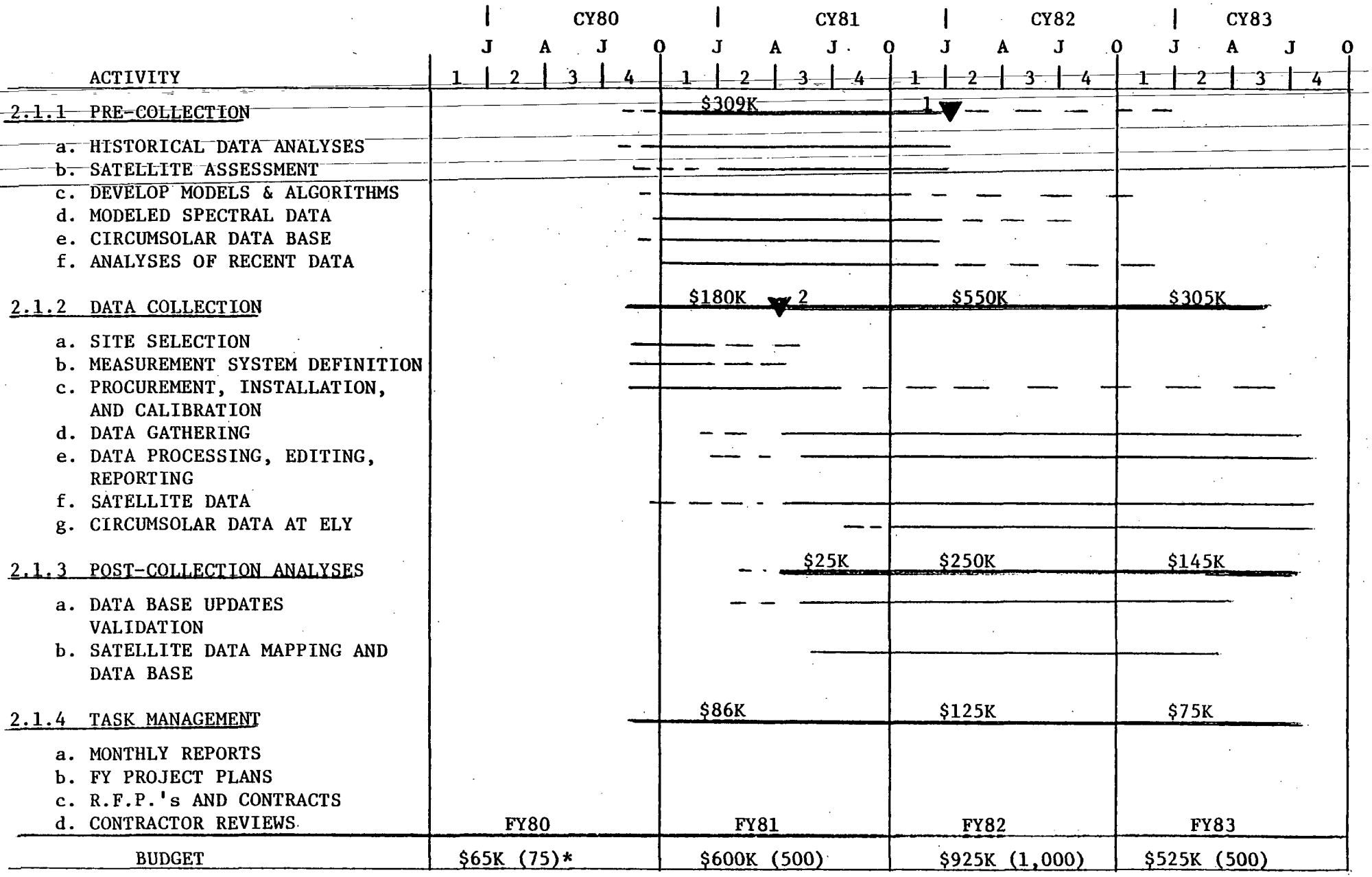
M-X/RES INSOLATION MEASUREMENT SENSORS

APPROACH

SENSOR/MEASUREMENT	TYPE OF STATION					
	0	I	IIA	IIB	III	IV
1. HORIZONTAL SI CELL PYRANOMETER		X	X	X	X	X
2. TILTED SURFACE SI CELL PYRANOMETER				X	X	X
3. DIRECT BEAM THERMOPILE PYRHELIOMETER AND SOLAR TRACKER					X	X
4. MOBILE AUTOMATIC SCANNING PHOTO-METER (MASP)						X


STATE OF UTAH
LAND STATUS MAP OF NEVADA
M-X/RES Insolation and Wind
Resources Assessment Program
MEASUREMENT SITE PLAN
WIND SITES
INSOLATION SITES
M-X DEPLOYMENT

MX-RES INSOLATION ASSESSMENT FY81, 82, 83 SCHEDULE/PLAN/BUDGET



TOTAL = $2.12M (2.08)

1. DATA BASE FOR DECISION PACKAGE
2. START DATA GATHERING

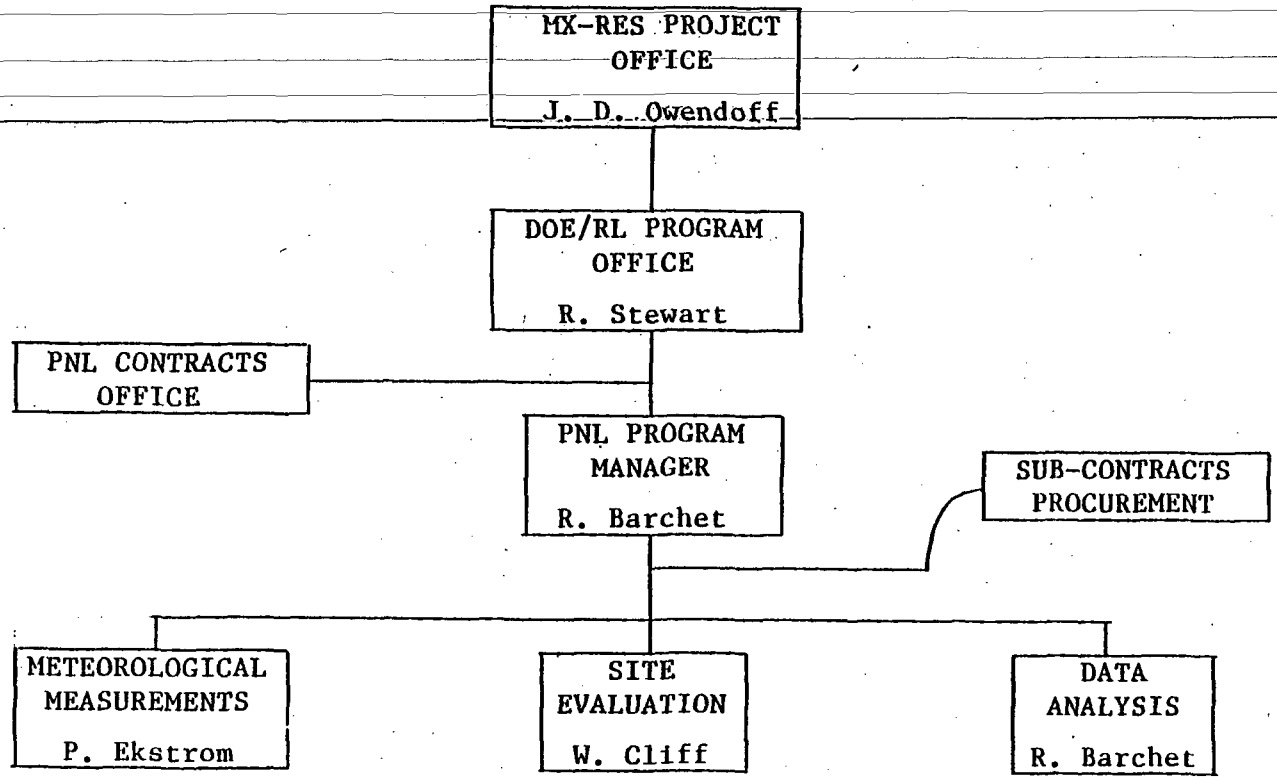
* MX-RES PROJECT PLAN (JULY 28, 1980)

SERI MX-RES INSOLATION RESOURCE ASSESSMENT - FY81 BUDGET

ITEM	DOLLARS ($1,000)
2.1.1 PRE-COLLECTION	309
a. HISTORICAL DATA ANALYSES (80)	
b. SATELLITE ASSESSMENT (75)	
c. DEVELOP MODELS & ALGORITHMS (50)	
d. MODEL SPECTRAL DATA (20)	
e. CIRCUMSOLAR DATA BASE (50)	
f. RECENT DATA (34)	
2.1.2 DATA COLLECTION	180
a. SITE SELECTION (10)	
b. MEASUREMENT SYSTEM DEFINITION (5)	
c. PROCUREMENT, INSTALLATION, CALIBRATION (135)	
d. DATA GATHERING (10)	
e. DATA PROCESSING, EDITING, REPORTING (10)	
f. SATELLITE DATA (10)	
g. CIRCUMSOLAR DATA AT ELY (0)	
2.1.3 POST-COLLECTION ANALYSES	25
a. DATA BASE UPDATES & VALIDATION	
b. SATELLITE DATA MAPPING & DATA BASE	
2.1.4 TASK MANAGMENT	86
a. MONTHLY REPORTS	
b. FY PROJECT PLANS	
c. RFP's & CONTRACTS	
d. CONTRACTOR REVIEWS	
	FY81 TOTAL = $600K

MX-RES WIND RESOURCE ASSESSMENT

MANAGEMENT FLOW



MX-RES WIND RESOURCE ASSESSMENT

MANAGEMENT FLOW

OBJECTIVES OF MX-RES WIND RESOURCE ASSESSMENT

- OBTAIN DATA TO DETERMINE THE VIABILITY OF WIND AS AN MX-RES ENERGY SOURCE
  - EVALUATE BASELINE WIND DATA ASSUMPTIONS
  - DETERMINE GEOGRAPHIC VARIABILITY OF RESOURCE
  - PROVIDE DATA FOR RES SYSTEM SELECTION
  - PROVIDE DATA FOR RES SYSTEM INTEGRATION
  - IDENTIFY PROSPECTIVE WIND ENERGY SYSTEM SITES
- ADVANCE THE STATE-OF-THE-ART OF
  - WIND ENERGY PROSPECTING STRATEGIES
  - WIND RESOURCE DATA BASES
  - WIND ENERGY SYSTEM SITE EVALUATION

MX-RES WIND RESOURCE ASSESSMENT

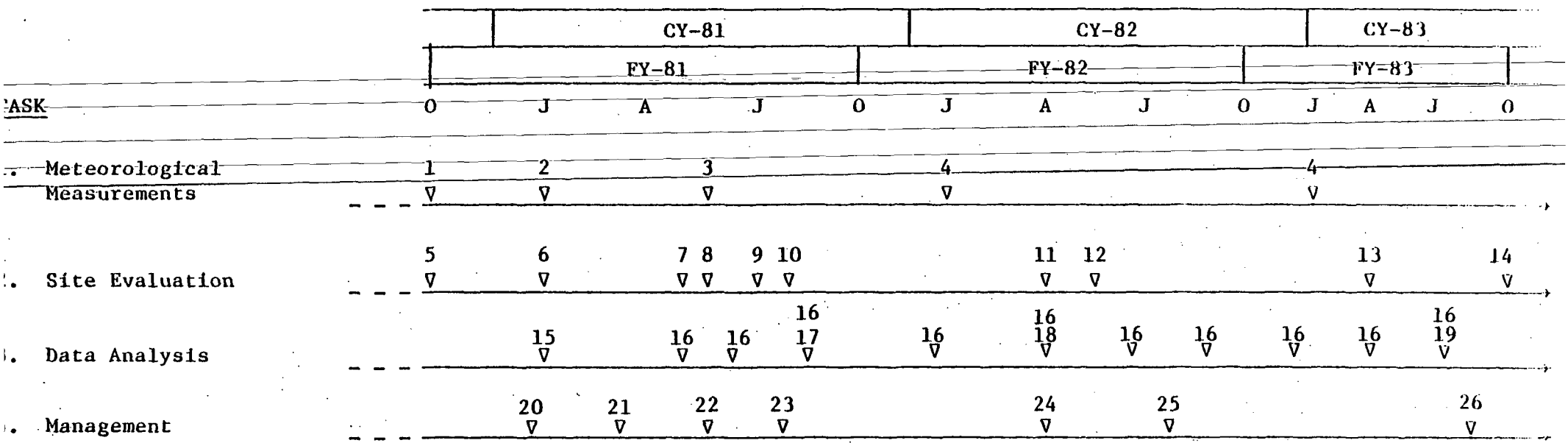
MANAGEMENT FLOW

PNL MANAGEMENT AND SCHEDULE MILESTONES TO DATE

	Item	Date
1.	PRELIMINARY WIND RESOURCE ASSESSMENT DOCUMENT	January 10, 1980
2.	INITIAL CONTACT WITH THE AEROSPACE CORPORATION	April 22, 1980
3.	FY-80 PROGRAM PLAN SUBMITTED TO DOE	June 11, 1980
4.	PROJECT OFFICE APPROVAL OF FY80 PLAN ($105,000)	June 24, 1980
5.	AEROSPACE/PNL MEETING (AT AEROSPACE)	July 16, 1980
6.	AEROSPACE/PNL/SERI MEETING (AT AEROSPACE)	August 6-7, 1980
7.	PROJECT OFFICE REVISION OF FY80 FUNDING LEVEL TO $145,000	August 13, 1980
8.	AEROSPACE/PNL MEETING	August 15, 1980
9.	AEROSPACE/PNL/SERI MEETING AT SERI	August 27, 1980
10.	AEROSPACE/PNL/SERI MEETING AT AEROSPACE	September 11, 1980
11.	DRAFT OF RFP SUBMITTED FOR REVIEW	September 19, 1980

MX-RES WIND RESOURCE ASSESSMENT

SCHEDULE AND MILESTONES, FY-81, 82, and 83



MX-RES WIND RESOURCE ASSESSMENT

SCHEDULE AND MILESTONES, FY-81, 82, and 83

MILESTONES for FY-81, 82, and 83

1. RFP Release
2. Measurement system subcontract starts
3. Measurement system operational
4. Subcontract reviewed/revised/ renewed
5. 0th order site ranking
6. Type 0's deployed
7. First order site ranking
8. Initial Type I's, II's, and III's deployed
9. Second order site ranking
10. Second set Type I's and Type IIa's installed
11. Third order site ranking
12. Additional Type I's and Type II's installed
13. Site turbulence and shear studies completed
14. Array analyses in progress
15. TMY reanalysis
16. MX-RES data base book review/update
17. Synoptic climatology completed
18. Wind resource mapped
19. Areal distribution completed, performance simulation in progress
20. Joint insolation/wind statistics defined
21. Subcontractor management and QA plans approved
22. PNL/SERI data reporting format defined
23. PNL/SERI site recycle PNL-FY-82 program plan
24. PNL/SERI/Aerospace coordination on DPD input
25. PNL FY-83 program plan
26. PNL FY-84 program plan

MX-RES WIND RESOURCE ASSESSMENT

FY-80-FY-81 TRANSITION EXPENDITURE PLAN

TASK	MONTH						TOTAL
	J	A	S	O	N	D	
1. Meteorological Measurements	14.1	18.4	22.9	14.0	29.0	23.0	121.4
2. Site Evaluation	1.0	2.6	5.2	43.0	8.0	2.0	61.8
3. Data Analysis					5.0	4.0	9.0
4. Management	1.9	1.9	2.0	1.6	1.6	1.6	10.6
Monthly Totals	17.0	22.9	30.1	58.6	43.6	30.6	202.8
Cumulative Total	17.0	39.9	70.0	128.6	172.2	202.8	

Budget Authorizations

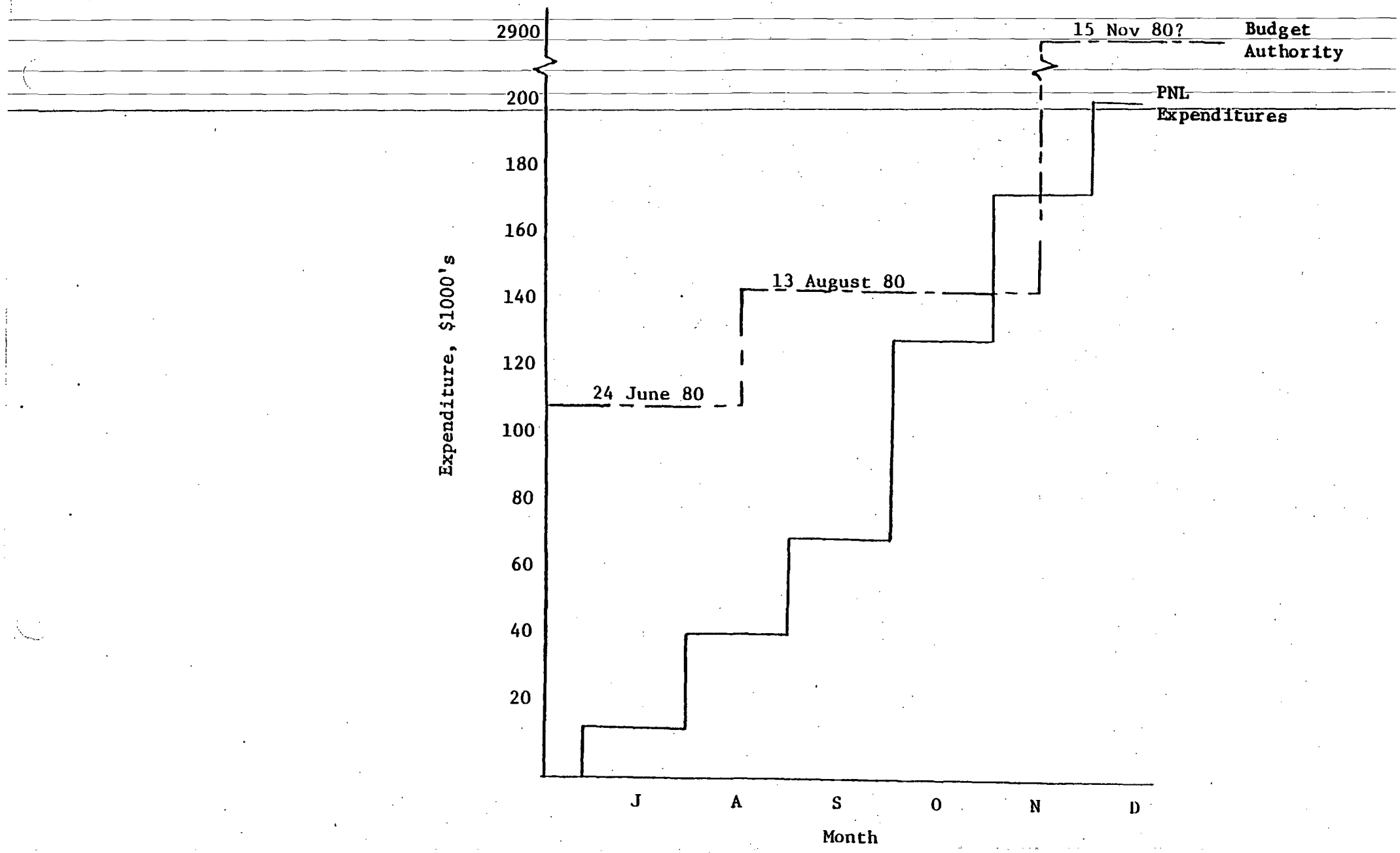
24 June 80 — 105 →

13 August 80 — 145 →

15 November 80? — 2900 →

MX-RES WIND RESOURCE ASSESSMENT

FY-80-FY-81 TRANSITION EXPENDITURE PLAN



MX-RES WIND RESOURCE ASSESSMENT

PNL FY-81 BUDGET ($1,000's)--$2900

1. METEOROLOGICAL MEASUREMENTS		2390
Subcontractor Selection	20	
Measurements Subcontract	430 + 1790*	
Subcontractor Monitoring	80	
Data Base Management	75	
Wind Prospector	135	
2. SITE EVALUATION		150
Site Ranking and Evaluation	40	
Site Use Permits	20	
Model Simulations	50	
Wind Erosion	40	
3. DATA ANALYSIS		205
MX-RES Data Base Book--Wind	25	
Correlation/Regression Analysis	50	
Statistical Needs Analysis	10	
Synoptic Climatology	80	
Wind Resource Mapping	10	
TMY Reanalysis	30	
4. MANAGEMENT		155
Planning	60	
Quality Assurance	40	
Liaison	35	
Reporting	20	

* 140K of SERI furnished instrumentation not included.

MX-RES WIND RESOURCE ASSESSMENT

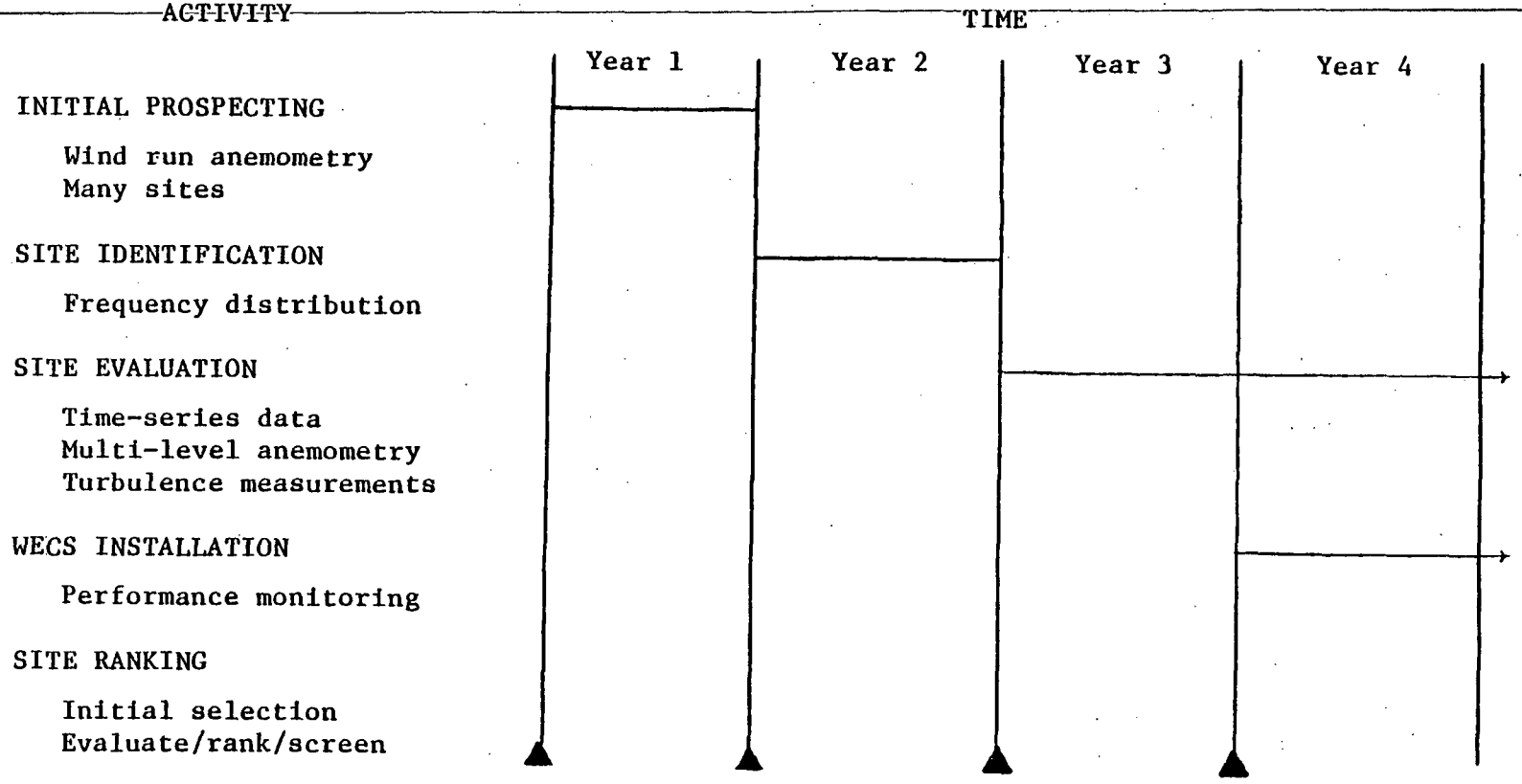
PNL PROPOSED BUDGETS ($1,000's)--FY-82, $4445 ; FY-83, $3370

	FY-82	FY-83
1. METEOROLOGICAL MEASUREMENTS	3030	1860
Subcontract Review/Renewal	50	60
Subcontract Monitor	100	110
Measurements Subcontractor	550 + 2,000	600 + 1,000
Data Base Management	80	90
Profiling System	250	
2. SITE EVALUATION	840	810
Site Ranking and Recycle	40	40
Model Simulations	400	170
Turbulence/Shear	400	500
Array Analysis		100
3. DATA ANALYSIS	375	475
MX-RES Data Base Book--Wind	25	25
Correlation Regression	50	50
Resource Mapping	100	100
Synoptic Climatology	50	50
Areal Distribution	50	50
WECS Performance Simulation	100	200
4. MANAGEMENT	200	225
Planning	80	90
Quality Assurance	50	55
Liaison	40	45
Reporting	30	35

MX-RES WIND RESOURCE ASSESSMENT

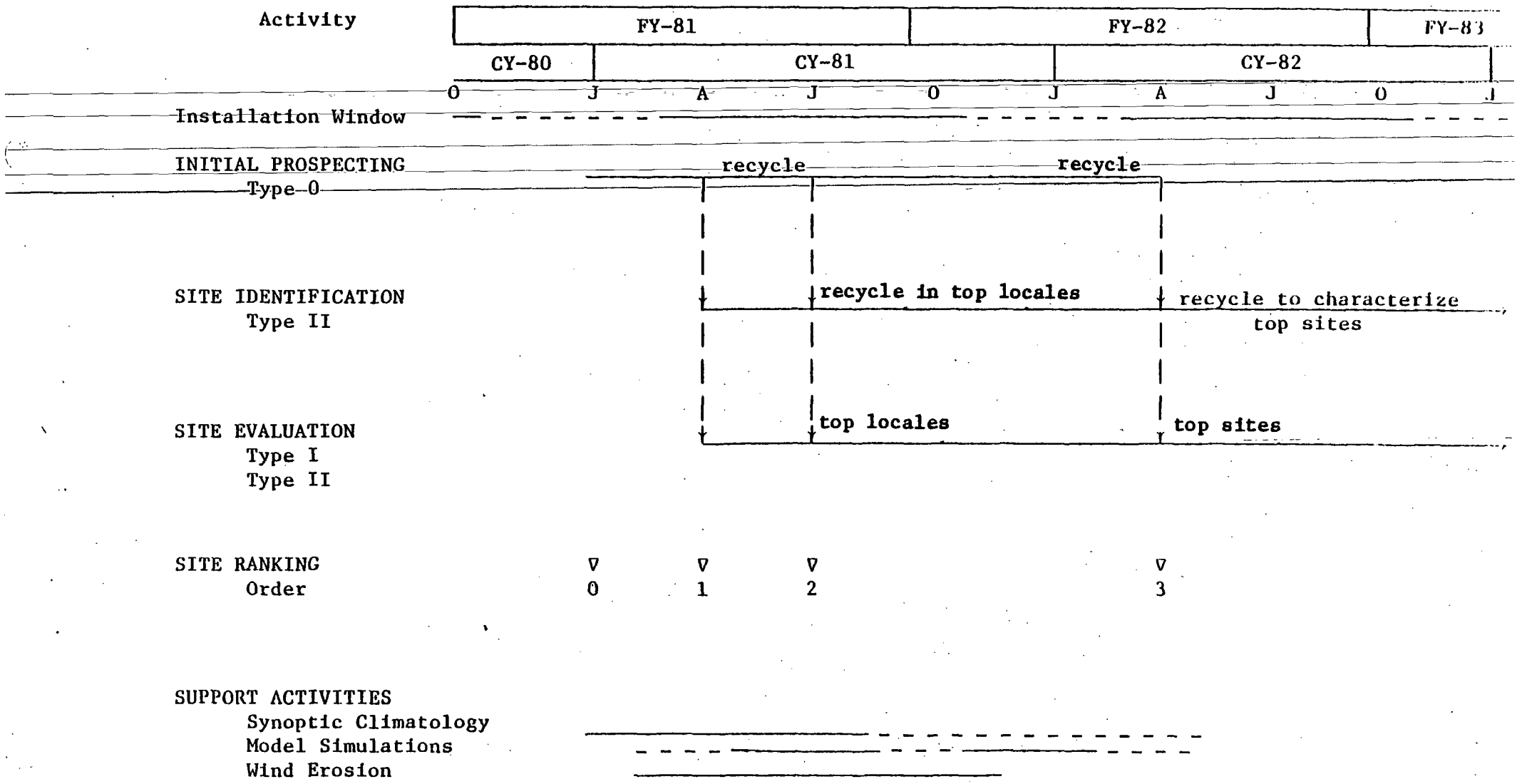
MANAGEMENT FLOW

IDEAL WIND ENERGY PROSPECTING SEQUENCE



MX-RES WIND RESOURCE ASSESSMENT

SITE PROSPECTING



M-X/RES WIND RESOURCE ASSESSMENT

SITE RANKING METHODOLOGY

0 0^{TH} ORDER: INITIAL SELECTION OF POTENTIAL LOCALES AND SITES

- EXTANT DATA, CLIMATOLOGY, TOPOGRAPHY, SITE VISIT
- TYPE 0 PROSPECTOR INSTALLATIONS

0 1^{ST} ORDER: IDENTIFY INITIAL POTENTIAL LOCALES AND SITES

- 0^{TH} ORDER RANKING INFORMATION
- TYPE 0 DATA AND CORRELATIONS
- INITIAL TYPE I, TYPE II, AND TYPE III INSTALLATIONS
- RECYCLE TYPE 0 AS REQUIRED

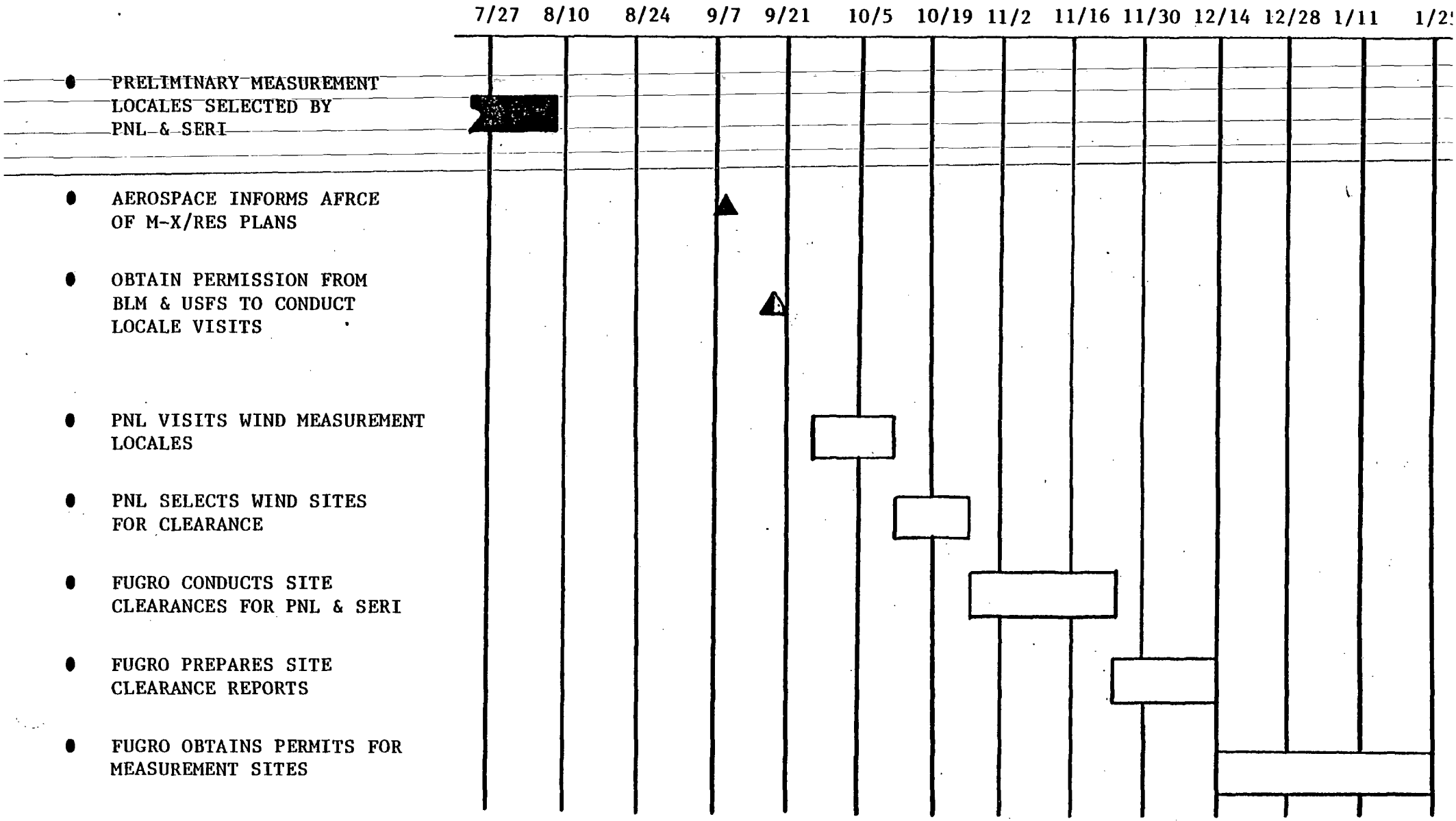
0 2^{ND} ORDER: IDENTIFY TOP LOCALES

- 0^{TH} AND 1^{ST} ORDER RANKING INFORMATION
- TYPE 0, INITIAL TYPE I, TYPE II, AND TYPE III DATA AND CORRELATIONS
- SYNOPTIC CLIMATOLOGY AND MODEL SIMULATIONS
- UPGRADE TOP TYPE IIa SITES TO TYPE I SITES
- RECYCLE TYPE 0 AND TYPE IIa AS REQUIRED

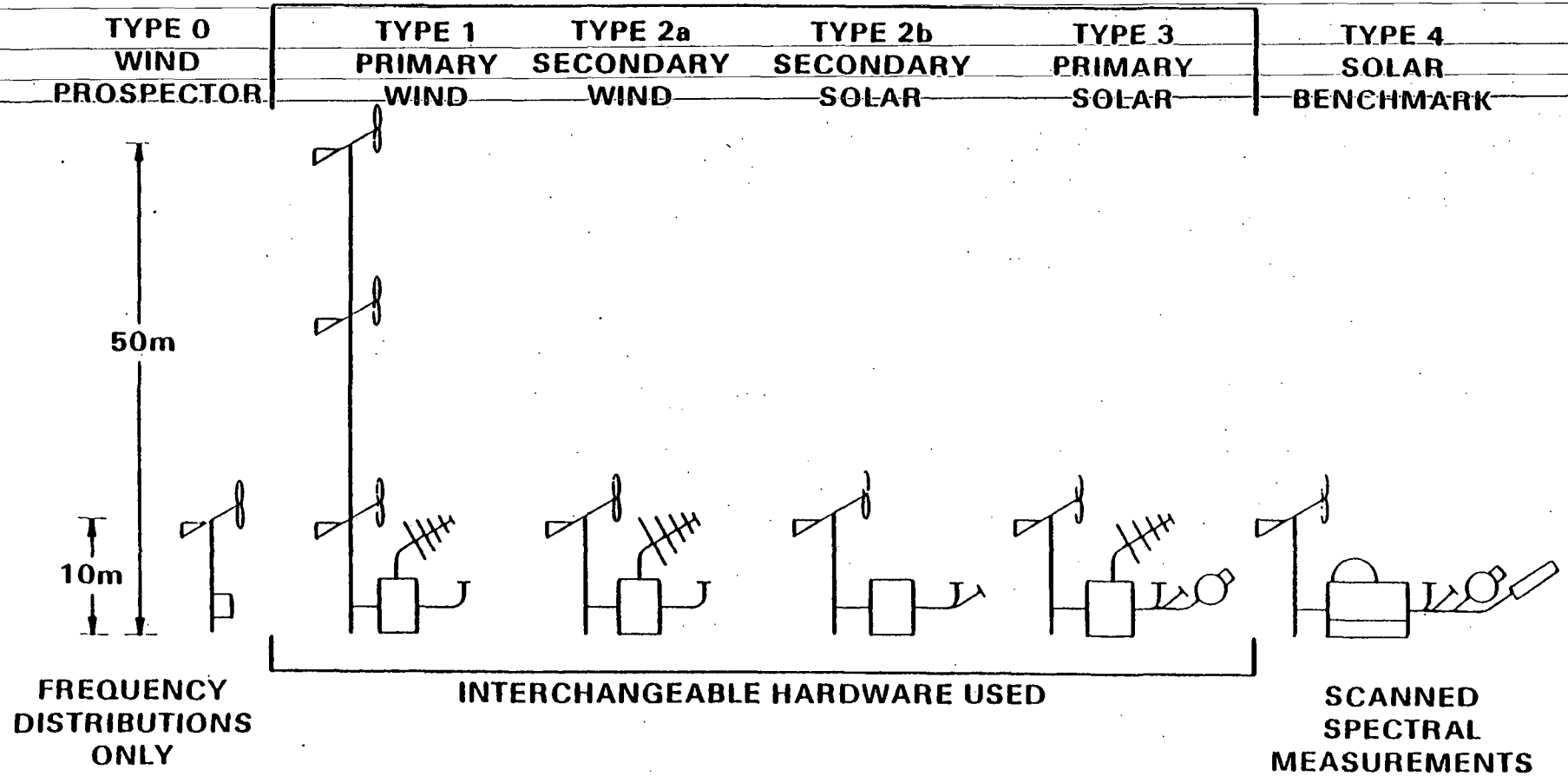
0 3^{RD} ORDER: IDENTIFY TOP SITES FOR PROSPECTIVE TURBINE INSTALLATIONS

- 0^{TH}, 1^{ST}, 2^{ND} ORDER RANKING INFORMATION
- UPDATED TYPE 0, TYPE I, TYPE II, AND TYPE III DATA AND CORRELATIONS
- UPDATED SYNOPTIC CLIMATOLOGY AND MODEL SIMULATIONS
- INTERFACE AND ENVIRONMENTAL CONSTRAINTS IDENTIFIED
- BEGIN SITE CHARACTERIZATION BY CLUSTERING TYPE IIa AROUND TOP TYPE I SITES, UPGRADE OTHER SITES, TOO
- RECYCLE TYPE 0 AND TYPE IIa, AS REQUIRED

SCHEDULE FOR M-X/RES MEASUREMENT SITES CLEARANCE AND USE PERMITS



MEASUREMENT STATIONS



MX-RES METEOROLOGICAL MEASUREMENTS

SYSTEM COMPONENT MATRIX

Item	Type 0	Type I	Type IIa	Type IIb	Type III	Type IV
μ Processor	1	1	1	1	1	*
Tape Cassette		1	1	1	1	*
Telemetry		1	1	0	1	
Wind Speed & Direction	1	3	1	1	1	1
Total Insolation		1	1	2	2	2
Direct Insolation		0	0	0	1	1
Temperature	1	2	1	1	1	1
Humidity		1	0	0	1	0
Icing		1	0	0	1	0
10 m Tower	1	0	1	1	1	1
50 m Tower/Elevators		1	0	0	0	0

* Included with the PNL-MASP Installation

MX-RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

METEOROLOGICAL MEASUREMENT STATION CONFIGURATION

Designator	Site Selected by	Station Primary Use	Data Storage and Transmission	Security Provisions	Sensor Complements
Type 0	PNL	Initial Wind Prospecting	Processor Memory	None	Wind Speed and Direction at 30 ft Temperature at Ground Solar Panel Output
Type I	PNL	Rich Wind Resource Site Characterization	Telemetry Cassette Recorder	Chain-Link Fence Door Monitor on TM	Wind Speed and Direction at 30, 100, and 150 ft Temperature at 30 and 150 ft Humidity at 30 ft Icing at 150 ft Horizontal Global Insolation (SI Cell)
Type IIa	PNL	Wind Site Prospecting and Satellites to Type I Station	Cassette Recorder Telemetry	Barbed Wire Fence	Wind Speed and Direction at 30 ft Temperature at 30 ft Horizontal Global Insolation (SI Cell)
Type IIb	SERI	Satellites to Type III Station	Cassette Recorder	Barbed Wire Fence Warning Horn	Wind Speed and Direction at 30 ft Temperature at 30 ft Horizontal Global Insolation Tilted Surface Global Insolation Direct Insolation
Type III	SERI	Rich Solar Resource Site Characterization	Telemetry and Cassette Recorder	Chain Link Fence Door Monitor on TM	Wind Speed and Direction at 30 ft Humidity at 30 ft Icing at 30 ft Temperature at 30 ft Horizontal Global Insolation Tilted Surface Global Insolation Direct Insolation
Type IV	SERI	Benchmark Station	Cassette Recorder	Locked Walk-In Shelter	Wind Speed and Direction at 30 ft Temperature at 30 ft Humidity at 30 ft Icing at 30 ft Horizontal Global Insolation Tilted Surface Global Direct Insolation Circumsolar Telescope

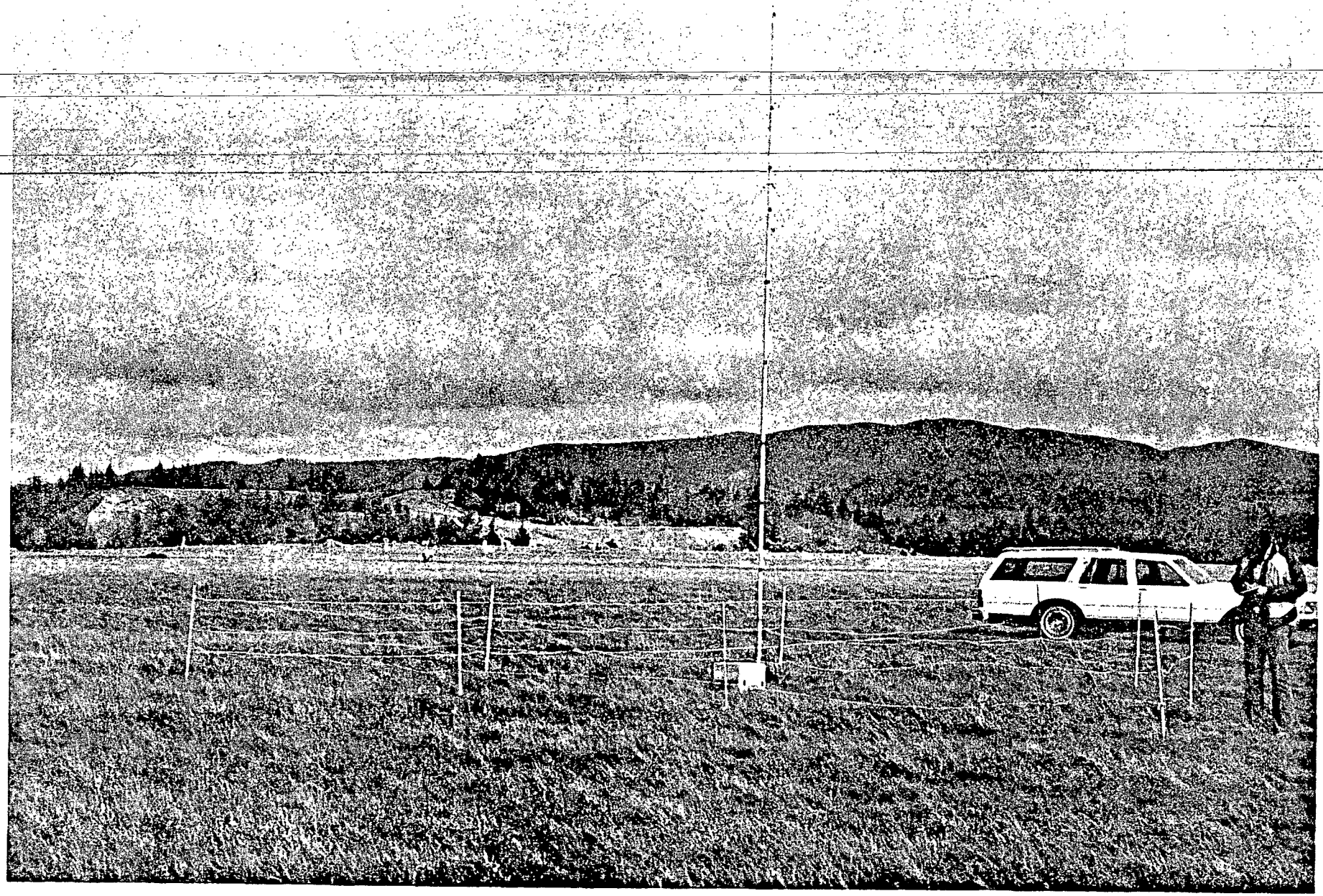
NOTES: 1) All data in time series format, except type 0.
2) All stations have a microprocessor controlled data acquisition system.

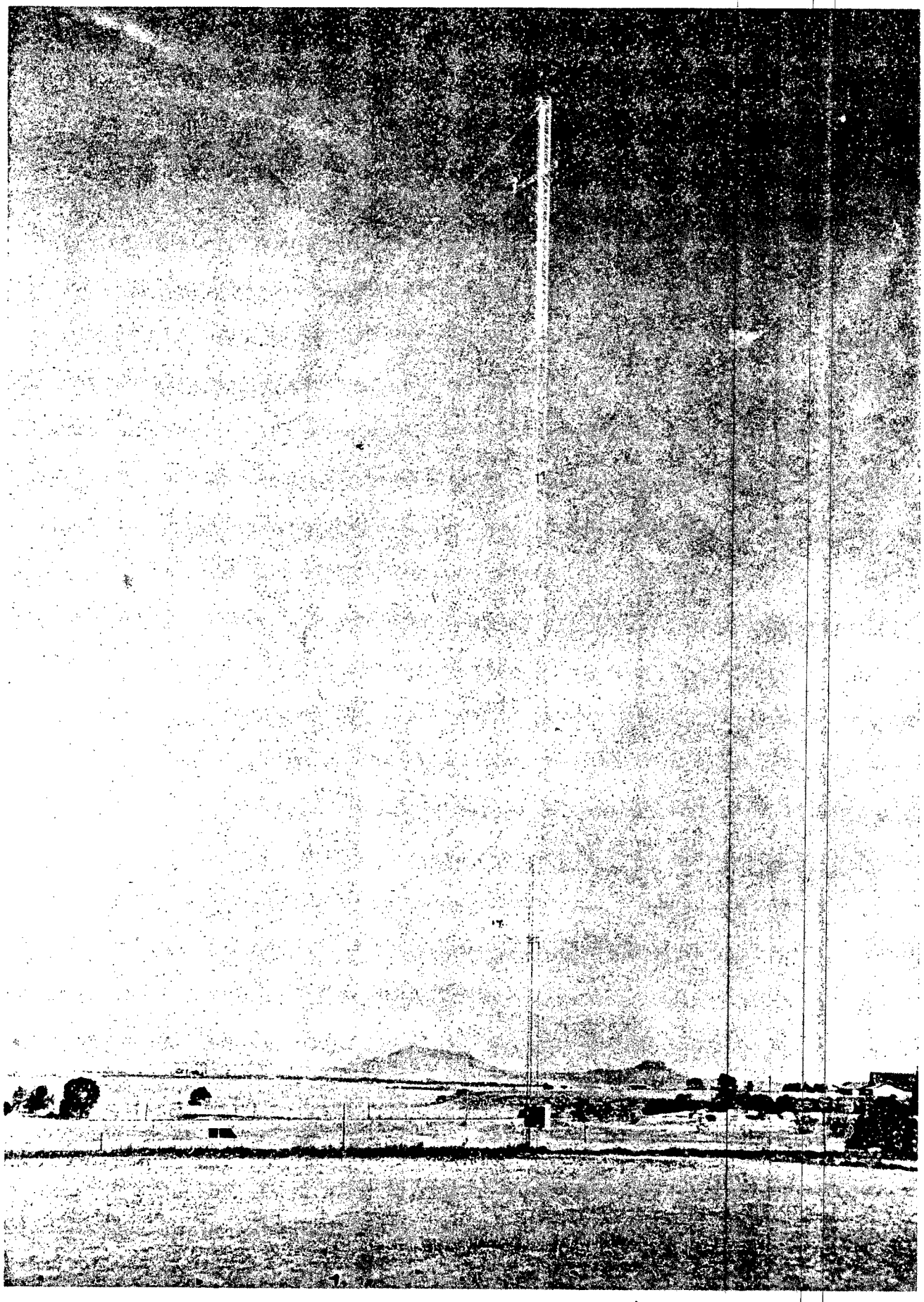
COMMONALITY OF STATION CONFIGURATIONS

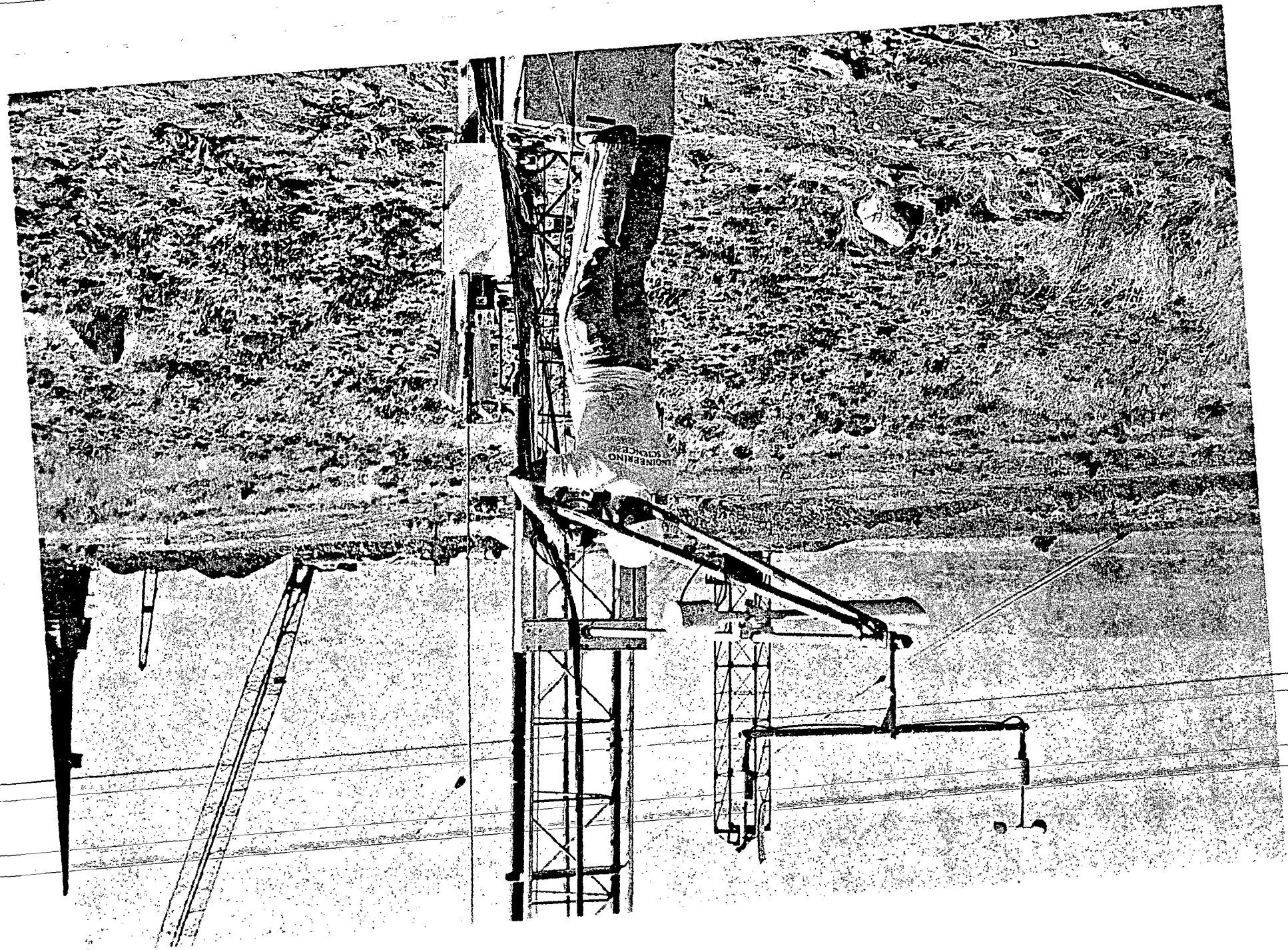
- INTERMODAL CORRELATIONS FACILITATED BY JOINT INSOLATION AND WIND MEASUREMENTS
- DATA FOR SPATIAL VARIABILITY OF INSOLATION AND WIND RESOURCES GENERATED
- GREATER ACCURACY OBTAINED WITH COMMON DATA FORMAT AND PROCESSING
- WIND MEASUREMENT AT 30 FEET CONFORMS WITH NATIONAL WEATHER SERVICE PRACTICE
- MODULAR STATIONS EASILY RECONFIGURED

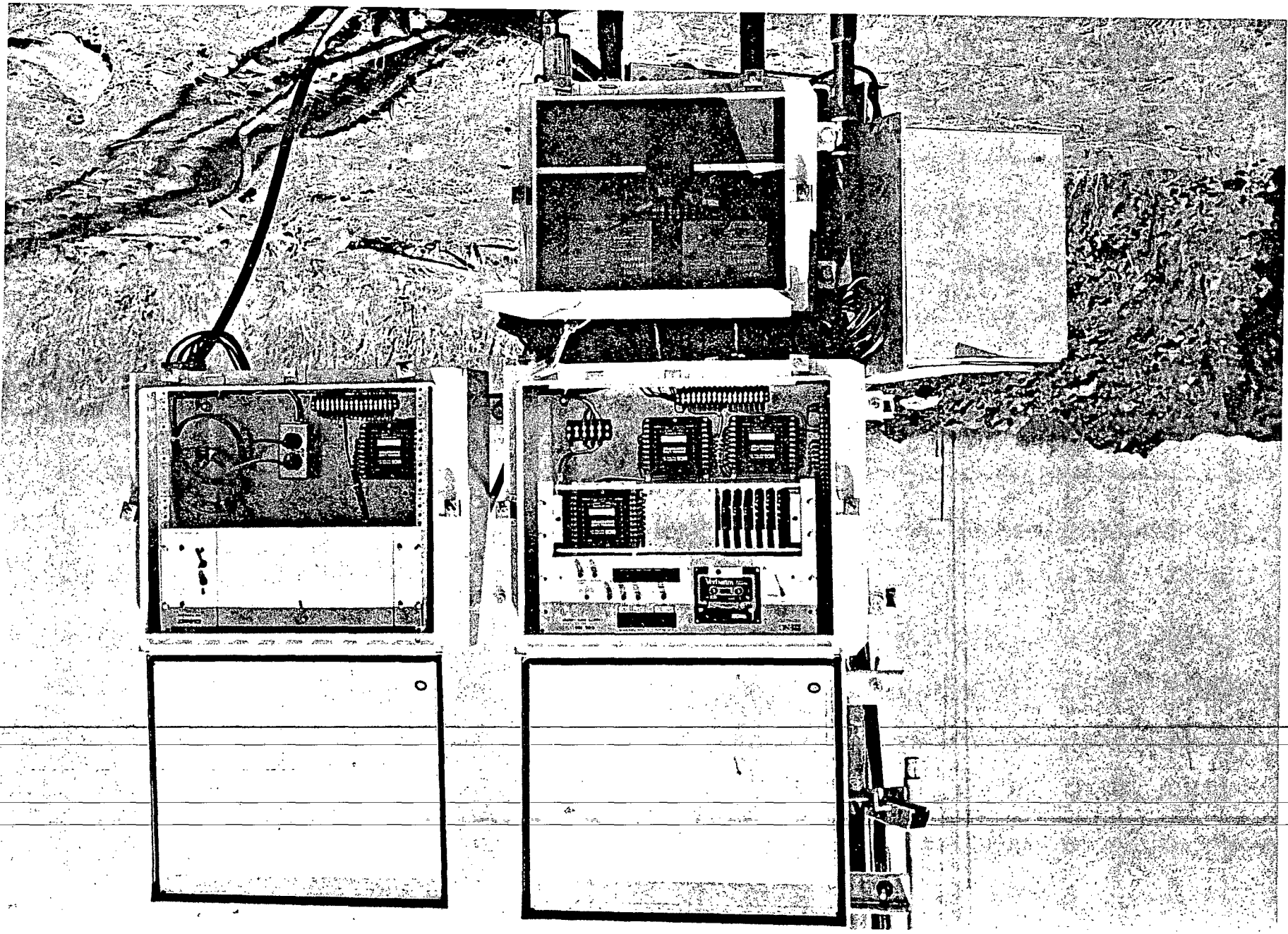
UNIQUE FEATURES OF STATION CONFIGURATIONS

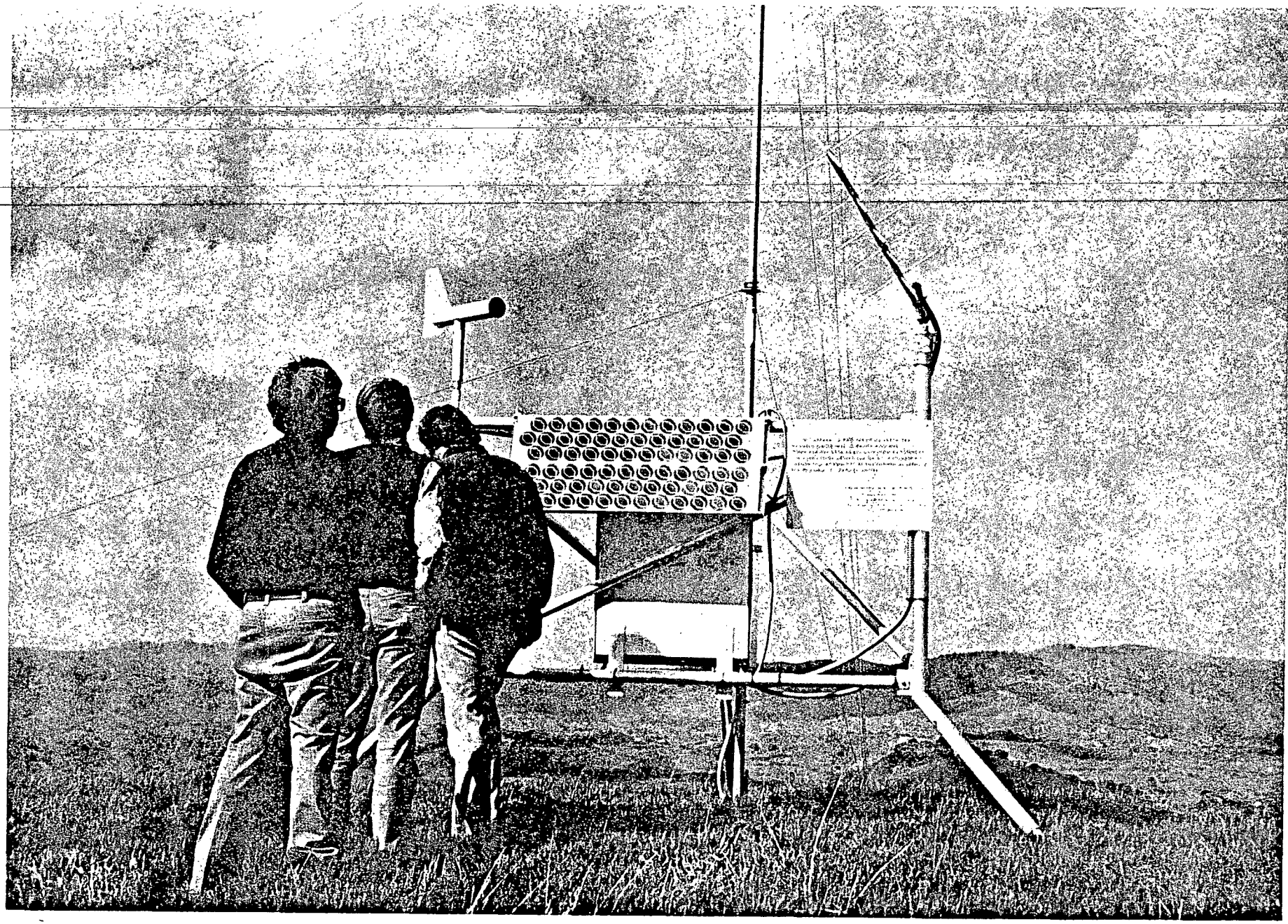
- TYPE 0 (WIND):
  - JOINT FREQUENCY DISTRIBUTIONS ONLY
- TYPE I (WIND):
  - WIND DATA AT MULTIPLE LEVELS FOR ACCURATE EXTRAPOLATION TO HUB HEIGHTS
  - WIND SENSORS AT SAME LEVELS AS IN DOE NATIONAL PROGRAM
- TYPE IIa (WIND):
  - SATELLITE TO TYPE I
  - PROSPECTOR FOR GOOD WIND SITES
- TYPE IIb (INSOLATION):
  - SUPPORTS TILTED SURFACE ALGORITHM FOR SOLAR ENERGY APPLICATIONS
  - TELEMETRY DEFERRED TO FY82
- TYPE III (INSOLATION):
  - SUPPORTS TILTED SURFACE ALGORITHM FOR SOLAR ENERGY APPLICATIONS
  - PROVIDES INFORMATION FOR CONCENTRATING SYSTEMS
- TYPE IV (INSOLATION):
  - SUPPORTS TILTED SURFACE ALGORITHM FOR SOLAR ENERGY APPLICATIONS
  - PROVIDES INFORMATION FOR CONCENTRATING SYSTEMS
  - CIRCUMSOLAR TELESCOPE PROVIDES
    - SOLAR AUREOLE DATA FOR ENTIRE M-X DEPLOYMENT AREA
    - SPECTRAL DATA
    - BENCHMARK FOR MEASUREMENT PROGRAM











M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

MEASUREMENT PROGRAM PLANNING COSTS PER STATION

All Figures are in Thousands of Dollars

	Type 0	Type I	Type IIa	Type IIb	Type III	Type IV
• HARDWARE						
SECURITY SYSTEM	--	1.1	0.5	0.6	1.2	Included in the MASP
DATA-LOGGER, μ-PROCESSOR, AND TELEMETRY XMTR	0.5	10.0	10.0	6.0 (No TM)	10.0	10.9** (No TM)
POWER SUPPLY	0.2	0.7	0.1	0.1	0.7	0.6
SENSORS/TOWERS/ELEVATORS/ SIGNAL CONDITIONING	0.6	19.4	4.7	5.3	22.4	25.7*
SPARES @ 10%	0.1	3.1	1.4	1.2	3.4	2.6
SUBTOTAL	1.4	34.3	16.7	13.2	37.7	39.8
• INSTALLATION						
PRE-INSTALLATION	0.2	1.9	0.2	0.2	1.9	3.7
FIELD INSTALLATION/ CONSTRUCTION	1.8	35.5	4.0	2.0	2.4	9.4
SUBTOTAL	2.0	37.4	4.2	2.2	4.3	13.1
• OPERATION FOR FY-81						
MAINTENANCE AND DATA RETRIEVAL (INCLUDES FIELD CALIBRATION)***	4.0	5.0	4.5	4.5	9.0	31.3
COMPUTER TIME (DATA PROCESSING)	0.1	0.3	0.1	0.1	0.2	9.6
SUBTOTAL	4.1	5.3	4.6	4.6	9.2	40.9
TOTAL	7.5	77.0	25.5	20.0	51.2	93.8
• RECYCLE						
REMOVAL	1.0	11.5 (Restoration Deferred)	3.1			
PRE-INSTALLATION	0.2	1.9	0.2			
FIELD INSTALLATION/ CONSTRUCTION	1.8	35.5	4.0			
TOTAL	3.0	48.9	7.3			

* Assumes that a circumsolar telescope will be available on a GFE basis. If a new circumsolar telescope must be bought, its cost will be about $75,000.

** Includes expanded μ Processor and 9-track magnetic tape recorder.

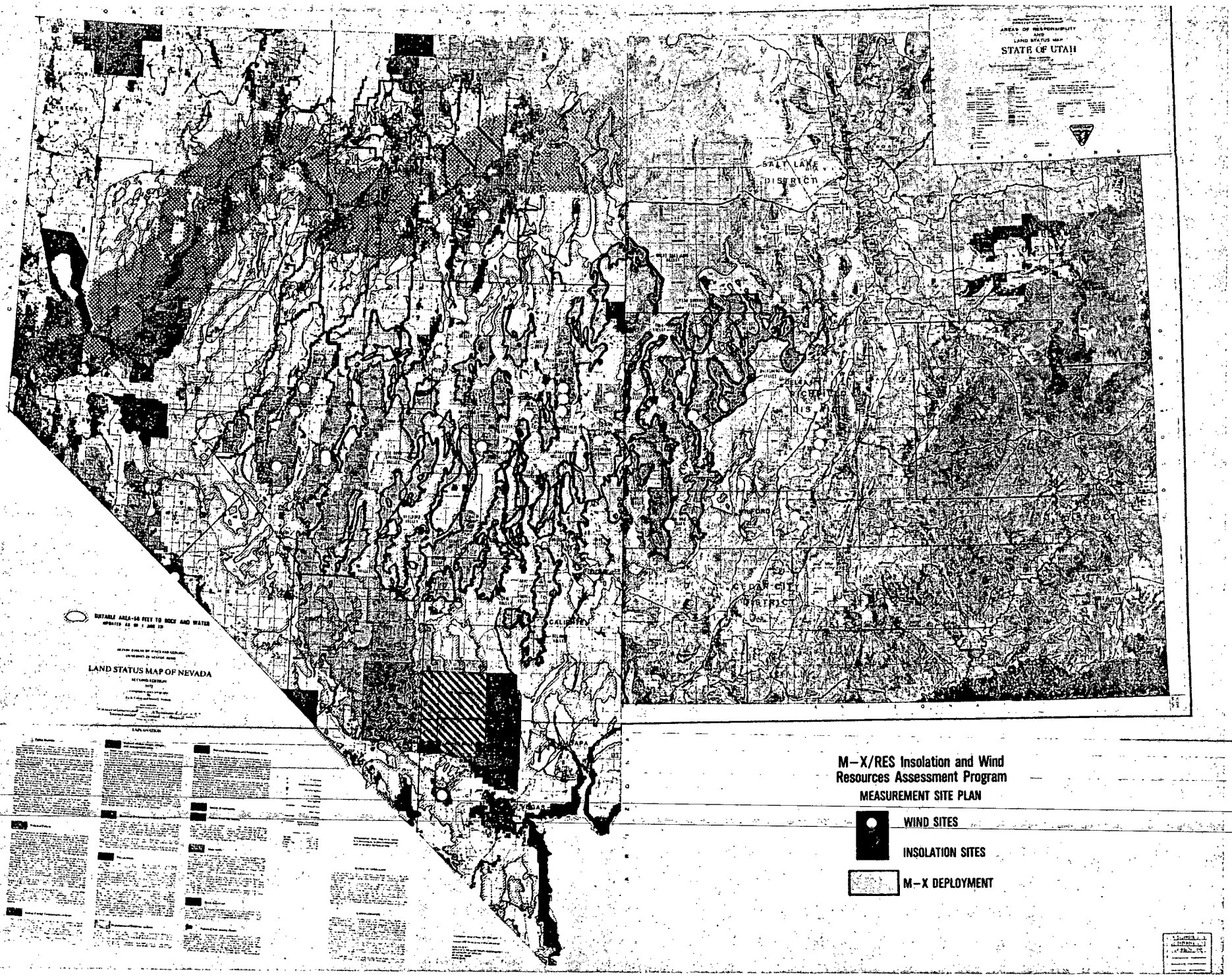
*** Nine months' operations

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

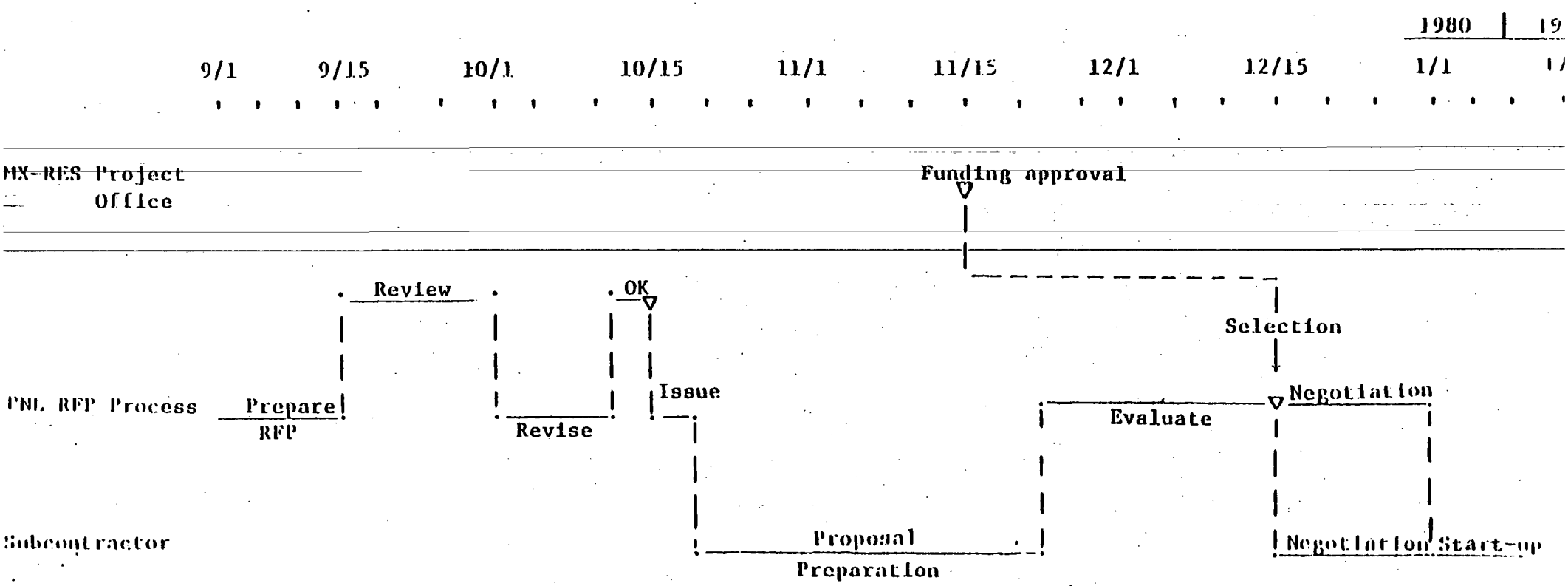
MEASUREMENT PROGRAM PLANNING COSTS

ITEM	COST, $K
• PNL FIXED COSTS	1088.0
• SERI FIXED COSTS	465.0
• ESTIMATED STATION COSTS	
(30) TYPE 0's INSTALLED	225.0
(20) TYPE 0's NOT INSTALLED	28.0
(6) TYPE I's INSTALLED*	454.5
(20) TYPE IIa's INSTALLED	510.0
(10) TYPE IIb's INSTALLED	200.0
(6) TYPE III's INSTALLED	307.2
(1) TYPE IV INSTALLED	93.8
• CONTINGENCY AND RECYCLING	128.5
• TOTAL FY 81 SPENDING	3500.0

*LESS THAN 9 MONTH's OPERATION


STATE OF UTAH
SALT LAKE DISTRICT
CEDAR CITY DISTRICT
LAND STATUS MAP OF NEVADA
M–X/RES Insolation and Wind Resources Assessment Program
MEASUREMENT SITE PLAN
WIND SITES
INSOLATION SITES
M–X DEPLOYMENT

TIME LINE FOR PNL MET CONTRACT



M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

SUMMARY

- ACCOMPLISHMENTS
- SCHEDULE
- JOINT SITING MAP
- KEY CONCERNS
- ACTION STATUS
- COMMENTS BY M-X/RES PROJECT OFFICE

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

ACCOMPLISHMENTS TO DATE

- ESTABLISHED JOINT INSOLATION AND WIND PROGRAM
  - o MANAGEMENT PLAN
    - OBJECTIVES
    - ROLES AND RESPONSIBILITIES
    - POINTS OF CONTACT
    - SCHEDULES
  - o FY80 and FY81 FUNDING
- DEFINED METEOROLOGICAL STATIONS
  - o CONFIGURATIONS
    - RATIONALE
    - COST ESTIMATES
    - DATA RECOVERY/ANALYSIS
  - o DEPLOYMENT
  - o SCHEDULES
  - o RFP PREPARATION
- ESTABLISHED PLAN FOR MEASUREMENT SITES CLEARANCES/PERMITS
- PNL AND SERI AGREED TO CONTINUE SUPPORT OF M-X/RES DATA BASE PREPARATION

M-X/RES JOINT INSOLATION AND WIND RESOURCE ASSESSMENT PROGRAM

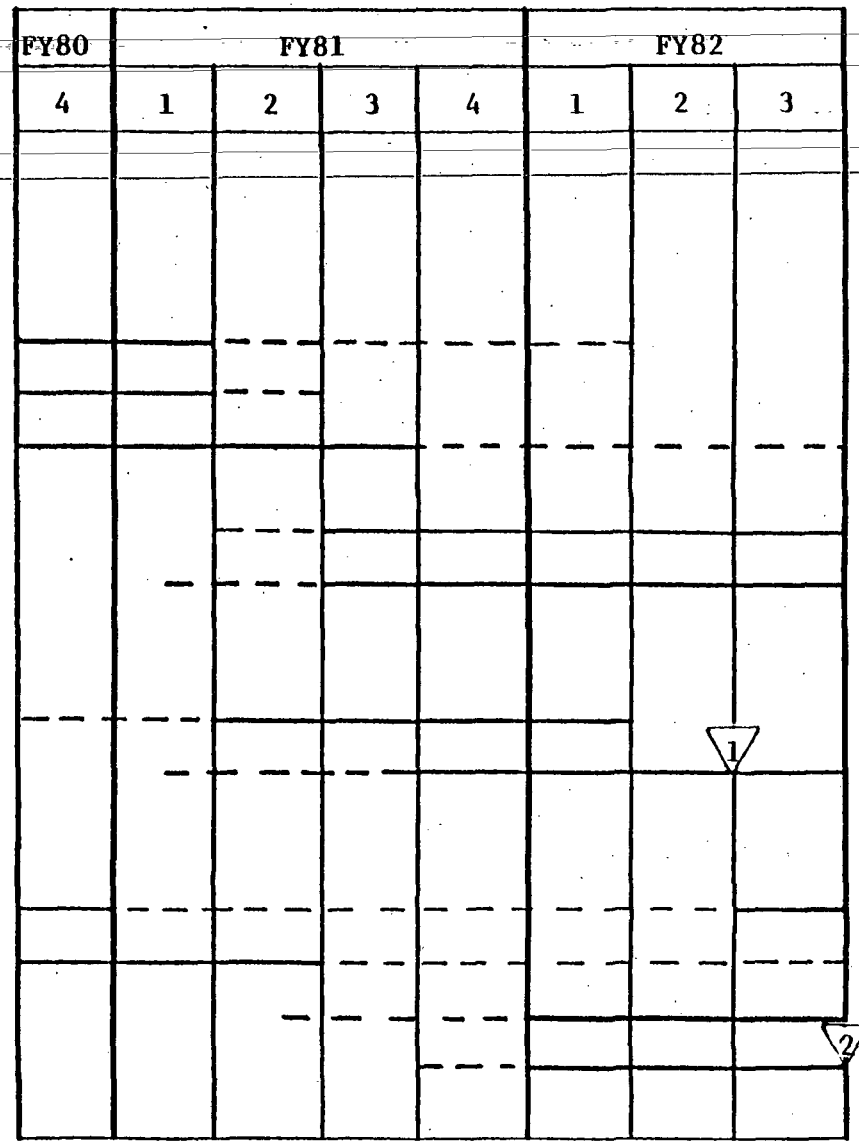
SCHEDULE

RESOURCES ASSESSMENT TASKS (PNL AND SERI)

- MEASUREMENT ACTIVITIES
  - o SITE SELECTION
  - o MEASUREMENT SYSTEM DEFINITION
  - o EQUIPMENT PROCUREMENT, INSTALLATION AND CALIBRATION
  - o MEASUREMENTS AND DATA GATHERING
  - o DATA PROCESSING, EDITING AND REPORTING
- ANALYSES ACTIVITIES
  - o HISTORICAL DATA
  - o POST-MEASUREMENT

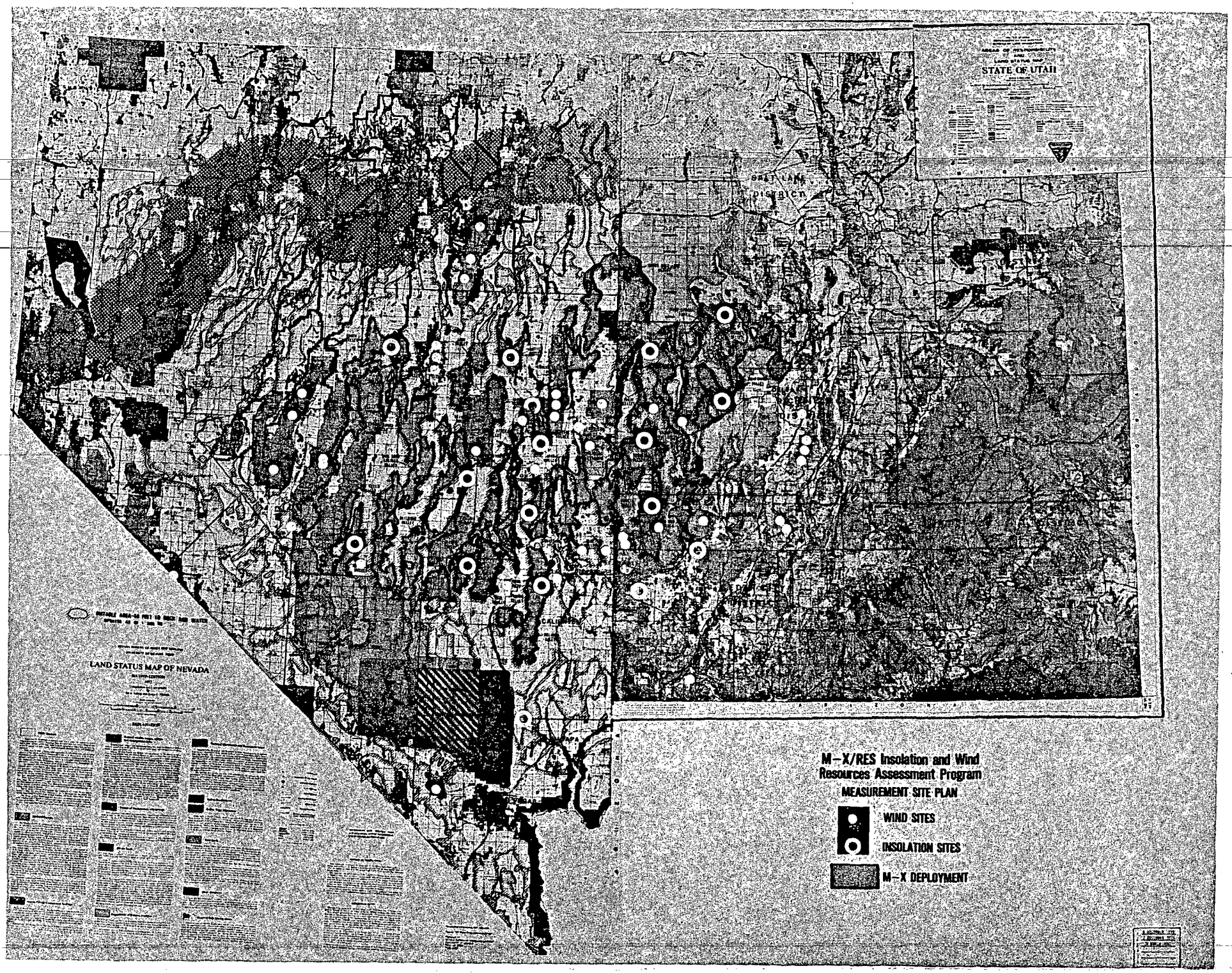
SYSTEMS INTEGRATION ACTIVITY (AEROSPACE)

- RESOURCE REQUIREMENTS DEFINITION
- INTERACTION WITH RESOURCES ASSESSMENT AGENCIES
- APPLICATION ANALYSES
- INTEGRATED RES ANALYSES



1 INPUTS TO DECISION PACKAGE

2 DECISION PACKAGE


STATE OF UTAH
LAND STATUS MAP OF NEVADA
M-X/RES Insolation and Wind
Resources Assessment Program
MEASUREMENT SITE PLAN
WIND SITES
INSOLATION SITES
M-X DEPLOYMENT

KEY CONCERNS

- FUNDING
  - o PROCUREMENT OF METEOROLOGICAL STATIONS DELAYED
  - o NUMBER OF STATIONS INITIALLY LIMITED
  - o RELIABILITY OF DATA RECOVERY FROM TYPE IIb STATIONS
- SCHEDULE
  - o MAY NOT HAVE FULL YEAR'S MEASUREMENTS BY DECISION PACKAGE DATE
    - SITE CLEARANCES
    - PROCUREMENT LEAD TIME
    - WINTER WEATHER
- TECHNICAL
  - o CLIMATOLOGICAL CONSTRAINTS ON STATION INSTALLATION AND REPAIR
  - o TRACKING PYRHELIOMETER DEVELOPMENT
  - o AVAILABILITY OF CIRCUMSOLAR TELESCOPE
  - o RECYCLING STRATEGY
  - o PLANNING FOR PHASE B

M-X/RES JOINT INSOLATION AND WIND RESOURCES ASSESSMENT PROGRAM

ACTION STATUS

• PNL TO FORWARD EXTANT UTAH DATA TO AEROSPACE	CLOSED
• AEROSPACE TO PROVIDE PRELIMINARY SITE SELECTION DATA TO PNL	CLOSED
• SERI WILL OBTAIN AND ESTIMATE AVERAGE ANNUAL PRECIPITATION IN MX DEPLOYMENT AREA	CLOSED
• PNL AND SERI WILL ISSUE PURCHASE REQUESTS TO FUGRO FOR CLEARANCES/PERMITS FOR SITES OF INTEREST	OPEN
• SERI WILL DETERMINE IF A NEW CIRCUMSOLAR TELESCOPE MUST BE PURCHASED	OPEN
• AEROSPACE WILL ESTABLISH A MEETING WITH BLM AND NFS TO DISCUSS ACCESS TO AREAS OF INTEREST, I.E., POTENTIAL MEASUREMENT SITES	CLOSED (19 SEPT 80)
• SERI WILL SELECT TRACKING PYRHELIOMETERS FOR TYPE III AND IV STATIONS	CLOSED

COMMENTS BY M-X/RES PROJECT OFFICE

- DOES THE PROGRAM AS OUTLINED MEET YOUR EXPECTATIONS?

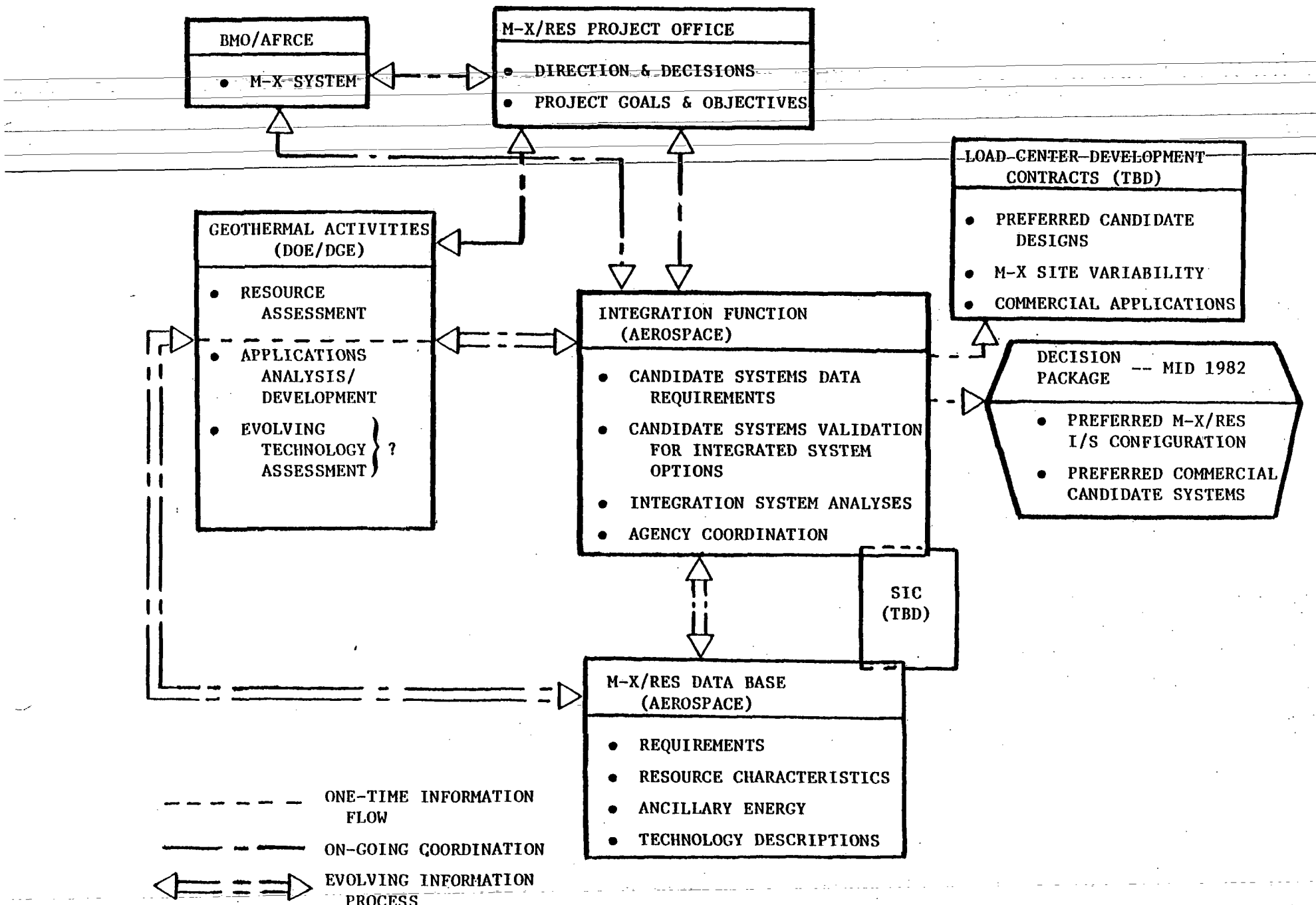
- ARE THERE ADDITIONAL PROGRAM CONSTRAINTS WHICH COULD AFFECT THIS APPROACH?

- SHOULD WE PROCEED AS IS?

M-X/RES GEOTHERMAL BRIEFING TOPICS

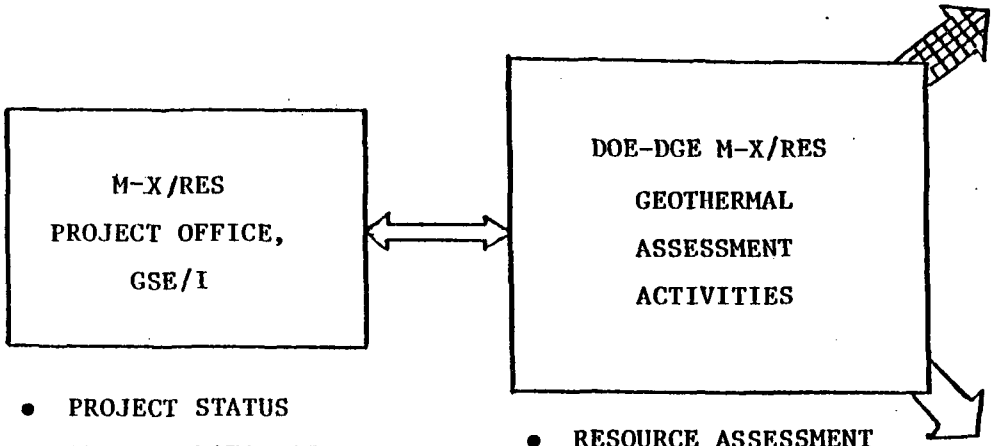
- PRELIMINARY DATA REQUIREMENTS
  - INTEGRATION RELATIONSHIPS AND INFORMATION FLOW
  - GEOTHERMAL INPUTS TO M-X/RES DATA BASE BOOK
  - RESOURCE AND APPLICATIONS DATA FOR INTEGRATED SYSTEM ANALYSES
  - SCHEDULE OF INFORMATION DELIVERABLES
- ACTIVITY STATUS
  - MEETINGS AND COORDINATION TO DATE
  - SIGNIFICANT RESOLUTIONS/FINDINGS
  - SUMMARY OF DATA EXCHANGES
- CURRENT CONCERNS
  - SCHEDULE AND COMMUNICATION IMPLICATIONS
  - PHILOSOPHY OF EMPHASIS ON RESOURCES/APPLICATIONS
  - DATA BASE CONTENT
  - DATA INCONSISTENCY
  - MIL-STANDARD ROLE IN M-X/RES
- ANTICIPATED FOLLOW-UP (AEROSPACE)

M-X/RES GEOTHERMAL ACTIVITY - INTEGRATION RELATIONSHIPS



M-X/RES GEOTHERMAL ASSESSMENT

INFORMATION FLOW



- PROJECT STATUS
- CURRENT DATA BASE
- EVOLVING DATA NEEDS

- RESOURCE ASSESSMENT
- APPLICATIONS ANALYSIS/ DEVELOPMENT

GEOTHERMAL INPUTS TO M-X/RES DATA BASE:

- RESOURCE CHARACTERIZATION
- ANCILLARY ENERGY CAPABILITY
- SOCIO-INSTITUTIONAL CONSIDERATIONS
- TECHNOLOGY DESCRIPTION (TBD)

GEOTHERMAL INPUTS TO INTEGRATED SYSTEM ANALYSIS:

- PERFORMANCE
- AVAILABILITY
- COSTS (M-X, COMMERCIAL)
- SOCIO-INSTITUTIONAL
- PERTINENT ISSUES

GEOTHERMAL INPUTS TO M-X/RES DATA BASE BOOK

WBS ELEMENT SUPPORTED	DATA BASE BOOK ELEMENT LOCATION (TENTATIVE)
2.3 GEOTHERMAL ASSESSMENT (RESOURCES)	5.0 RESOURCE DATA BASE 5.4 GEOTHERMAL
3.1 GEOTHERMAL APPLICATIONS DEVELOPMENT	3.4 ANCILLARY ENERGY 3.4.1 GEOTHERMAL 6.0 SOCIO-INSTITUTIONAL DATA 6.1 REGULATORY 6.2 LEGAL 6.3 ENVIRONMENTAL
3.3 EVOLVING TECHNOLOGY ASSESSMENT } ?	7.0 TECHNOLOGY DESCRIPTIONS

M-X/RES DATA BASE, SECTION 5.4 (TENTATIVE)

GEOTHERMAL RESOURCE ASSESSMENT

5.4.1 DATA FORMAT

5.4.1.1 LOCATION/SITE
5.4.1.2 TEMPERATURE (WELLHEAD)
5.4.1.3 WATER/STEAM QUALITY
5.4.1.4 TYPE (VAPOR, HYDROTHERMAL, HOT ROCK)
5.4.1.5 FLOW RATES VS WELLHEAD PRESSURE (ARTESIAN, PUMPED)
5.4.1.6 TOTAL DISSOLVED SOLIDS (TDS) CHEMICAL COMPOSITION
5.4.1.7 DISSOLVED GAS CONSTITUENTS
5.4.1.8 SUBSURFACE DESCRIPTION

5.4.2 KNOWN GEOTHERMAL RESOURCE AREAS (KGRAs)

5.4.2.1 STEAMBOAT SPRINGS, NV
5.4.2.2 DESERT PEAK PROSPECT, NV
5.4.2.3 DIXIE VALLEY, NV
5.4.2.4 HUMBOLT HOUSE, NV
5.4.2.5 BEOWAWE, NV
5.4.2.6 ROOSEVELT HOT SPRINGS, UT

5.4.3 OPERATING BASES

5.4.3.1 COYOTE (KANE) SPRINGS, NV
5.4.3.2 BERYL, UT
5.4.3.3 MILFORD, UT
5.4.3.4 ELY, NV
5.4.3.5 DELTA, UT

5.4.4 OTHER SITES

5.4.4.1 (TBD)
5.4.4.n

5.4.5 REFERENCES, SOURCES

GEOTHERMAL RESOURCE CHARACTERIZATION DATA -- EXAMPLE

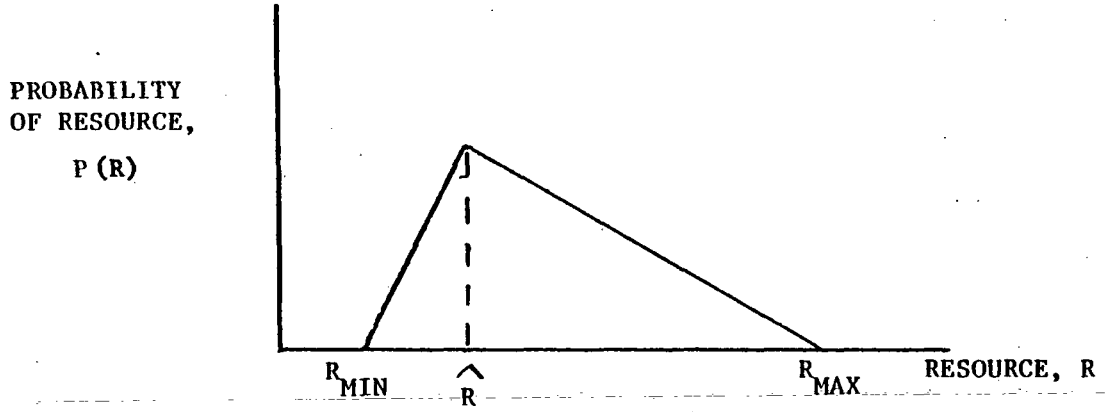
0 SITE DEPENDENT RESOURCE CHARACTERISTICS

- SITE LOCATION AND ACCESSIBILITY
- SUBSURFACE DESCRIPTION OF GEOLOGIC FORMATION (PRODUCTION ZONE LOCATION, PERMEABILITY/ POROSITY, HYDROLOGY, TERRANE STRUCTURE, ETC.)
- RESOURCE TYPE (VAPOR, HYDROTHERMAL, HOT ROCK)

0 PARAMETRICALLY DISTRIBUTED RESOURCE CHARACTERISTICS

- WELLHEAD TEMPERATURE (STEADY FLOW)
- WATER/STEAM QUALITY
- FLOW RATES VS WELLHEAD PRESSURE (STEADY FLOW)
- TDS CONSTITUENTS MAKE-UP
- DISSOLVED GAS CONSTITUENTS
- OTHERS

0 PARAMETERIZED RESOURCE DATA FORMAT



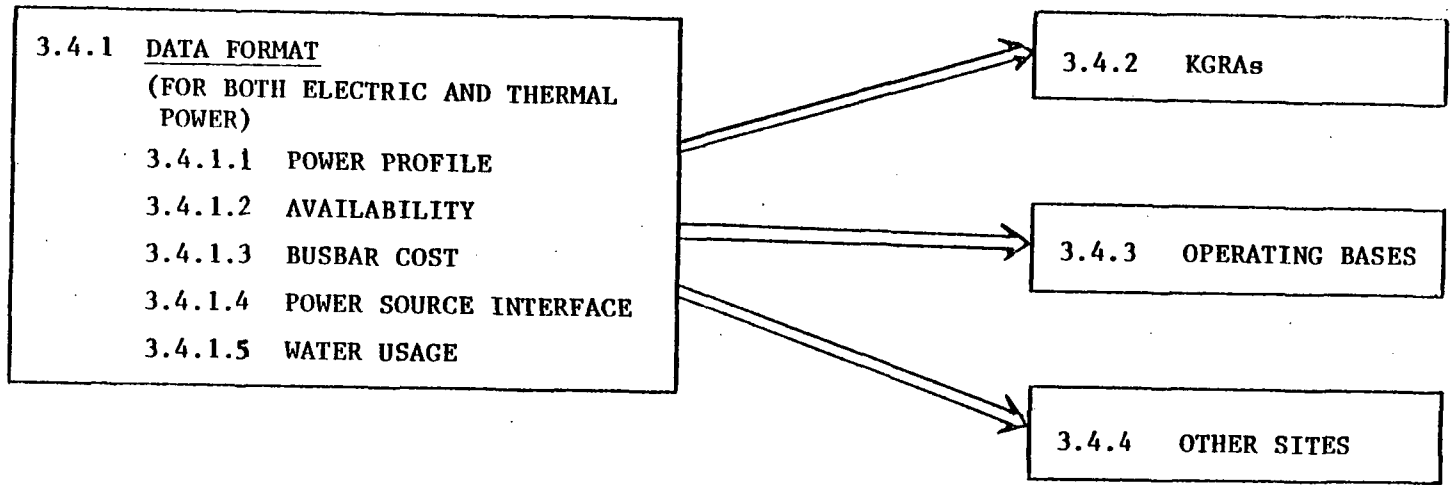
M-X/RES DATA BASE, SECTION 3.4 (TENTATIVE)

GEOTHERMAL "ANCILLARY ENERGY"

- BASIS - CLUSTER, OPERATING BASE SOWs (PARAGRAPH 2.7):

  "Geothermal and large-scale wind energy sources are being considered for incorporation as part of an integrated MX-RES system. If these sources are included, then a portion of their generated energy may be made available, either continuously, during nightime or daytime only, or at random times. The Contractor shall indicate how his preferred RES design, as developed in Subtask 2.1, would be changed if this external RES energy were to be available. The Contractor shall also define associated cost and operational impacts. The amounts of such energy which might be available will be specified in the MX-RES Data Base."

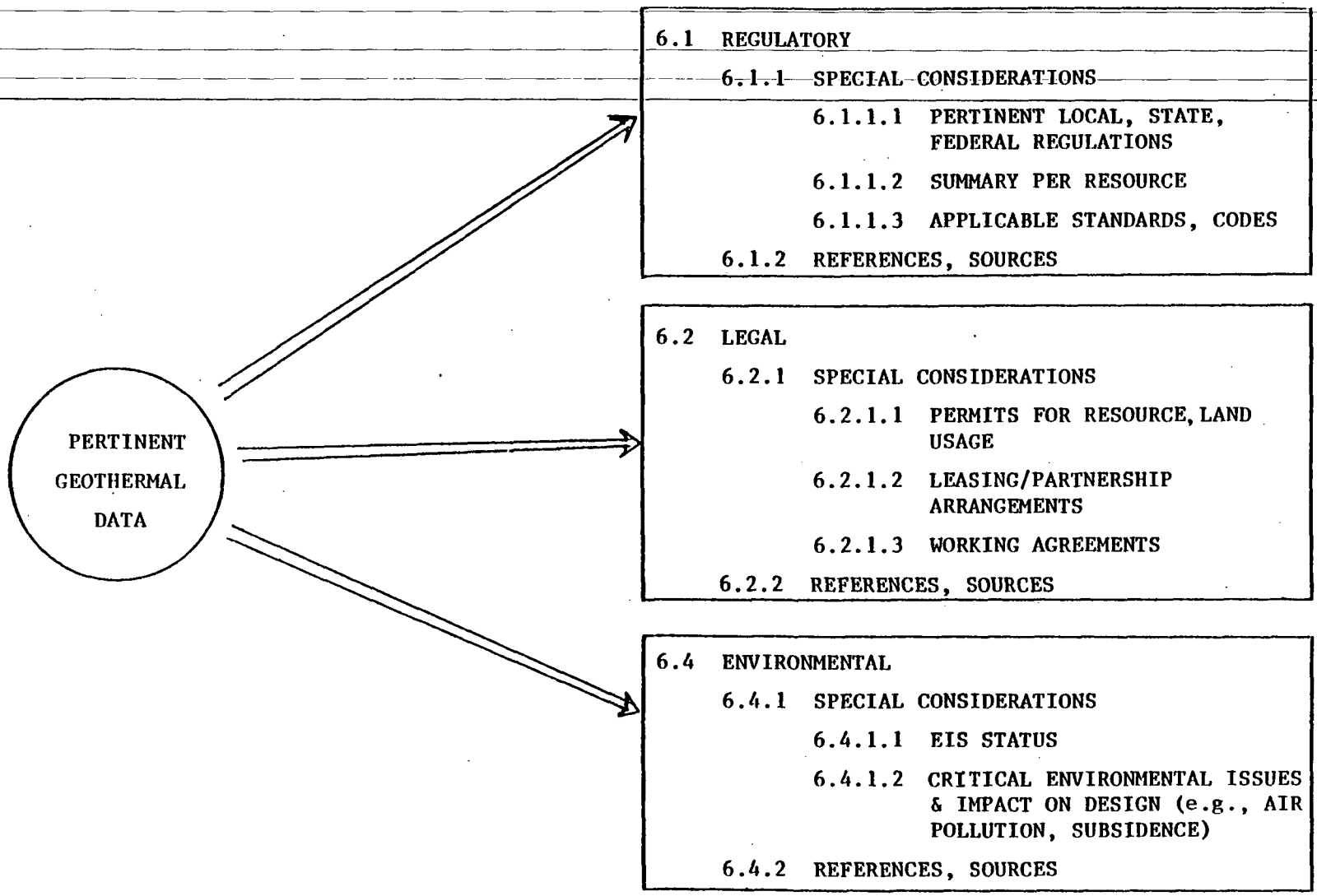
- PROPOSED DATA BASE CONTENT, SECTION 3.4.1:



3.4.5 REFERENCES, SOURCES

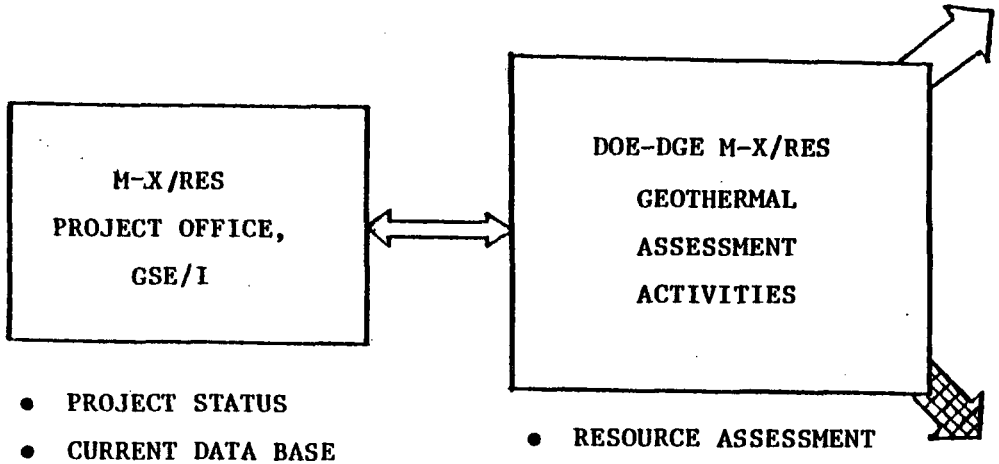
M-X/RES DATA BASE, SECTION 6.0 (TENTATIVE)

GEOTHERMAL SOCIO-INSTITUTIONAL DATA



M-X/RES GEOTHERMAL ASSESSMENT

INFORMATION FLOW



- PROJECT STATUS
- CURRENT DATA BASE
- EVOLVING DATA NEEDS

- RESOURCE ASSESSMENT
- APPLICATIONS ANALYSIS/ DEVELOPMENT

GEOTHERMAL INPUTS TO M-X/RES DATA BASE:

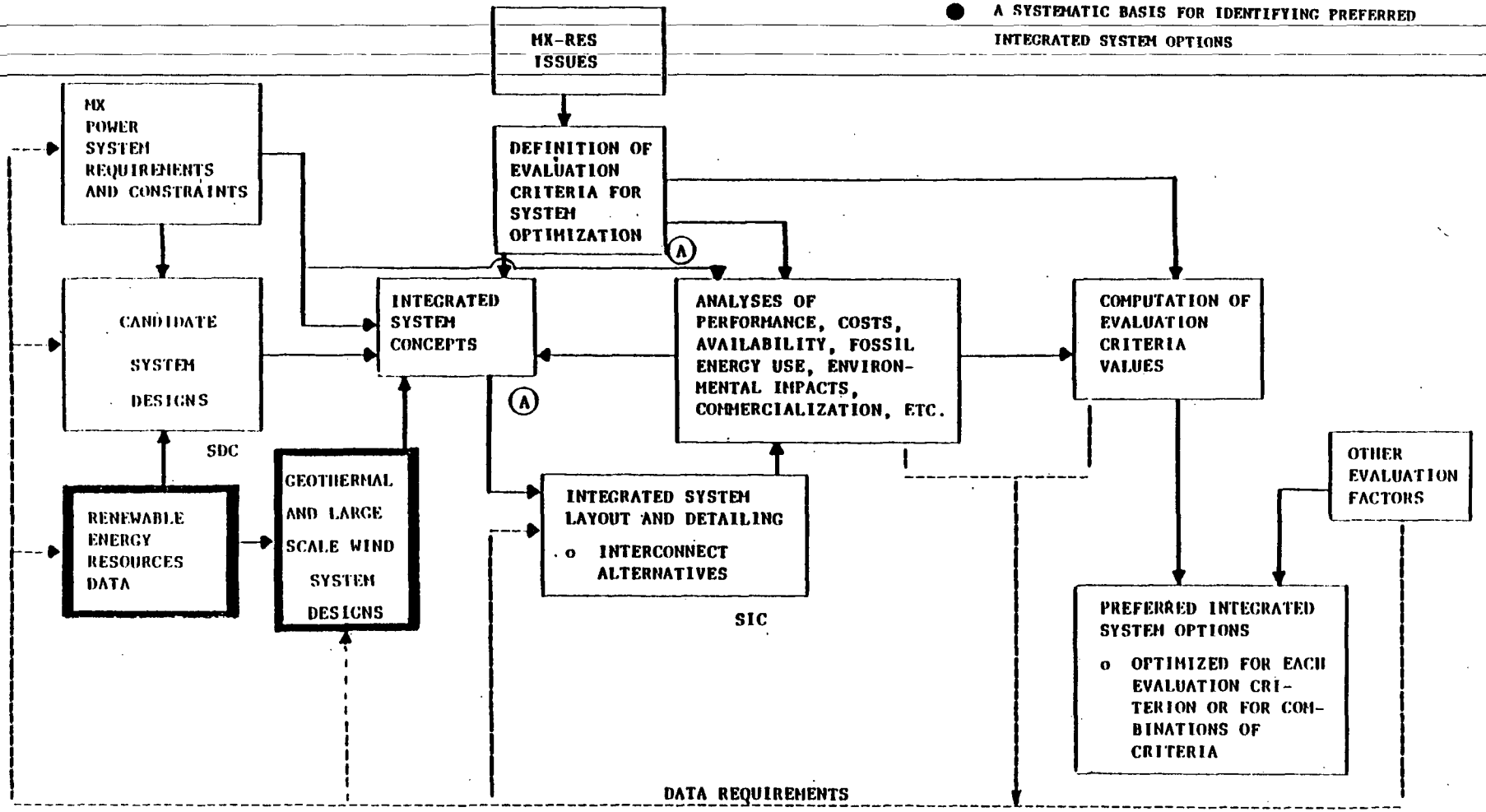
- RESOURCE CHARACTERIZATION
- ANCILLARY ENERGY CAPABILITY
- SOCIO-INSTITUTIONAL CONSIDERATIONS
- TECHNOLOGY DESCRIPTION (TBD)

GEOTHERMAL INPUTS TO INTEGRATED SYSTEM ANALYSIS:

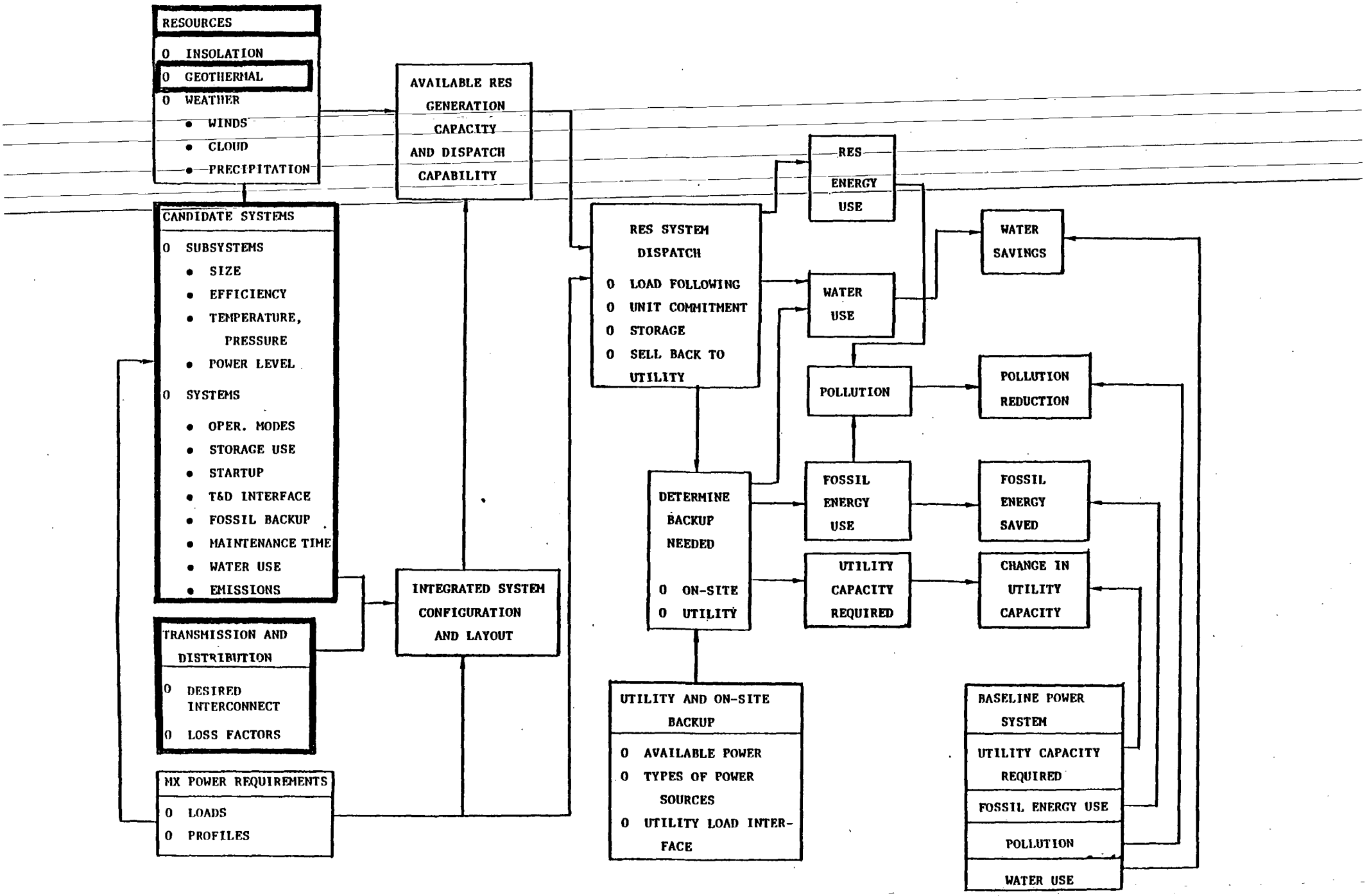
- PERFORMANCE
- AVAILABILITY
- COSTS (M-X, COMMERCIAL)
- SOCIO-INSTITUTIONAL
- PERTINENT ISSUES

MX-RES INTEGRATED SYSTEMS EVALUATION METHODOLOGY

● A SYSTEMATIC BASIS FOR IDENTIFYING PREFERRED INTEGRATED SYSTEM OPTIONS



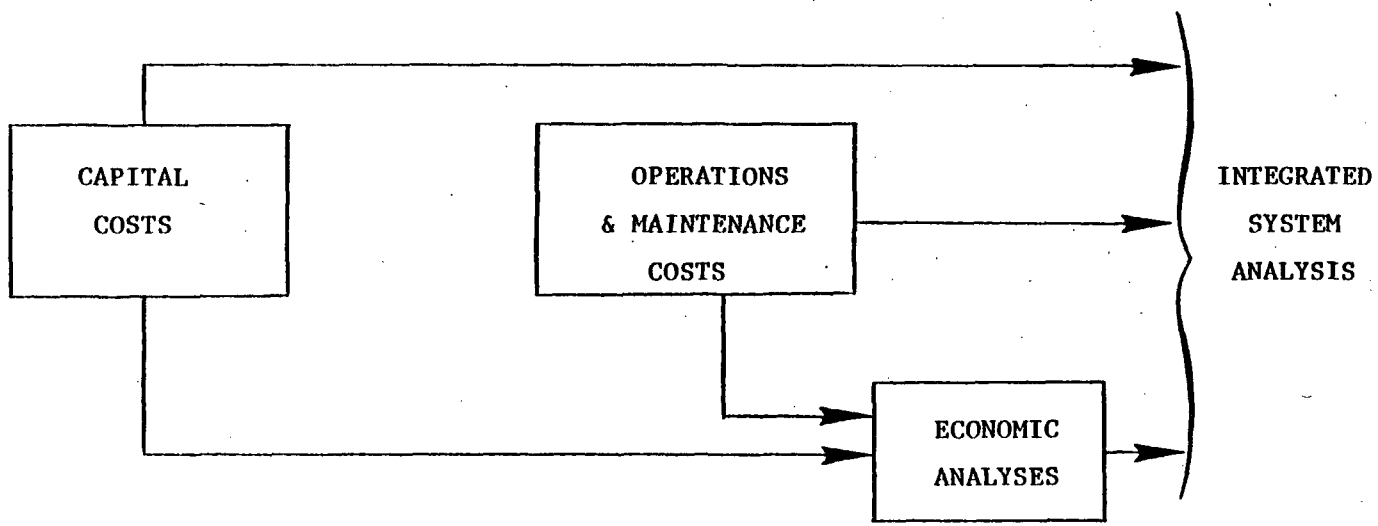
PERFORMANCE ANALYSIS



M-X/RES INTEGRATED SYSTEM COST ANALYSIS

PRELIMINARY GEOTHERMAL DATA REQUIREMENTS

- GENERAL COST DATA CATEGORIES:



- TWO SETS REQUIRED:
  - M-X APPLICATIONS
  - COMMERCIAL APPLICATIONS

M-X/RES GEOTHERMAL CAPITAL COST DATA

- 0 LAND
- 0 FACILITIES (CONSTRUCTION/INSTALLATION):
  - OPERATIONAL
  - MAINTENANCE
- 0 CONVERSION SUBSYSTEMS:
  - TURBINE-GENERATORS
  - COOLING
- 0 EMISSION ABATEMENT
- 0 MASTER/SUBSYSTEM CONTROL
- 0 SWITCHING/INTERCONNECT
- 0 PERMITS
- 0 SITE PREPARATION/DEVELOPMENT
- 0 WELLS AND SURFACE PIPING:
  - CASINGS
  - SEPARATORS/HEAT-EXCHANGERS
  - PUMPS/VALVES
  - INSTRUMENTATION
  - HEADERS
- 0 STORAGE SUBSYSTEMS (IF APPLICABLE)
- 0 TRANSMISSION/DISTRIBUTION:
  - ELECTRIC
  - DIRECT THERMAL
- 0 "LEARNING CURVES"

M-X/RES GEOTHERMAL OPERATIONS/MAINTENANCE COST DATA

- OPERATING PERSONNEL:
  - TRAINING
  - LABOR
- MAINTENANCE:
  - MATERIALS
  - SPARE PARTS
  - LABOR
- WATER USE
- FUEL (IF APPLICABLE)
- UTILITY POWER

M-X/RES GEOTHERMAL ECONOMIC ANALYSIS DATA

0 COST ANALYSIS:

- LIFE CYCLE COSTS
- DISCOUNT RATES
- FY 1980 DOLLARS (NPV)
- ENVIRONMENTAL
- HEALTH AND SAFETY

0 SYSTEM COST SENSITIVITIES:

- CUMULATIVE PRODUCTION
- PRODUCTION RATE
- LENGTH OF CONSTRUCTION/PRODUCTION PERIODS
- VARIATIONS IN CONNECTED LOAD, RESOURCE/WATER AVAILABILITY
- SUBSYSTEM CAPACITIES
- PERFORMANCE PARAMETERS

0 INCREMENTAL COSTS:

- LOAD GROWTH POTENTIAL
- FOSSIL FUEL COSTS

} IMPLICATIONS FOR DESIGN, PERFORMANCE, OPERATION, SITING

M-X/RES PRELIMINARY GEOTHERMAL SYSTEM AVAILABILITY DATA

(CONSISTENT WITH SOW)

0 DEFINITION ≡ TIME POWER OF ACCEPTABLE QUALITY
TIME REQUIRED (i.e., CONTINUOUS)

0 PRELIMINARY AVAILABILITY DATA:

- PROBABILITY OF SYSTEM/RESOURCE STATES
- SUBSYSTEM UNAVAILABILITY FRACTIONS:
  - MTBF, MTTR
  - BACKUP (IF APPLICABLE)
  - SCHEDULED MAINTENANCE
  - SCHEDULED REPLACEMENT
- SUBSYSTEM FAILURES DUE TO LARGE FLUCTUATIONS:
  - DEMAND
  - RESOURCE
  - WATER
- OPERATIONAL LIFETIME
- FMEA HIGHLIGHTS OF DESIGN EMPHASIS

0 DETAILED AVAILABILITY DATA:

- REFINED PRELIMINARY DATA
- PARAMETER UNCERTAINTIES/RANGES
- SUITABLE ENVIRONMENTAL REGIMES OF OPERATION
- IMPACT OF REGIME EXCURSIONS ON SYSTEM RELIABILITY
- PERFORMANCE DEGRADATION DUE TO LONG-TERM EXPOSURE

0 DETAILED INSTRUCTIONS FORTHCOMING PER M-X/RES PROJECT OFFICE

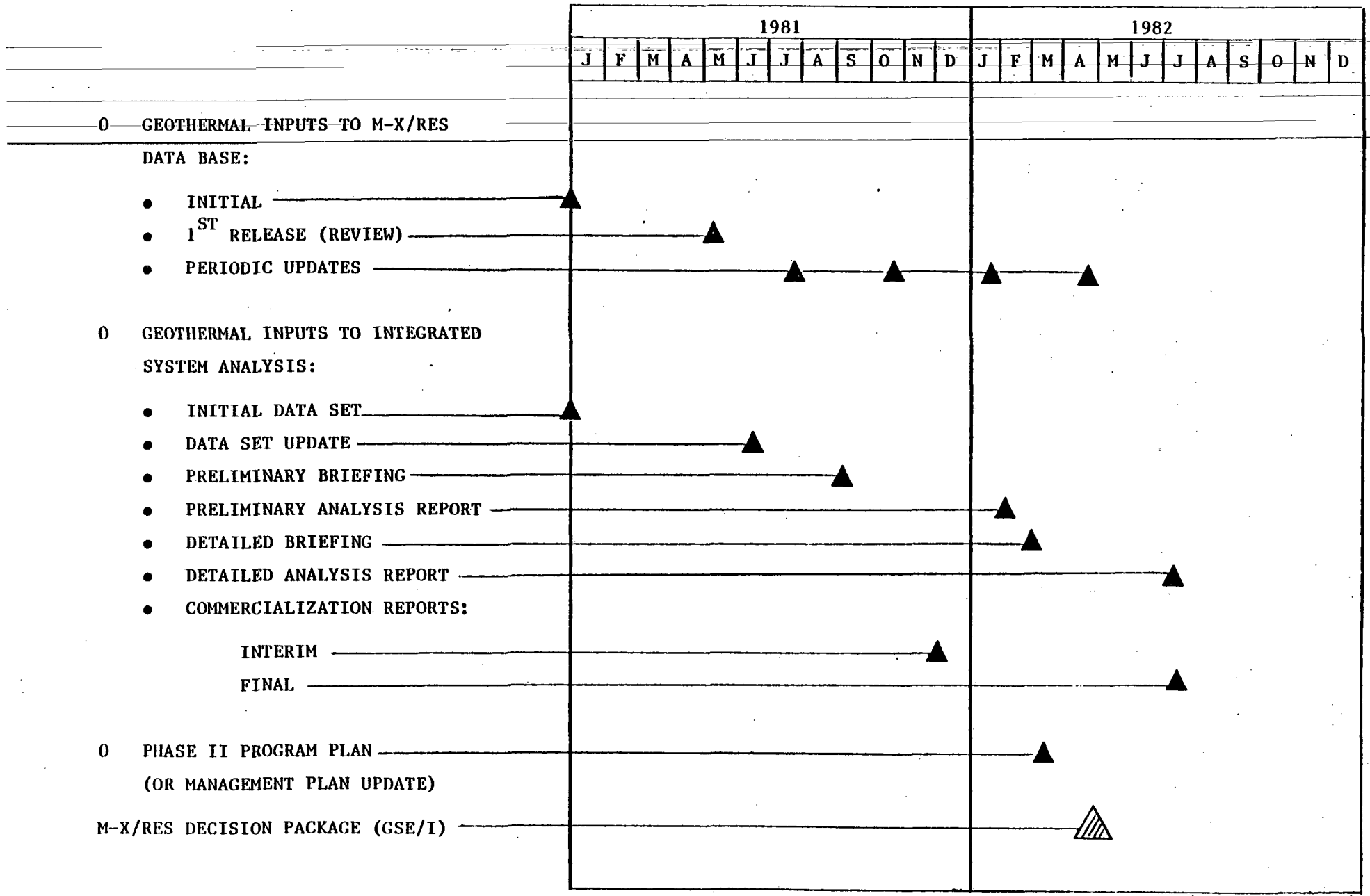
SUPPLEMENTAL M-X/RES GEOTHERMAL DATA REQUIREMENTS FOR INTEGRATED SYSTEM ANALYSES

- INTERPRETATIONS OF SOCIO-INSTITUTIONAL
  - PERMITS
  - LEASING ARRANGEMENTS
  - WATER RIGHTS
  - PUBLIC OPINION/SENSITIVITY
  - ENVIRONMENTAL (EMISSIONS, SUBSIDENCE, AESTHETICS)
- IDENTIFICATION OF PERTINENT ISSUES, e.g.:
  - PLU PRESERVATION
  - SAFETY
  - VULNERABILITY
  - SCHEDULE RISKS
  - HUMAN FACTORS

PRELIMINARY DATA DELIVERABLES

M-X/RES GEOTHERMAL ASSESSMENT (PHASE I)

(CONSISTENT WITH SOW)*



* Excludes Detailed Design Specification

M-X/RES GEOTHERMAL ACTIVITY STATUS

- MEETINGS AND COORDINATION TO DATE:
  - DOE-NV INITIAL CONTACT MEETING
  - GEOTHERMAL WORKING GROUP MEETING
  - FUGRO NATIONAL MEETING
  - AFRCE BRIEFING
  - INDUSTRY DISCUSSIONS AND TELECONS
  - IMPERIAL VALLEY AND CERRO PRIETO TOUR
- SIGNIFICANT RESOLUTIONS/FINDINGS TO DATE:
  - GEOTHERMAL/LOAD-CENTER DATA CONSISTENCY
  - MANAGEMENT PLAN PREPARATIONS
  - PROCUREMENT OPTION TRADEOFFS
  - DATA REQUIREMENT RESPONSIBILITY
  - RESOURCE AND APPLICATIONS DEFINITIONS
  - APPLICABLE GEOPHYSICAL INVESTIGATIONS
  - M-X FEDERAL/STATE AGENCY COORDINATION
- DATA EXCHANGES TO DATE:
  - PROJECT INFORMATION
  - SOWs AND ATTACHMENTS
  - MAPS AND REPORTS
  - MEETING SUMMARIES
  - DELIVERIES OUTSTANDING

M-X/RES GEOTHERMAL KEY EVENTS TO DATE

TYPE	AGENCIES IN ATTENDANCE	LOCATION/DATE (CY 80)
WORKING GROUP MEETING	M-X/RES P.O., DOE-DGE, DOE-ID, DOE-NV, ESL-UURI, AEROSPACE	DOE-NV/8-25
DATA AVAILABILITY MEETING	DOE-ID, DOE-NV, ESL-UURI, NBM, UGS, FUGRO NATIONAL, AEROSPACE	FUGRO NATIONAL/8-27
AFRCE COORDINATION BRIEFING	AFRCE, AEROSPACE	AFRCE/9-8
INITIAL INTER-AGENCY COORDINATION	DOE-NV, AEROSPACE	DOE-NV/8-11
GEOTHERMAL FACILITY TOURS	BMO/TRW, AEROSPACE	CERRO PRIETO, EAST MESA, BRAWLEY/5-14 TO 5-15

SIGNIFICANT RESOLUTIONS TO DATE

- GEOTHERMAL/LOAD CENTER DATA CONSISTENCY--APPLICATIONS AND RESOURCE CHARACTERIZATION IS TO BE CONSISTENT WITH CHARACTERIZATION REQUIREMENTS OF SHELTER, CLUSTER, BASE SOWs
- DOE GEOTHERMAL MANAGEMENT PLAN (EARLY OCTOBER, 1980):
  - RESOURCE ASSESSMENT APPROACH
  - APPLICATIONS ANALYSIS APPROACH
  - DELIVERABLES
  - SEMANTICS
- PROCUREMENT OPTION TRADEOFFS FOR APPLICATIONS ANALYSIS:
  - UTILITY
  - FIELD DEVELOPER
  - A&E
- AEROSPACE RESPONSIBILITY FOR GEOTHERMAL DATA REQUIREMENTS:
  - M-X/RES DATA BASE BOOK
  - INTEGRATED SYSTEM ANALYSIS
- RESOURCE AND APPLICATIONS DEFINITIONS (PHASE I)
  - APPLICATIONS ANALYSIS ≡ INVESTIGATION ACTIVITY DOWNSTREAM OF THE WELLHEAD (ENERGY CONVERSION OR DIRECT USE)
  - RESOURCE ASSESSMENT ≡ ACTIVITY RELATED TO BELOW THE WELLHEAD (EXPLORATION AND DRILLING)
- APPLICABLE GEOPHYSICAL INVESTIGATIONS
  - KGRAs
  - OB SITES
  - OTHER INTRA-DEPLOYMENT AREA SITES
- COORDINATION CHANNELS
  - FORMAL INFORMATION REQUESTS THROUGH DOE-DGE (INFORMALLY EXPEDITED)
  - AFRCE/FUGRO COORDINATION THROUGH AEROSPACE
  - FEDERAL/STATE AGENCY CONTACTS FOR M-X CAUTIONED

FINDINGS RESULTING FROM FUGRO NATIONAL EXPLORATIONS/INVESTIGATIONS

(M-X DEPLOYMENT AREA)

- DRILLING PROGRAM APPROXIMATELY 80% COMPLETE:
  - LIMITED TO SURFACE AND SHALLOW HOLE INVESTIGATIONS
  - OPPORTUNITY EXISTS TO "LINE" AND INSTRUMENT NON-OPTIMALLY LOCATED HOLES AT OB SITES
  - BALANCE OF PLANNED DRILLING RELATIVELY INFLEXIBLE AT "OTHER" INTRA-DEPLOYMENT AREA SITES

- DRILLING ACTIVITY FOR M-X NOT DESIGNED TO PROVIDE RESOURCE LOCATION ASSESSMENT INFORMATION:
  - EXISTING BOREHOLE USEFULNESS UNDETERMINED
  - ACTIVITY AT KGRAs AVOIDED PER BMO/AFRCE GROUNDRULE
  - INTERPRETATION OF RAW DATA MAY BE USEFUL TO M-X?RES ACTIVITY

- OTHER ACTIVITIES IDENTIFIED FOR M-X/RES POTENTIAL:
  - WATER RESOURCES INVESTIGATION MAY HELP SPECIFY CANDIDATE SYSTEM DESIGN CONSTRAINTS
  - EXISTING RELATIONSHIPS BETWEEN FEDERAL/STATE AGENCIES MAY BE USEFUL TO M-X/RES ACTIVITY
  - EXISTING PERMITS CAN BE EXTENDED

M-X/RES PROJECT

GEOTHERMAL DOCUMENT DISTRIBUTION (8-25-80)

ORGANIZATION (NAME)	3 DRAFT SOWs (1)*	RFP ATTACHs H,I,J (2)	SIX MAPS O.B.s (3)	ESAAB LETTER (4)	ESAAB BRIEFING (5)	ESL-UURI BRIEFING (6)	FEAS. TASK OBs (7)
M-X/RES P.O. (Capt. J. Owendoff)	-	-	-	-	-	1	1
DOE-DGE (R. Gray)	1	1	1	1	1	1	1
DOE-NV (A. Roberts)	3	3	3	3	3	3	-
DOE-ID (L. Mink)	2	2	2	2	2	2	2
ESL-UURI (D. Nielson)	2	2	2	2	2	-	2
AEROSPACE (D. Rountree)	-	-	-	3	3	3	3
THE FOLLOWING WERE DISTRIBUTED BY DOE-NV SUBSEQUENT TO THE MEETING:							
NEVADA BUREAU OF MINES AND GEOLOGY (D. Trexler)	1	1	1	-	-	-	-
UTAH GEOLOGIC SURVEY (P. Murphy)	1	1	1	-	-	-	-

(ABOVE NUMBERS INDICATE COPIES RECEIVED)

*(1) M-X/RES SHELTER, CLUSTER, OPERATING BASE SOWs, 17 AUGUST 1980.

(2) ATTACHMENTS SUPPORTING ABOVE RFPs: H, M-X AND M-X/RES POWER CHARACTERISTICS AND REQUIREMENTS; I, INSOLATION AND WIND RESOURCES; J, REGIONAL AND SITE CHARACTERIZATION DATA.

(3) FUGRO NATIONAL OPERATING BASE LAYOUT OPTIONS FOR ESCALANTE DESERT, BERYL AREA: STEPTOE VALLEY, ELY AREA; COYOTE SPRINGS/KANE SPRINGS - ESCALANTE DESERT AREA; MILFORD AREA; SEVIER DESERT, DELTA AREA; AND SELECTION OF POSSIBLE LOCATIONS IN SEVIER DESERT, DELTA AREA.

(4) ESAAB MEMORANDUM 1-80 TITLED: "ENERGY SYSTEMS ACQUISITION ADVISORY BOARD (ESAAB) MEETING NO. 80-8: M-X RENEWABLE ENERGY SYSTEMS, JULY 31, 1980," 15 AUGUST 1980.

(5) BRIEFING CHARTS REGARDING M-X/RES PROJECT PRESENTED BY D. CAMPBELL AND LT. COL. L. MONTULLI TO ESAAB ON 31 JULY 1980.

(6) ESL-UURI DOCUMENT: "BACKGROUND INFORMATION AND PLAN FOR MX MISSILE SYSTEM, GEOTHERMAL RESOURCE ASSESSMENT AND DEVELOPMENT, NEVADA AND UTAH," 25 AUGUST 1980.

(7) DOE-NV HANDOUT: "FEASIBILITY STUDY - TASK OBJECTIVES," UNDATED.

OTHER M-X/RES GEOTHERMAL DATA EXCHANGES

- DATA DELIVERIES:

RECIPIENT ORGANIZATIONS	COMPLETED		OUTSTANDING					
	FUGRO M-X/RES REPORT	NBMG MAPS	COLOR DEPL. MAPS	OB SITE MAPS	TABULATED BOREHOLE DATA	FUGRO MEETING VUGRAPHS	FUGRO REPORT LISTS	UTAH GEO MAP
DOE-ID	1	-	-	-	1	1	1	-
DOE-NV	3	-	-	-	1	1	1	-
ESL-UURI	1	-	1	1	1	1	1	-
NBMG	2	-	1	1	1	1	-	-
UGS	1	-	1	1	1	1	1	-
AEROSPACE	-	1	1	1*	1	1	2*	2

(ABOVE NUMBERS INDICATE NUMBER OF COPIES)

*INDICATES DATA IS BEING PREPARED FOR DELIVERY

- MEETING AND TOUR SUMMARY REPORTS TRANSMITTED TO M-X/RES PROJECT OFFICE AND APPROPRIATE DISTRIBUTION
- TECHNICAL REPORTS/PAPERS FOR RAFT RIVER BINARY SYSTEM, DOE-ID TO AEROSPACE

AEROSPACE CONCERNS FOR ACCOMPLISHMENT OF GEOTHERMAL ASSESSMENT OBJECTIVES

- SCHEDULE AND COMMUNICATION IMPLICATIONS
- PHILOSOPHY OF EMPHASIS ON RESOURCES/APPLICATIONS
- M-X/RES DATA BASE BOOK CONTENT
- POTENTIAL DATA INCONSISTENCY: GEOTHERMAL vs. OTHER TECHNOLOGIES
- MIL-STANDARD ROLE IN M-X/RES

SCHEDULE AND COMMUNICATION IMPLICATIONS FOR M-X/RES GEOTHERMAL ACTIVITIES

- IMPACTS DELIVERY OF HIGH-CONFIDENCE APPLICATIONS DATA FOR INTERIM AND DECISION PACKAGE MILESTONES

- REQUIRES SHORTENED PROCUREMENT CYCLE DEFINITION/IMPLEMENTATION FOR CONTRACTED SERVICES

- NEEDS TEAM EFFORT AND COMMUNICATION CHANNELS TO:
  - COORDINATE DATA DELIVERIES
  - OBTAIN PERMITTING

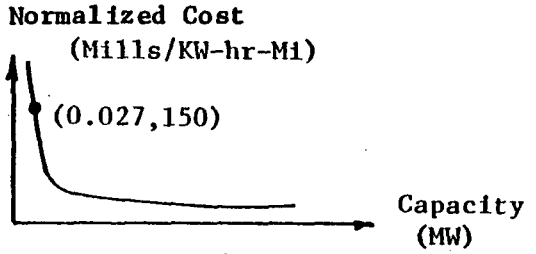
PHILOSOPHY OF EMPHASIS ON RESOURCES/APPLICATIONS

- CONSIDERATIONS FOR DISTRIBUTION OF ACTIVITY EFFORTS AND FUNDS:

ACTIVITY/BUDGET

SITE CATEGORY	RESOURCES		APPLICATIONS (PLANT, O&M, T&D, etc.)	
• KGRA • OB • OTHER	Specific Tasks	Allocated Funding ($3.5 M Total)	Specific Tasks	Allocated Funding ($2.5 M Total)

- POTENTIAL LOCATION IMPACTS:
  - TRANSMISSION AND DISTRIBUTION SYSTEM:

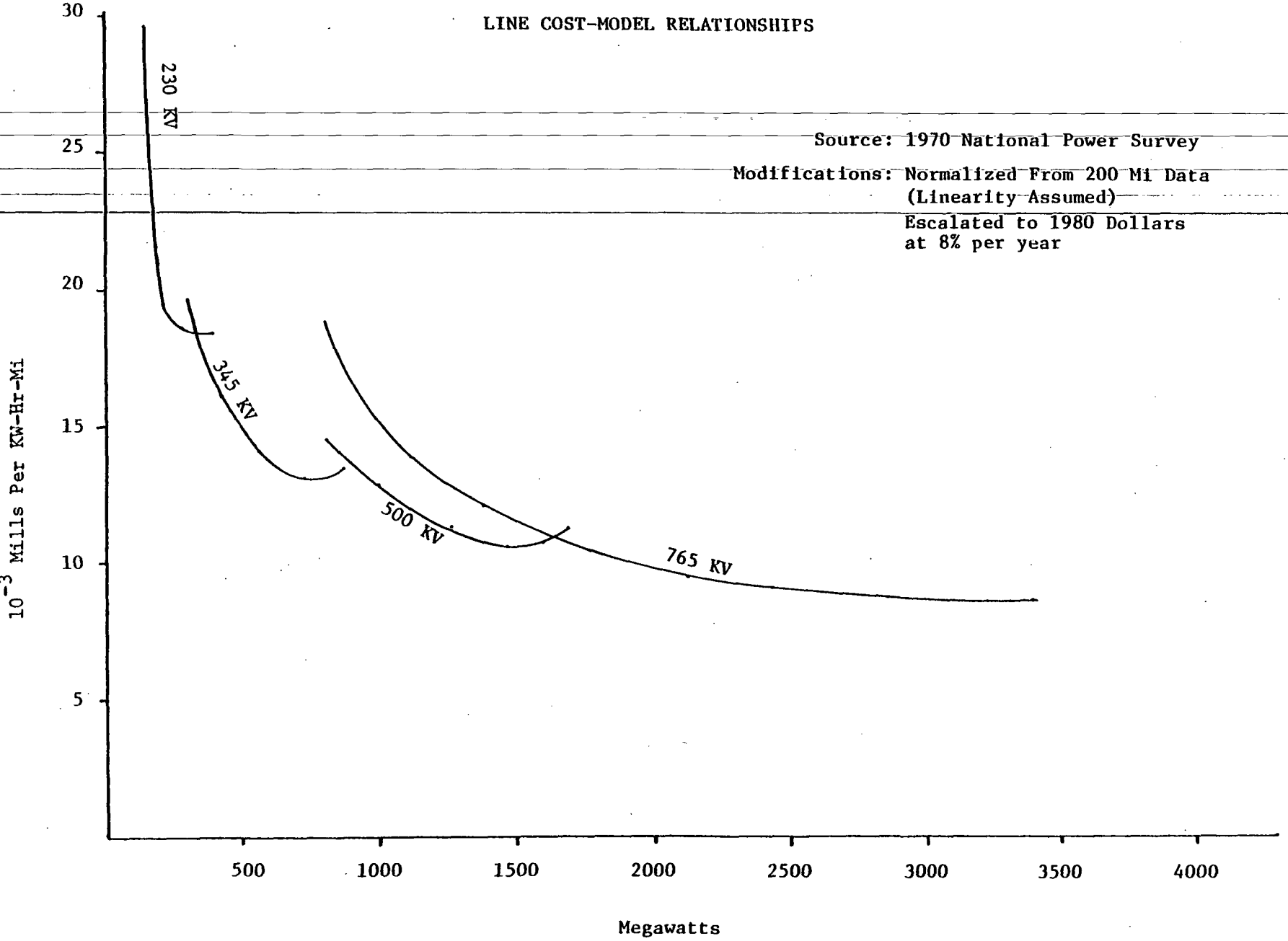


Low Line Capacity:
- High T&D Costs (~ 50% System)
- Atypical Design Tradeoffs Versus Line Length

  - WATER AVAILABILITY/USAGE TRADEOFFS:
    - Sharing with Alternate RES Technologies
    - Water Resource vs. Facility Proximity
    - Self-Use vs. Subsidence/Re-injection
  - IMPLIED INITIAL COMPLETION IN SOUTHEAST DEPLOYMENT SECTOR

PRELIMINARY GENERAL TRANSMISSION

LINE COST-MODEL RELATIONSHIPS



Source: 1970 National Power Survey

Modifications: Normalized From 200 Mi Data (Linearity Assumed)

Escalated to 1980 Dollars at 8% per year

M-X/RES DATA BASE BOOK CONTENT CONSIDERATIONS

- AGREEMENT REQUIRED FOR DELIVERY OF RESOURCE AND SOCIO-INSTITUTIONAL FORMATTED ITEMS

- AGREEMENT REQUIRED FOR ANCILLARY ENERGY IDENTIFIERS FOR LOAD-CENTER CONTRACTORS
  - POWER PROFILES
  - AVAILABILITY
  - BUSBAR COSTS
  - POWER SOURCE INTERFACE
  - WATER USAGE

  } GENERIC vs. SITE SPECIFIC

- SHOULD DESCRIPTIONS BE INCLUDED FOR EVOLVING GEOTHERMAL TECHNOLOGIES?
  - CATEGORIES
  - FUNDING
  - RESPONSIBILITIES

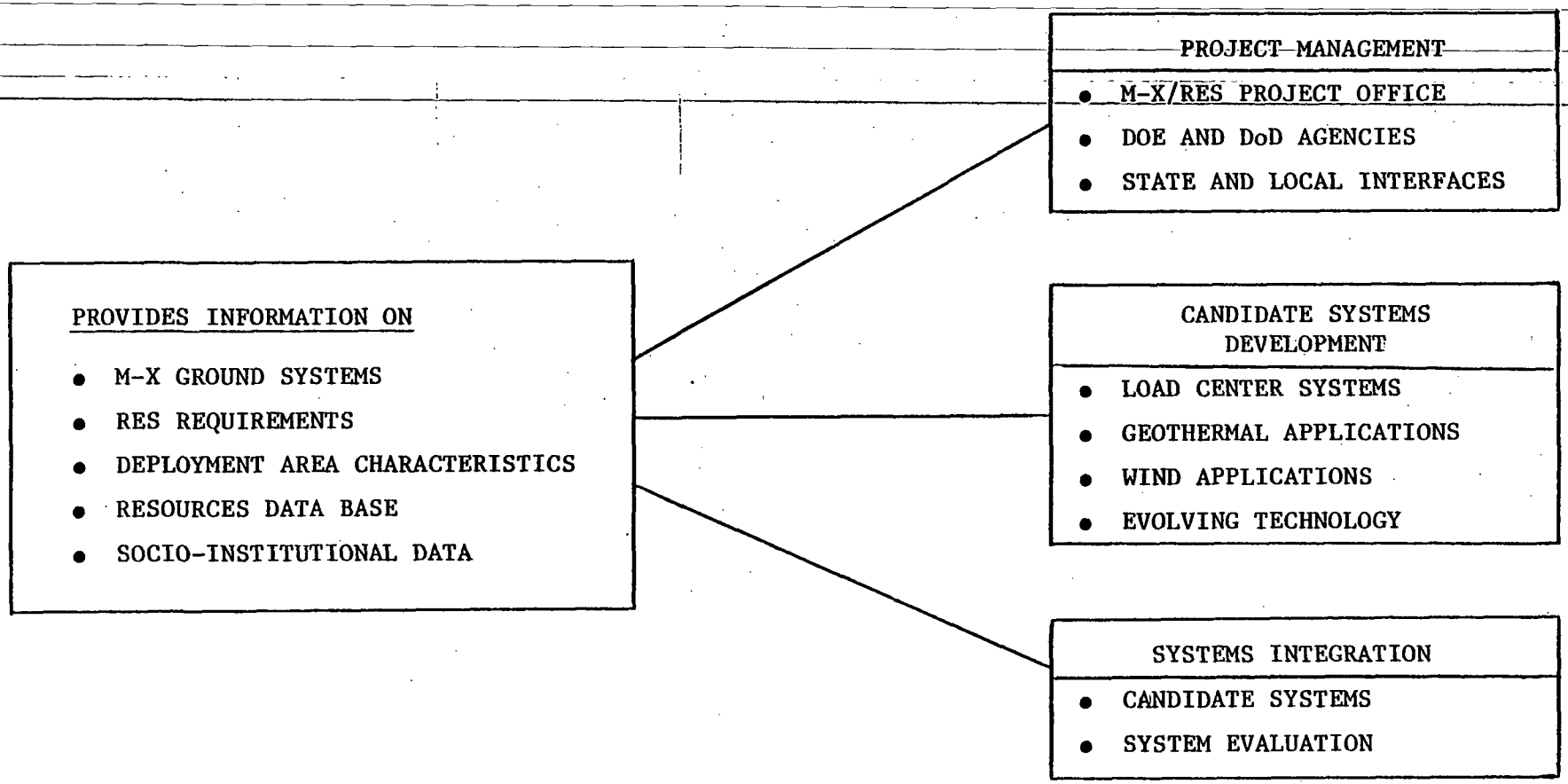
POTENTIAL M-X/RES DATA INCONSISTENCY: GEOTHERMAL vs OTHER TECHNOLOGIES

GEOTHERMAL APPLICATIONS	OTHER TECHNOLOGIES
● ESTABLISHED TECHNOLOGY	● TECHNOLOGY DEVELOPMENT STAGE
● DESIGN CONCEPTS	● PRELIMINARY AND DETAILED DESIGNS
● SPECIFICATION DELIVERABLE OMITTED	● DETAILED DESIGN SPECIFICATION

ANTICIPATED AEROSPACE FOLLOW-UP ACTIVITIES FOR M-X/RES GEOTHERMAL ASSESSMENT

- CONTINUE REFINING DATA REQUIREMENTS
  (DATA BASE BOOK, INTEGRATED SYSTEM ANALYSES)
- REVIEW DOE-DGE MANAGEMENT PLAN
- CONTINUE COORDINATION WITH DOE, AFRCE, FUGRO NATIONAL, AND OTHERS AS APPROPRIATE
- TOUR DOE RAFT RIVER PROJECT
- OBTAIN AND FORWARD DATA OUTSTANDING

RATIONALE FOR M-X/RES DATA BASE BOOK



M-X/RES DATA BASE OUTLINE

1.0 INTRODUCTION

- SCOPE
- METHODOLOGY

2.0 M-X FACILITIES AND POWER SYSTEM

- FACILITIES
- BASELINE POWER SYSTEM
- LOCAL UTILITY INTERFACES
- IMPLEMENTATION SCHEDULE

3.0 M-X/RES REQUIREMENTS

- SYSTEM POWER
- M-X SYSTEM/RES INTERFACES
- SYSTEM PERFORMANCE

4.0 M-X SITE CHARACTERISTICS

- DEPLOYMENT AREA
- DESIGN FACTORS
- SPECIAL CONSIDERATIONS

5.0 RESOURCES DATA BASE

- INSOLATION
- WIND
- JOINT INSOLATION/WIND
- GEOTHERMAL
- BIOMASS
- STORAGE

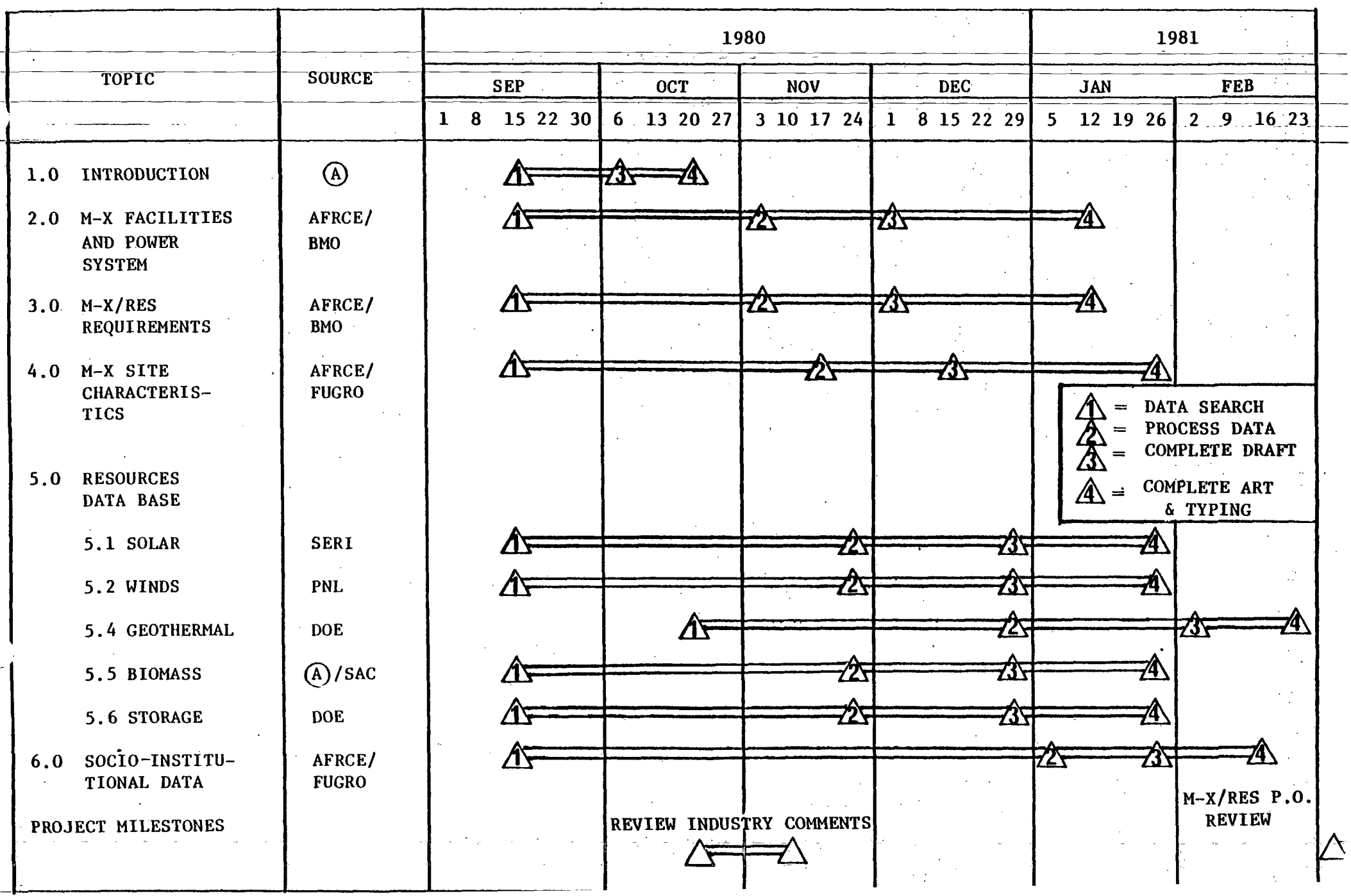
6.0 SOCIO-INSTITUTIONAL DATA

- REGULATORY
- LEGAL
- REGIONAL TRANSPORTATION
- REGIONAL COMMUNUCATIONS
- ENVIRONMENTAL

7.0 TECHNOLOGY DESCRIPTIONS

8.0 APPENDICES

M-X/RES DATA BASE SCHEDULE



MX-RES INTEGRATED SYSTEMS

EVALUATION CRITERIA AND ANALYSIS METHODOLOGY

(A STATUS REPORT)

PRESENTED TO: MX-RES PROJECT OFFICE

SEPTEMBER 1980

THE AEROSPACE CORPORATION

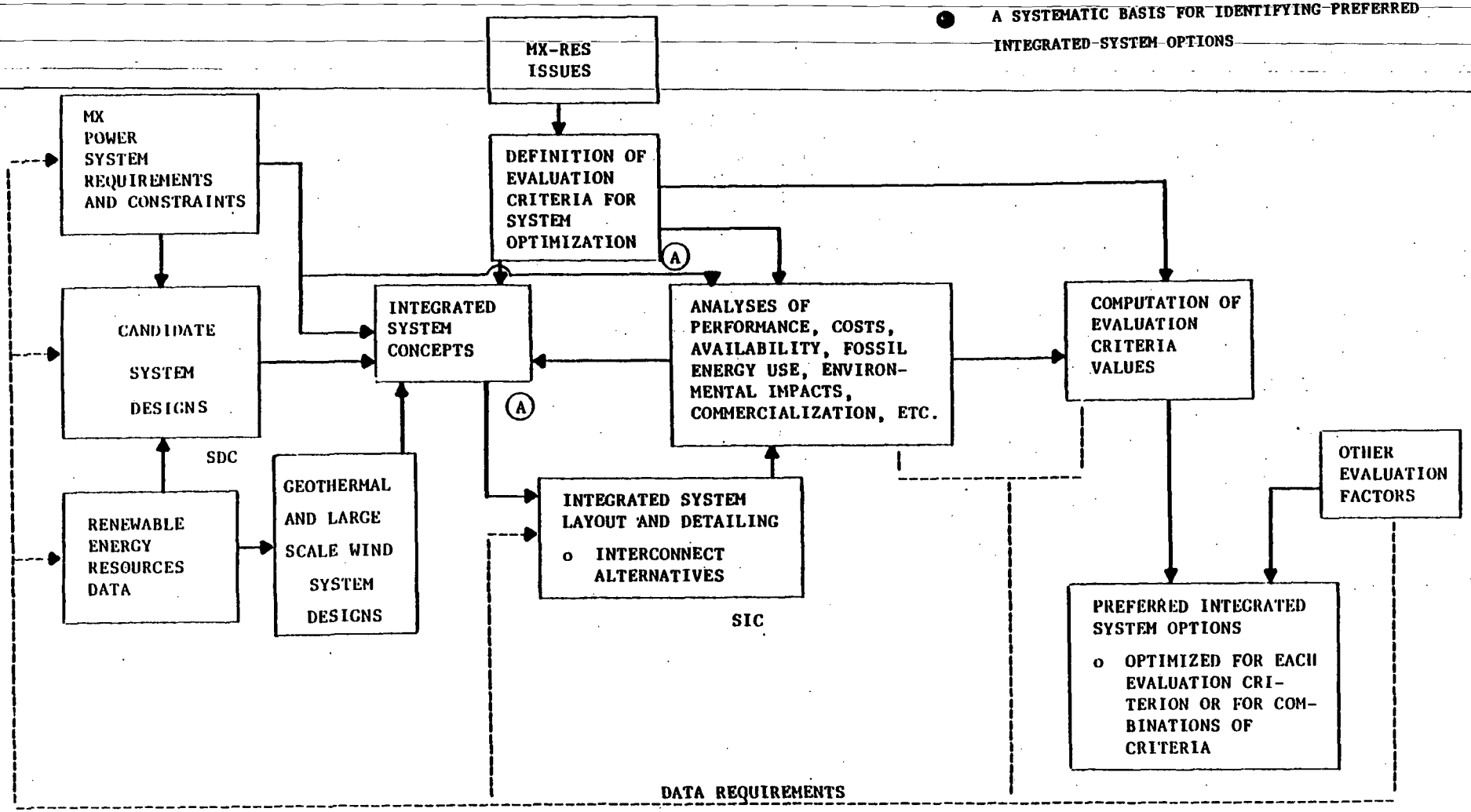
DEFINITIONS

CANDIDATE SYSTEM (CS) - POWER SYSTEMS WITH APPROPRIATE BACKUP AND STORAGE AS DESIGNED BY THE SDC'S TO SATISFY SHELTER, CLUSTER, AND OPERATING BASE POWER AND POWER AVAILABILITY REQUIREMENTS, AS WELL AS GEOTHERMAL AND LARGE-SCALE WIND SYSTEMS

INTEGRATED SYSTEM (I/S) - COMBINATIONS OF CANDIDATE SYSTEMS SATISFYING LOAD REQUIREMENTS AND OTHER CONSTRAINTS FOR THE OVERALL MX SYSTEM

MX-RES INTEGRATED SYSTEMS EVALUATION METHODOLOGY

● A SYSTEMATIC BASIS FOR IDENTIFYING PREFERRED INTEGRATED-SYSTEM OPTIONS



INTEGRATED SYSTEM EVALUATION CRITERIA FOR SYSTEMS OPTIMIZATIONS

ISSUES	CRITERION PARAMETER
COST	e.g., $= \sum_{t=1}^{N} C_t (1+k)^{-t}$
UTILITY CAPACITY	ADDITIONAL REQUIRED UTILITY CAPACITY
MX ENERGY INDEPENDENCE	TOTAL FOSSIL ENERGY SAVINGS BY MX
MX ENVIRONMENTAL ACCEPTABILITY	e.g., $= 1 - \left(a \frac{\Delta W_{RES}}{\Delta W_{BPS}} + b \frac{\Delta P_{RES}}{\Delta P_{BPS}} + c \frac{\Delta L_{RES}}{\Delta L_{BPS}} \right)$, $a + b + c = 1$
NATIONAL BENEFITS FROM ACCELERATED COMMERCIALIZATION	e.g., $= \sum_{t=1}^{N} (B_t - C_t) (1+k)^{-t}$
AVAILABILITY	NOT APPROPRIATE ISSUE FOR SYSTEM OPTIMIZATION (ALL INTEGRATED SYSTEMS MUST BE DESIGNED COMMENSURATE WITH MX AVAILABILITY REQUIREMENTS. MEANS OF DOING SO WILL BE REFLECTED IN COSTS, FOSSIL ENERGY UTILIZATION, ETC.)

* BPS - BASELINE POWER SYSTEM

ADDITIONAL EVALUATION FACTORS

CRITERION	DEFINITION	APPROACH	COMMENT
PLU PRESERVATION	ABILITY TO KEEP LOCATION OF MISSILE UNDETECTABLE	EACH I/S WILL BE EXAMINED BY TRW/BMO FOR COMPLIANCE WITH M X REQUIREMENTS	EACH I/S MUST SATISFY THIS REQUIREMENT OR BE ELIMINATED FROM CONSIDERATION
RESOURCE UNCERTAINTY	VARIATIONS FROM NOMINAL OF INSOLATION, WINDS AND GEO-THERMAL PROPERTIES	COST AND PERFORMANCE IMPLI-CATIONS OF RESOURCE UNCERTAINTY	JUDGMENTAL FACTOR
COST UNCERTAINTY	SPREAD IN NOMINAL LIFE-CYCLE COST CALCULATION	RANGE IN COSTS OF ALL SYSTEM COMPONENTS, O&M AND ECONOMIC PARAMETERS	LARGE RANGE WOULD HAVE AN EFFECT ON RANK ORDERING WITH RESPECT TO COST
GROWTH POTENTIAL	ABILITY TO INCREASE POWER LEVELS TO MEET FUTURE DEMANDS	EXAMINE PRACTICALITY AND COST OF ACHIEVING INCREASED POWER LEVELS	JUDGMENTAL FACTOR
SAFETY	MECHANICAL, OPTICAL, THERMAL AND CHEMICAL HAZARDS	EXAMINE HAZARDS GLEANED FROM DESIGNS	JUDGMENTAL FACTOR
VULNERABILITY	DEGRADATION OF SYSTEM PER-FORMANCE DUE TO NATURAL HAZARDS, VANDALISM AND SABOTAGE	IDENTIFICATION OF VULNERABILITY DISPLAYED BY DESIGNS	JUDGMENTAL FACTOR
SCHEDULE RISK	UNCERTAINTY IN MEETING DEPLOYMENT DATES	ASSESS POSSIBLE SCHEDULE IMPACTS OF ALL RISK ITEMS FOR I/S AND ASSOCIATED CS	JUDGMENTAL FACTOR
HUMAN FACTORS	COMPLEXITY OF O&M AND PROCEDURES	EXAMINE - • NUMBER, SKILL LEVELS AND REQUIRED TRAINING OF PERSONNEL • COMPLEXITY OF MAN-MACHINE INTERFACE	JUDGMENTAL FACTOR
VISUAL ACCEPTABILITY		EXAMINE VISUAL DESIGN FEATURES OF I/S	JUDGEMENTAL FACTOR

PREFERRED SYSTEM SELECTIONS

	ENERGY INDEPENDENCE	COST	UTILITY CAPACITY	ENVIRONMENTAL ACCEPTABILITY	NATIONAL BENEFITS	COMBINED CRITERIA #1	COMBINED CRITERIA #2
BEST SYSTEM	INTEGRATED SYSTEM #45	#23	#61	#55	#34	#43	#12
	#34	#55	#12	#12	# 6	#12	#55
	#55	#10	#55	#14	#55	#55	#45
	# 8	#39	# 8	#36	#12	#45	#36
	# 2	#78	.	#45	.	#78	.
LESS DESIRABLE SYSTEM	#47	.	.	.	.	.	.
	.	.	.	.	.	.	.
	.	.	.	.		.	.
	.			.		.	.
	.						

CANDIDATE INTEGRATED SYSTEM DELINEATION PROCESS

TO SELECT A MANAGEABLE SET OF I/S FOR DETAILED ANALYSIS WHICH HAVE DESIRABLE ATTRIBUTES WHITH RESPECT TO VARIOUS EVALUATION CRITERIA

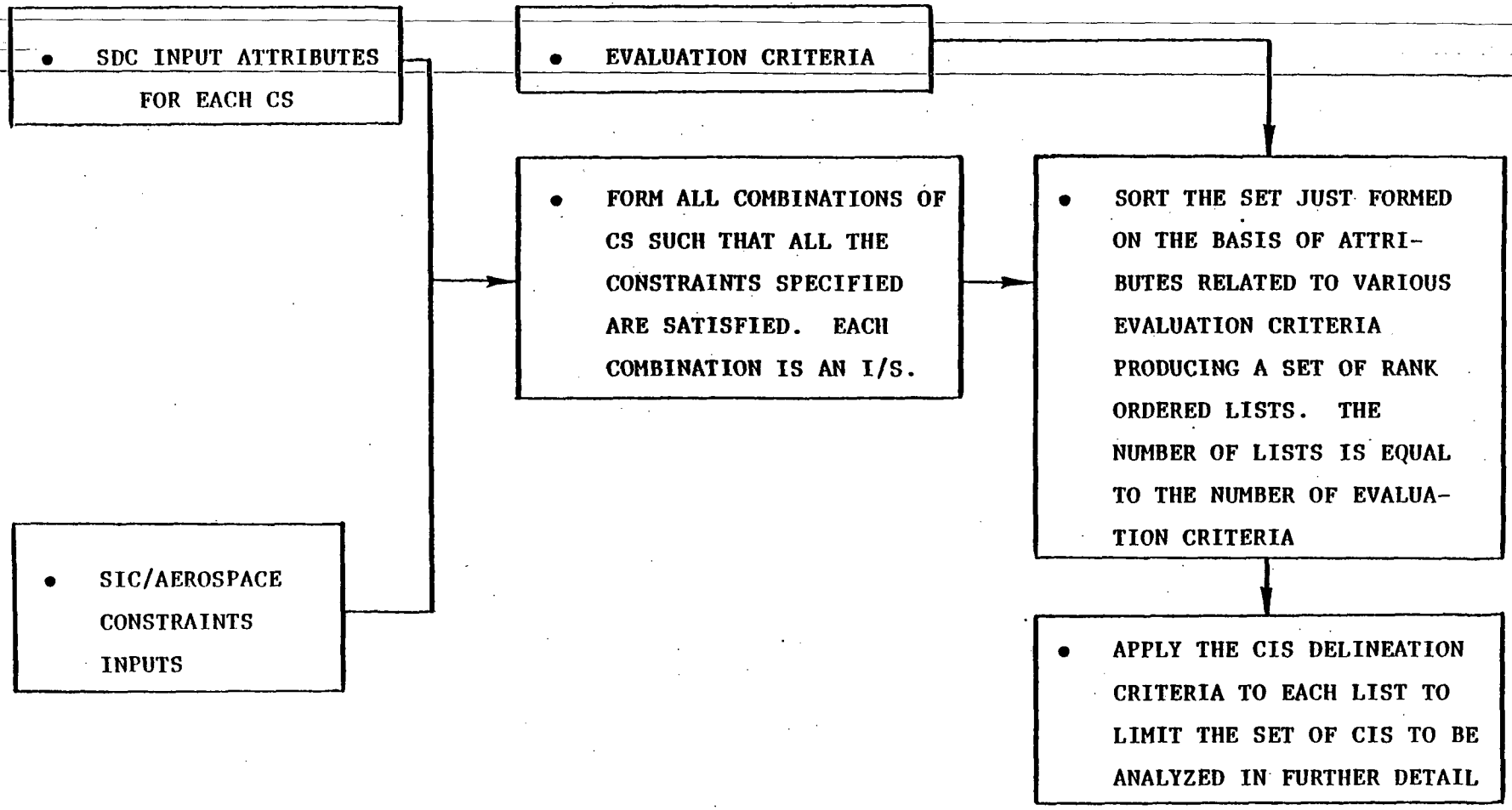
CANDIDATE INTEGRATED SYSTEM DELINEATION PROCESS - INPUT, OUTPUT

0 INPUT

- SDC CS ATTRIBUTES (FOR EACH CS)
  - / TYPE OF CS (E.G., PHOTOVOLTAIC, WIND TURBINE)
  - / POWER LEVEL
  - / LIFE CYCLE COST (TOTAL)
  - / FOSSIL ENERGY USE
  - / COST OF COMMERCIAL VERSIONS
  - / OTHERS
- SIC/AEROSPACE
  - / CONSTRAINTS
    - LOADS TO BE SATISFIED
    - DESIRED MIX OF RES TYPE
    - MAXIMUM LIFE CYCLE COST TOTAL
    - OTHERS
- EVALUATION CRITERIA
  - / MINIMUM LIFE CYCLE COST
  - / MINIMUM FOSSIL ENERGY USE
  - / OTHERS

CANDIDATE INTEGRATED SYSTEM DELINEATION PROCESS - METHODOLOGY

0 FLOW DIAGRAM OF METHODOLOGY



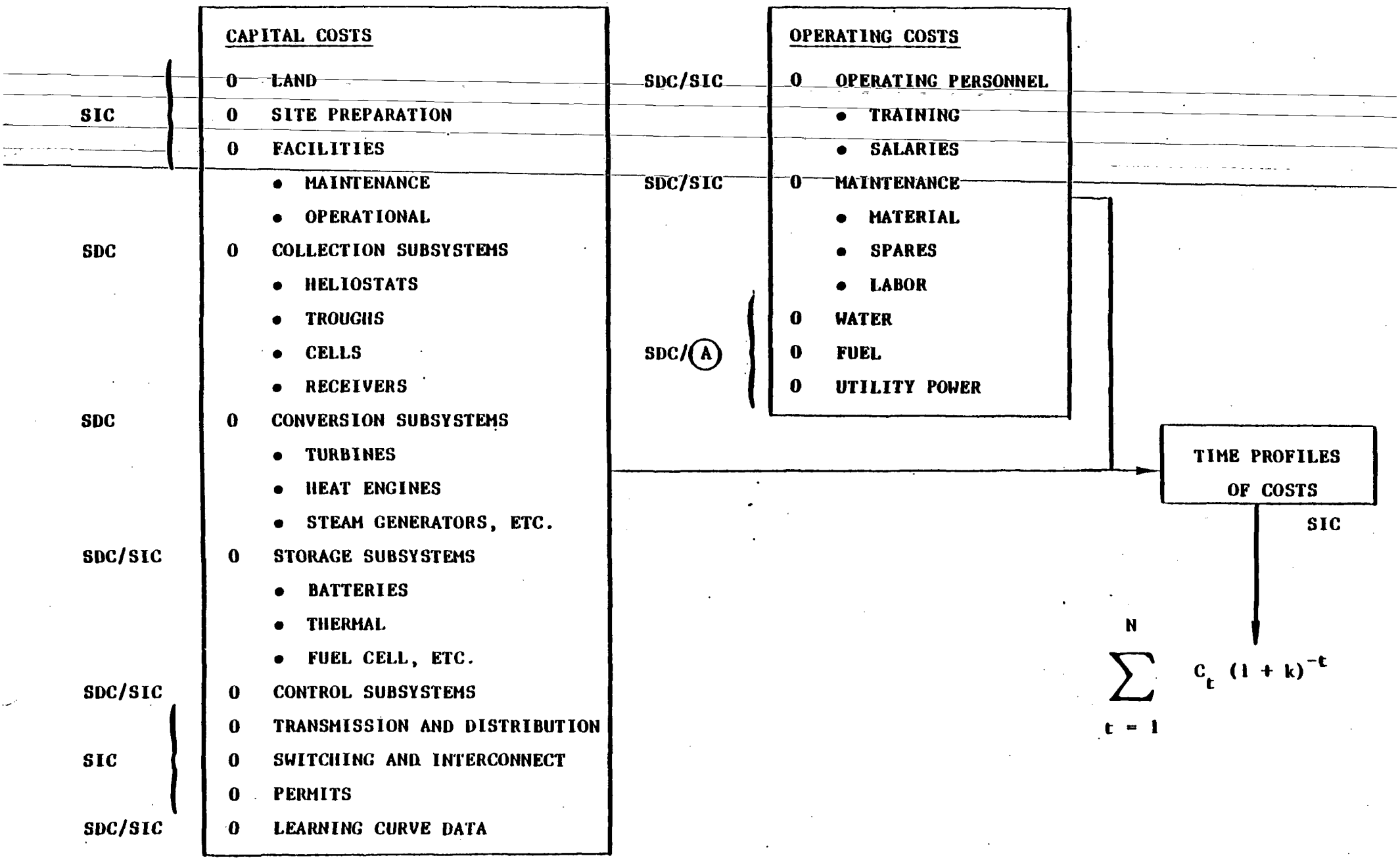
ANALYSIS METHODOLOGY OVERVIEW

ANALYSES \ CRITERIA	LIFECYCLE COST	UTILITY CAPACITY	MX ENERGY INDEPENDENCE	MX ENVIRONMENTAL ACCEPTABILITY	NATIONAL BENEFITS
COST	√		X		√
RELIABILITY/AVAILABILITY	X	√	X		
PERFORMANCE	X	√	√	√	X
MARKET PENETRATION					√
COMPARISONS WITH BPS		X	√	√	
DESIGN LAYOUTS	X			√	
ECONOMICS	√				√

√ = PRIMARY COMPONENT

X = CONTRIBUTOR TO PRIMARY COMPONENT(S)

COST ANALYSIS



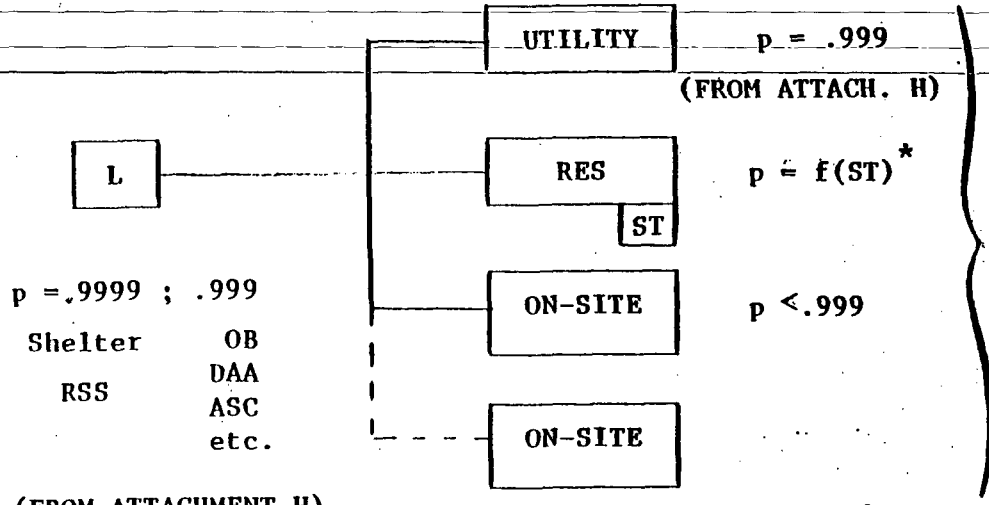
MX-RES INTEGRATED SYSTEM AVAILABILITY METHODOLOGY

INTRODUCTION

- OBJECTIVE - VERIFY THE AVAILABILITY OF A CANDIDATE INTEGRATED SYSTEM FOR M-X GIVEN THE AVAILABILITY AND POWER OF THE CANDIDATE SYSTEMS, RESOURCES, AND TRANSMISSION AND DISTRIBUTION SYSTEM

- AVAILABILITY
  - DEFINITION - THE RATIO OF ACTUAL OPERATING TIME TO TOTAL OPERATING TIME FOR A GIVEN LOAD
  - PROPERTIES
    - / STOCHASTIC
    - / DEPENDENT ON LOAD, RESOURCE AVAILABILITY, GENERATING UNIT RELIABILITIES INCLUDING BACKUPS (TIME TO FAILURE, TIME TO REPAIR, ETC. FOR COMPONENTS), GENERATING UNIT CAPACITIES INCLUDING BACKUPS, TRANSMISSION AND DISTRIBUTION SYSTEM CHARACTERISTICS

CANDIDATE SYSTEM AVAILABILITY



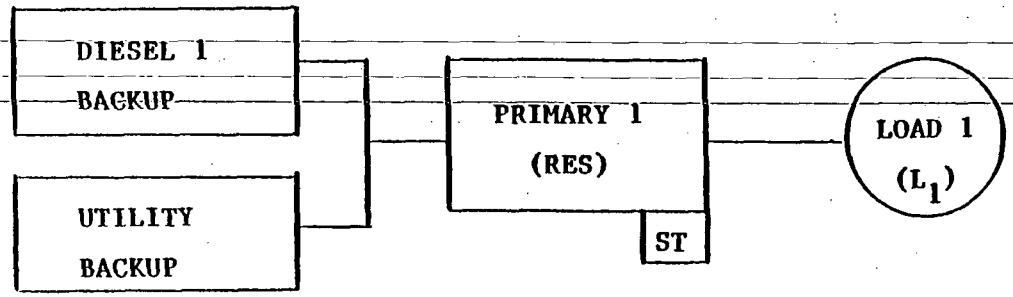
$$\text{AVAIL. OF POWER} = 1 - \left(1 - \frac{\text{AVAIL.}}{\text{G.S. \#1}}\right)\left(1 - \frac{\text{AVAIL.}}{\text{G.S. \#2}}\right) \cdots \left(1 - \frac{\text{AVAIL.}}{\text{G.S. \# n}}\right)$$

* EXTENT OF STORAGE DETERMINES FRACTION OF A DAY RES SYSTEM CAN DELIVER POWER (E.G., ~.2 FOR NO STORAGE UP TO 1.0 WITH STORAGE). THIS AVAILABILITY FRACTION MUST BE ADJUSTED DOWNWARD FOR UNAVAILABILITY DUE TO FAILURES, REPAIR TIMES AND CLIMATOLOGY.

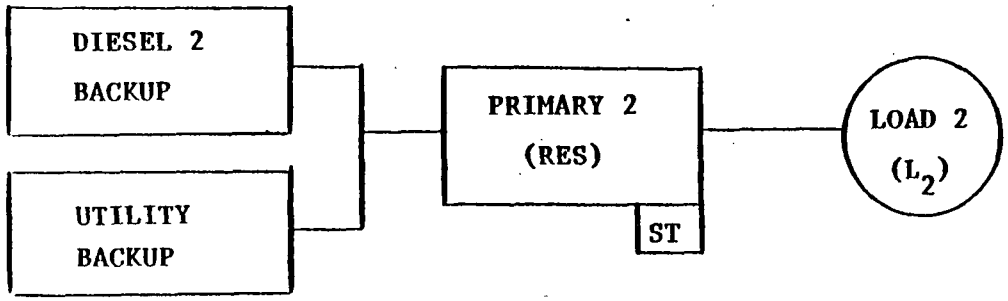
INTEGRATION OF CANDIDATE SYSTEMS

0 CANDIDATE SYSTEMS - EXAMPLE

- VALLEY 1

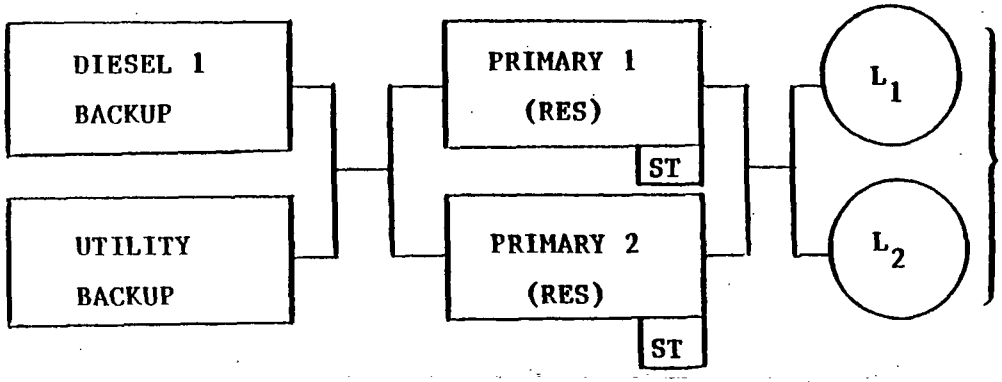


- VALLEY 2



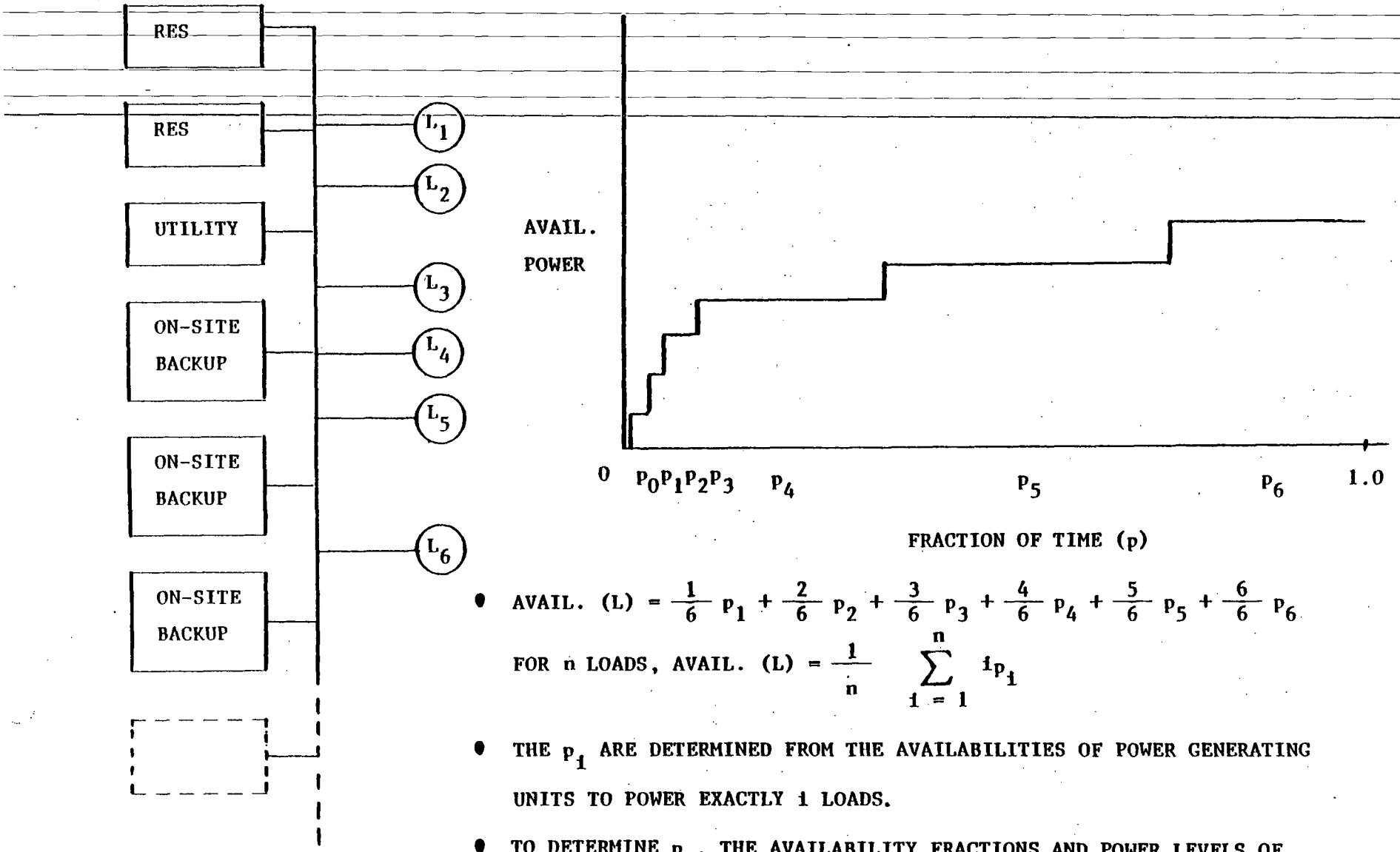
0 INTEGRATED SYSTEM - EXAMPLE

- VALLEY 1 AND VALLEY 2



- AEROSPACE TO VERIFY, BY USING CANDIDATE SYSTEM DATA, THAT INTEGRATED SYSTEM CONFIGURATIONS STILL MEET AVAILABILITY REQUIREMENTS FOR VARIOUS LOADS

INTEGRATED SYSTEM AVAILABILITY



- AVAIL. (L) $= \frac{1}{6} p_1 + \frac{2}{6} p_2 + \frac{3}{6} p_3 + \frac{4}{6} p_4 + \frac{5}{6} p_5 + \frac{6}{6} p_6$

  FOR n LOADS, AVAIL. (L) $= \frac{1}{n} \sum_{i=1}^{n} i p_i$

- THE p_i ARE DETERMINED FROM THE AVAILABILITIES OF POWER GENERATING UNITS TO POWER EXACTLY i LOADS.

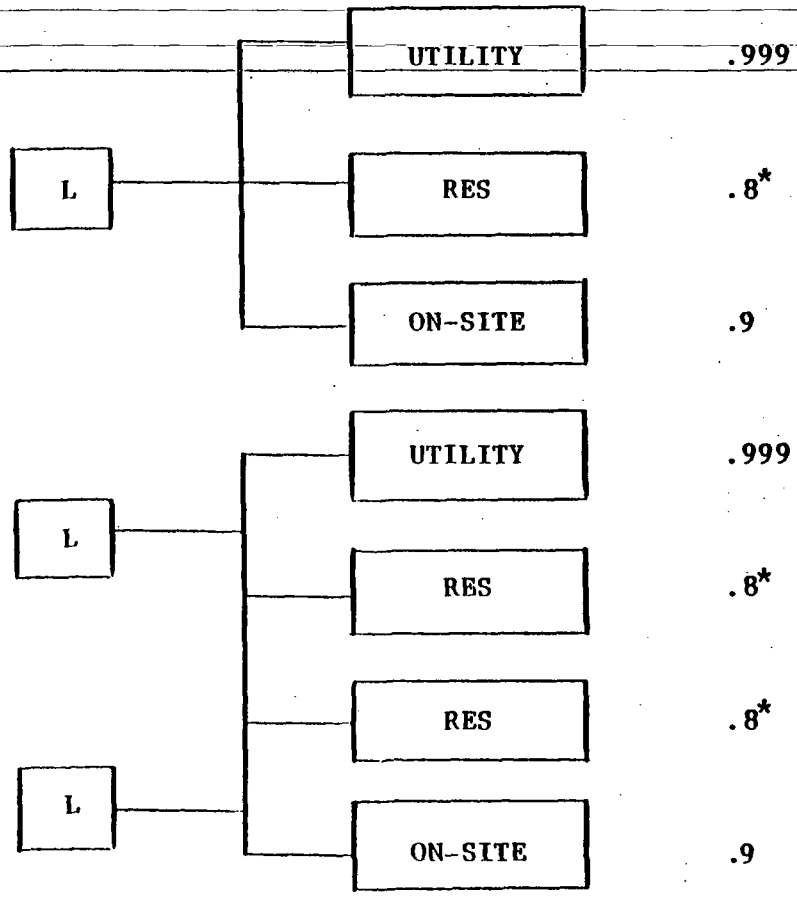
- TO DETERMINE p_i, THE AVAILABILITY FRACTIONS AND POWER LEVELS OF EACH GENERATING UNIT MUST BE INPUT.

MODELLING APPROACH FEATURES

- CAPABLE OF ANALYZING MEANINGFUL INTERCONNECT OPTIONS
- ALL ENERGY LOSSES ARE IGNORED
- ALL SHELTERS HAVE THE SAME LOAD REQUIREMENT
- EACH RES OR BACKUP MAY HAVE SINGLE OR MULTIPLE LOAD POWER CAPABILITY
- EACH RES OR BACKUP MAY HAVE FULL AND PARTIAL POWER
- SIMULTANEOUS UNAVAILABILITY OF RES UNITS AT "NIGHT" ARE TREATED AS SEPARATE CASES TO BE COMBINED WITH "DAYTIME" AVAILABILITY CALCULATIONS ON A TIME-WEIGHTED BASIS
- AVAILABILITY FRACTIONS FOR POWER FROM EACH RES AND BACKUP CAN BE INPUTS BASED ON CANDIDATE SYSTEM STUDIES, T&D LAYOUTS

EXAMPLE CALCULATIONS

AVAILABILITY



AVAIL. (L) = 1 - (1 - .999)(1 - .8)(1 - .9) = .999980

$$\text{AVAIL. (L)} = \frac{0 \cdot P_0 + P_1 + 2P_2}{2}$$

$$= \frac{0(.000004) + (.000068) + 2\ (.999928)}{2}$$

$$= .999962$$

NOTE: UTILITY CAN POWER 2L, WHEREAS RES AND ON-SITE BACKUP CAN POWER L

* WITH ROUND-THE-CLOCK STORAGE

EXAMPLES OF I/S AVAILABILITIES

Case	P_u	P_{r1}	P_{r2}	P_{d1}	P_{d2}	P_0	P_1	P_2	A_L	W no st.	$\bar{A}_L$	W w/st.	$\bar{A}_L$
1D	.999	.8	.8	0	0	.00004	.00032	.99964	.99980	.2		.8	
1N	.999	0	0	0	0	.001	0	.99900	.99900	.8	.99916	.2	.99964
2D	.999	.8	.8	.9	0	.000004	.000068	.999928	.999962	.2		.8	
2N	.999	0	0	.9	0	.0001	.0009	.99900	.99945	.8	.99955	.2	.99990
3D	.999	.8	.8	.9	.9	.0000004	.0000104	.9999892	.99999	.2		.8	
3N	.999	0	0	.9	.9	.00001	.00018	.99981	.99990	.8	.99992	.2	.99998

W = RATIO OF EFFECTIVE DATIME OR NIGHTIME HOURS (INCLUDING STORAGE) TO TOTAL HOURS

A_0 = AVAILABILITY WITH NO RES STORAGE

A_s = AVAILABILITY WITH RES STORAGE

SUMMARY

0 MODELLING APPROACH PROVIDES A VERSATILE MEANS FOR CALCULATING POWER AVAILABILITY TO ALL LOADS OF ANY GIVEN I/S, INCLUDING THE EVALUATION OF ALTERNATE WAYS OF INTERCONNECT OF GENERATING UNITS AND LOADS, THE EFFECTS OF STORAGE AND ON-SITE BACKUP SYSTEMS.

0 RES WITH MINIMUM OR NO STORAGE DOES LITTLE TO REDUCE UTILITY CAPACITY REQUIREMENTS OR NEED FOR ON-SITE BACKUP.

0 SUFFICIENT STORAGE CAN:

- REDUCE UTILITY CAPACITY REQUIRED AND INCREASES SELL-BACK OPPORTUNITIES
- REDUCE NUMBER OF NEEDED ON-SITE BACKUP

MX-RES INTEGRATED SYSTEM

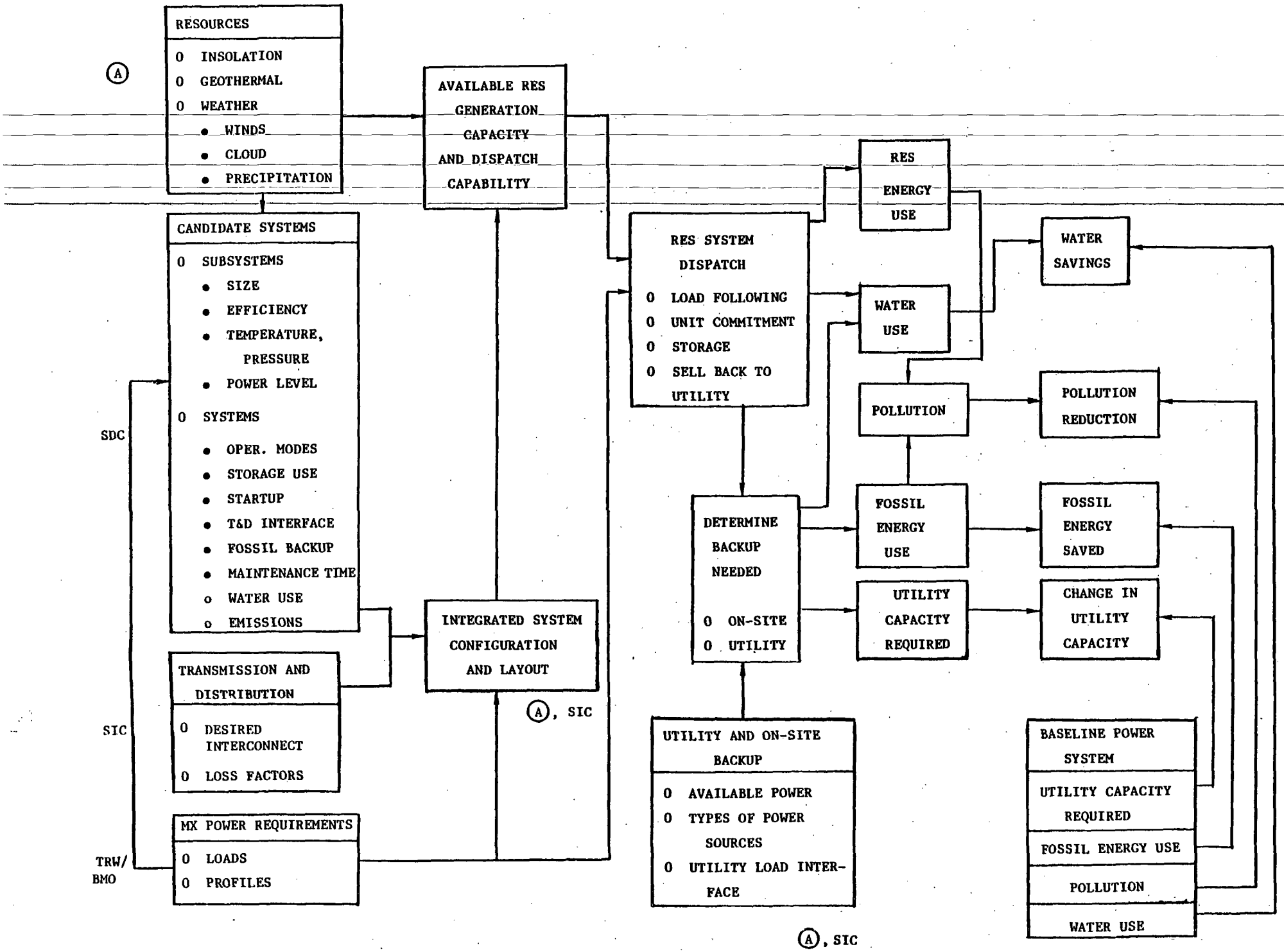
PERFORMANCE ANALYSIS METHODOLOGY

PRINCIPAL APPLICATIONS OF PERFORMANCE MODELLING

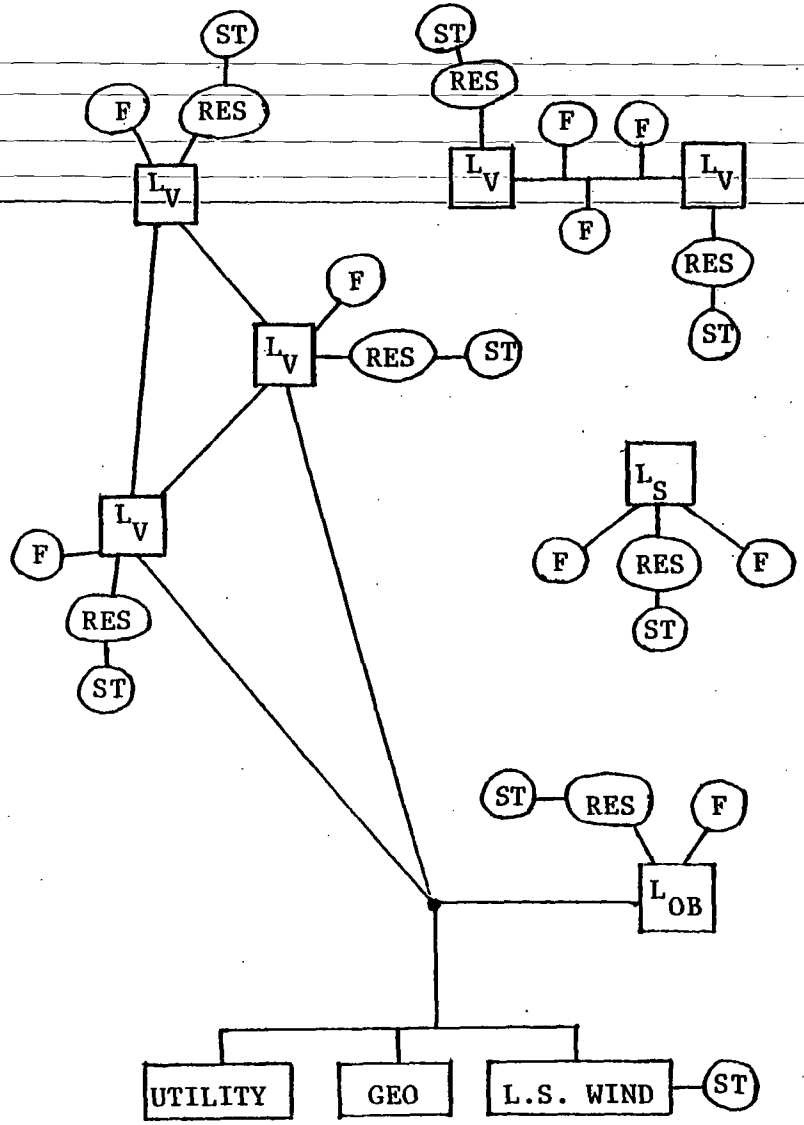
- PERFORMANCE ANALYSIS ENABLES COMPUTATION OF EVALUATION CRITERIA TO BE USED FOR:
  - DELINEATIONS OF INTEGRATED SYSTEM CONFIGURATIONS
  - EVALUATION OF FINAL INTEGRATED SYSTEMS
- CALCULATION OF SELECTED COMPONENTS OF EVALUATION CRITERIA

ISSUES	PERFORMANCE RELATED COMPONENTS OF ASSOCIATED CRITERION
• ENERGY INDEPENDENCE	FOSSIL ENERGY SAVINGS
• ENVIRONMENTAL ACCEPTABILITY	WATER SAVINGS, POLLUTION REDUCTION
• UTILITY CAPACITY	CHANGE IN UTILITY POWER REQUIRED

PERFORMANCE ANALYSIS



INTEGRATED SYSTEM PERFORMANCE SIMULATION



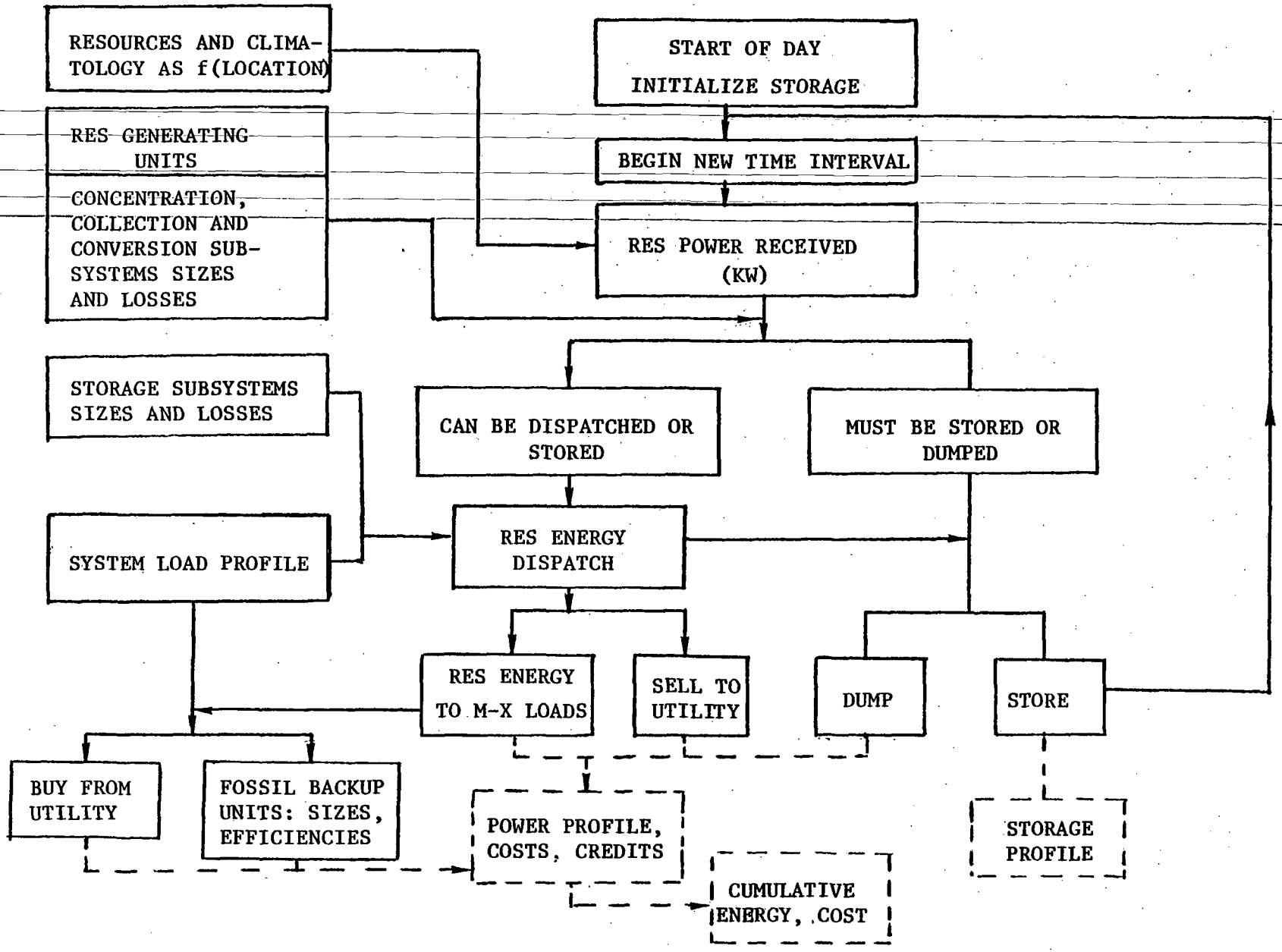
0 DETAILED ANALYSIS OF POWER AND ENERGY FLOW IN SYSTEM FOR KEY PERIODS

(KEY PERIODS INCLUDE DAYS OF AVERAGE AND EXTREME RESOURCE AND DEMAND, PLUS DAYS CHARACTERISTIC OF THE TECHNOLOGIES EMPLOYED)

- SITE-SPECIFIC RESOURCE AND CLIMATOLOGY VARIATIONS
- DISPATCH, STORAGE, AND SELLBACK/BUY ENERGY ROUTING ANALYSIS

0 ANNUAL ENERGY, WATER, FOSSIL FUEL AND UTILITY USE DATA EXTRAPOLATED FROM KEY PERIODS BASED ON DAILY RESOURCE AND DEMANDS LEVELS

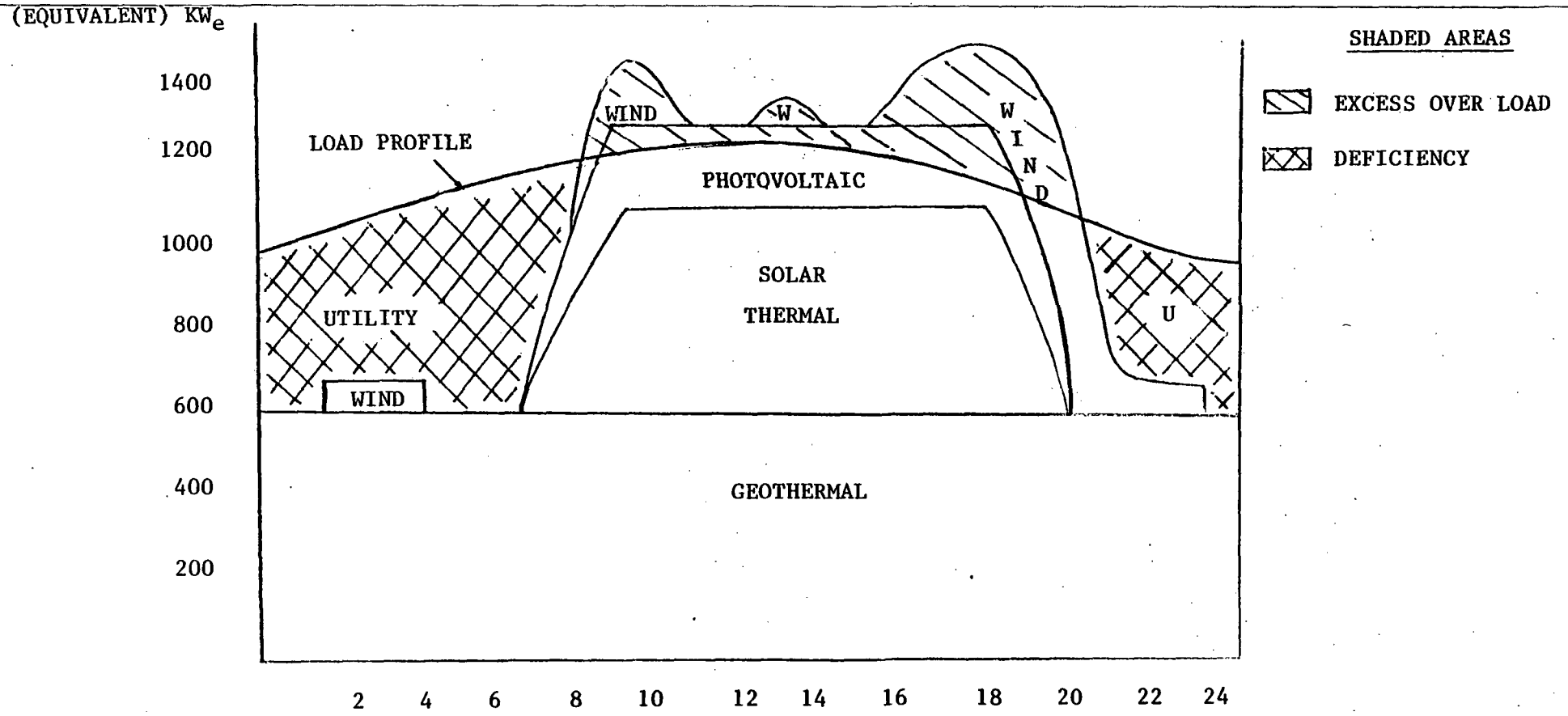
ENERGY FLOWS



KEY DAY PROFILE OF POWER

RECEIVED VS. LOAD FOR STRAWMAN SYSTEM

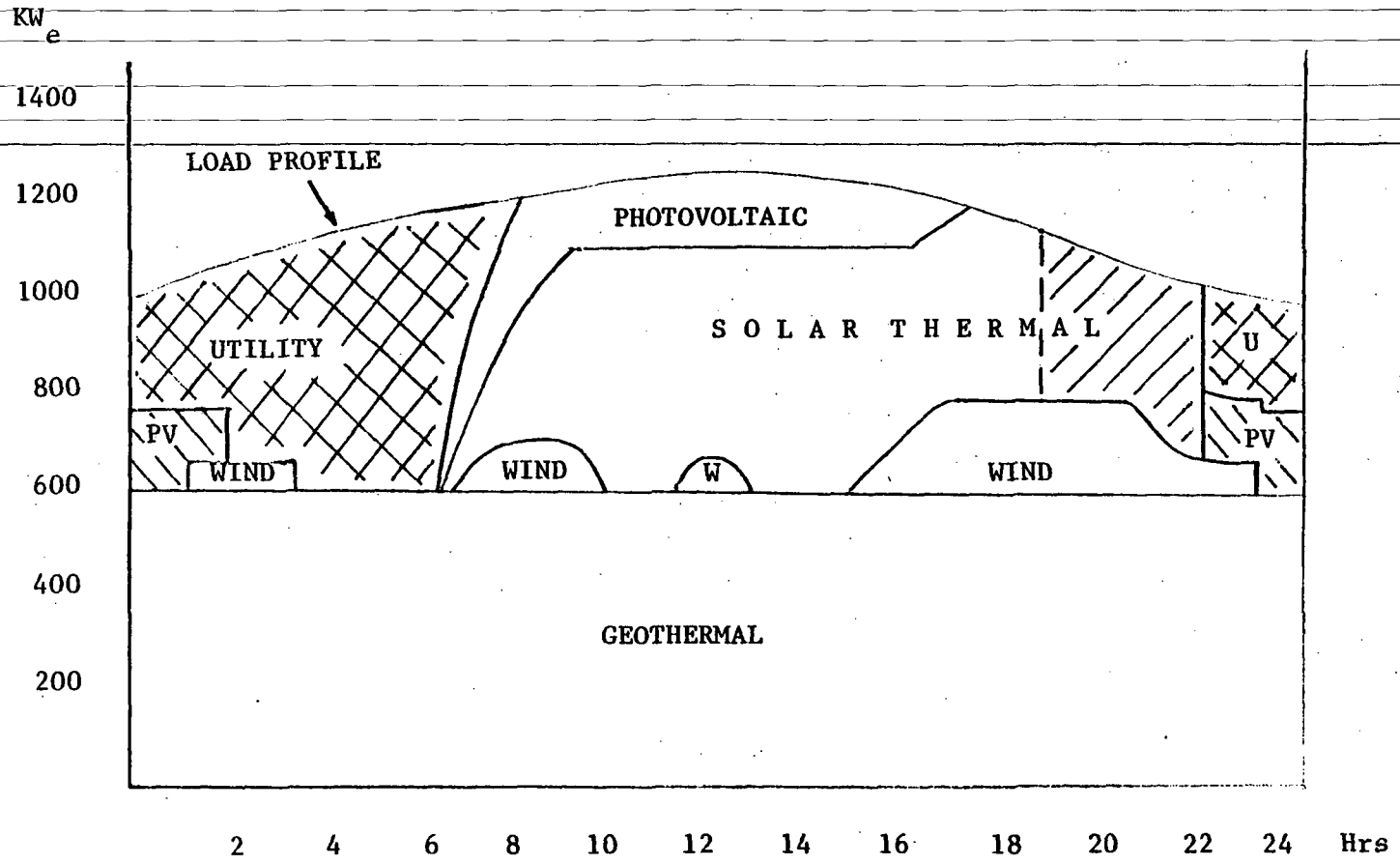
- ILLUSTRATION OF POSSIBLE DISPATCH
- EXCESS POWER MAY BE SOLD TO UTILITY OR STORED



SYSTEM UNIT #	CAPACITY	TYPE
1	600	GEOTHERMAL
2	500	SOLAR THERMAL CENTRAL RECEIVER
3	200	PHOTOVOLTAIC
4	200	WIND (VAWT, e.g., DARRIEUS)

DISPATCHING SCENARIO

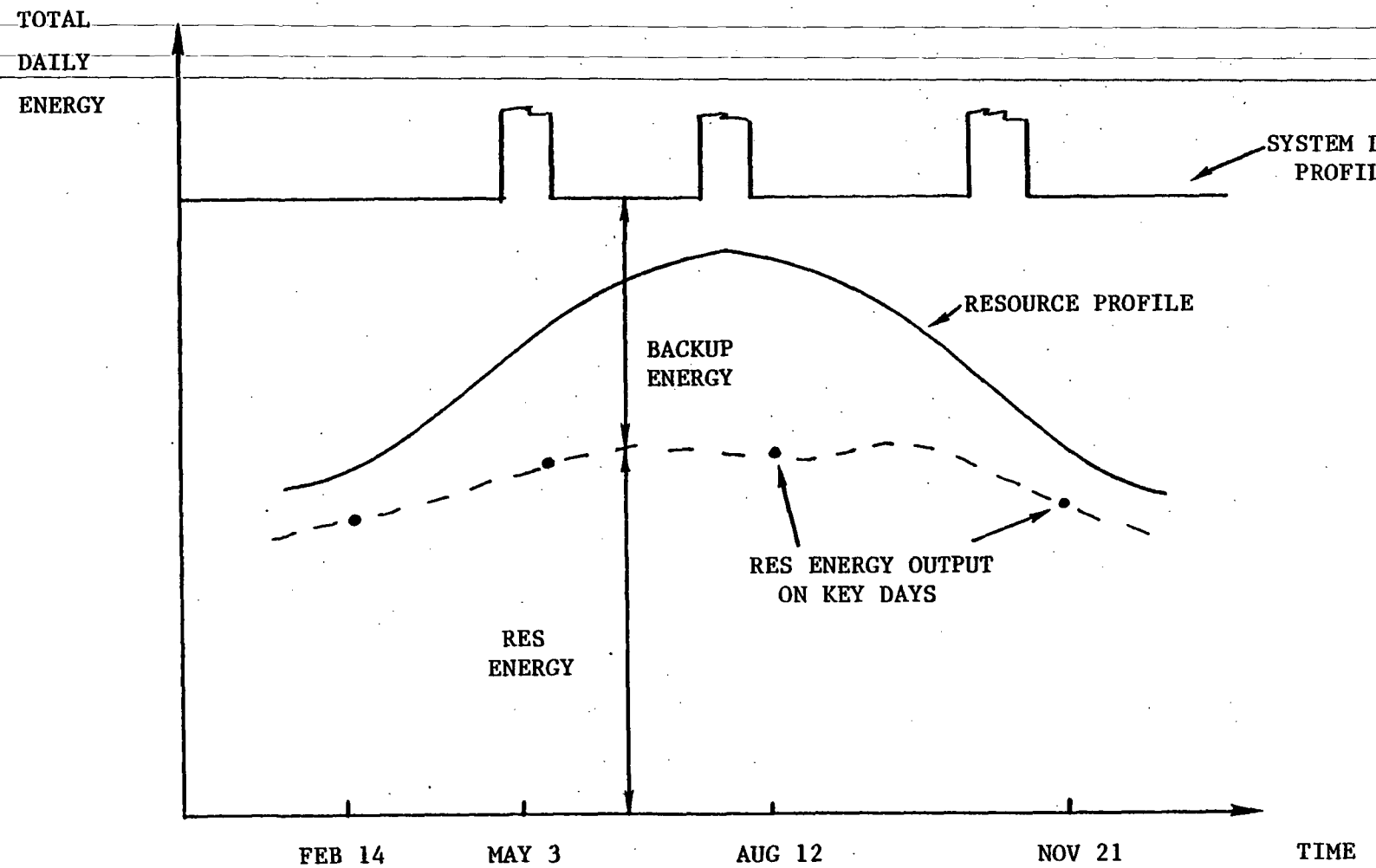
USING STORAGE TO DISPLACE UTILITY POWER



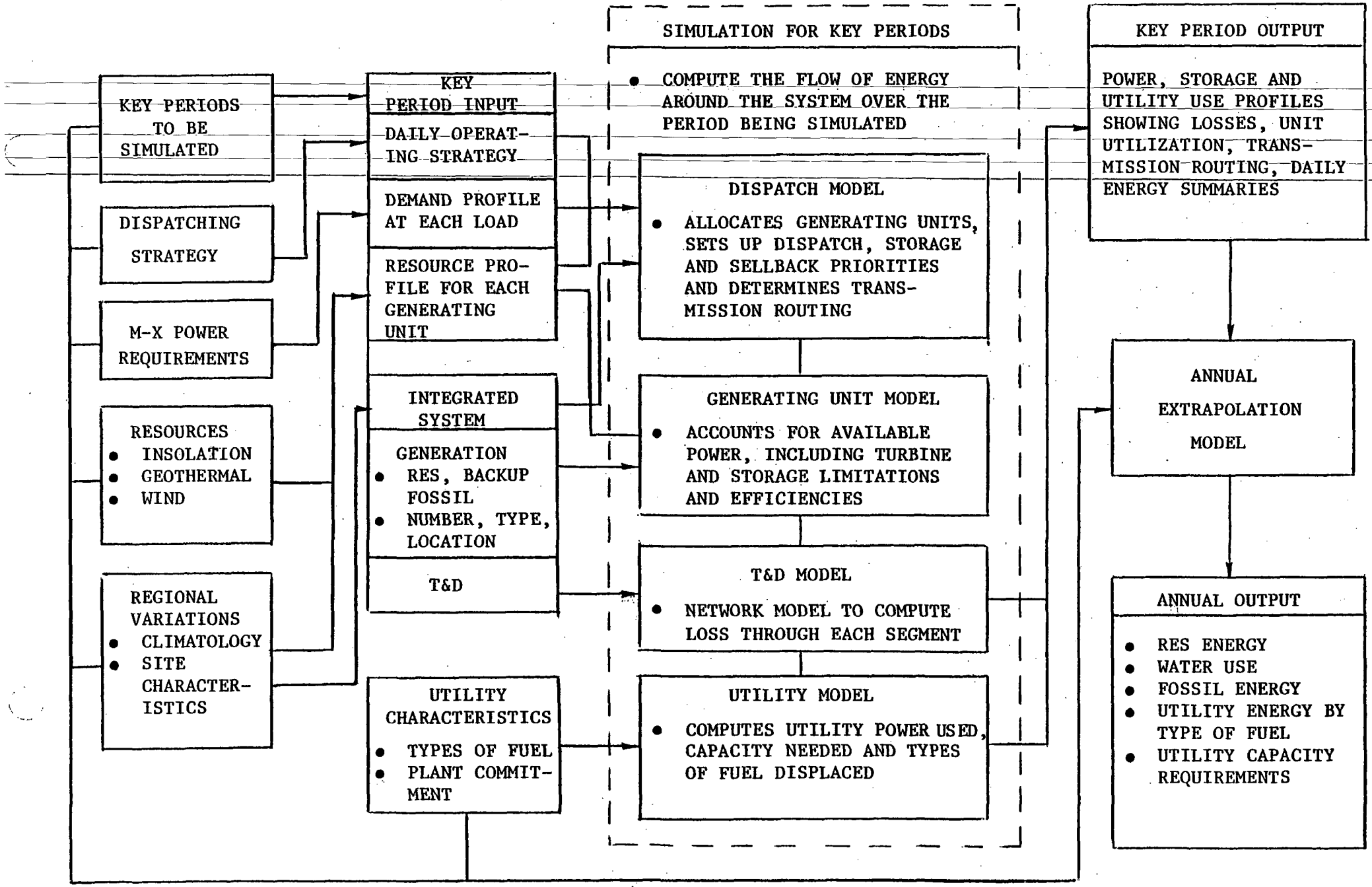
SHADED AREAS

- SOLAR THERMAL RUNNING OFF STORAGE
- PV STORAGE
- DEFICIENCY (UTILITY)

ENERGY EXTRAPOLATION



PERFORMANCE MODEL



ADDITIONAL APPLICATIONS OF I/S PERFORMANCE MODEL

0 COST	VARIABLE OPERATING AND MAINTENANCE COSTS, FUEL COSTS
0 AVAILABILITY/RELIABILITY	POWER LEVELS, OPERATING MODES AND DISPATCH
0 RESOURCE UNCERTAINTY	SENSITIVITY OF PERFORMANCE OUTPUTS TO RESOURCE VARIATIONS

I/S PERFORMANCE MODELLING SUMMARY

- RELATIVELY SIMPLE MODEL
- GOOD ACCURACY
- GOOD VISIBILITY INTO DATA, CRUCIAL TO ENGINEERING EFFORT
- INEXPENSIVE TO RUN
- ALLOWS PARAMETRIC STUDIES TO BE PERFORMED ON INTEGRATED SYSTEM CONFIGURATIONS
- ALLOWS VARIATION OF CONTRACTOR DATA FOR CANDIDATE SYSTEMS
- ALLOWS MODELLING OF COMBINATION AND INTERCONNECTION OF CANDIDATE SYSTEMS IN INTEGRATED SYSTEM
- ALLOWS ANALYSES OF DISPATCHING STRATEGY ALTERNATIVES
- PROVIDES DATA ESSENTIAL FOR STUDIES RELATIVE TO POWER TRANSFER AGREEMENTS
- PERMITS ADDITION OF MORE DETAILED MODELLING OF VARIOUS COMPONENTS OF INTEGRATED SYSTEM CONFIGURATIONS

NEAR TERM DEVELOPMENT PLANNED

- MODEL DEVELOPMENT
- STUDY OF VARIOUS STORAGE/DISPATCHING STRATEGIES
- TESTING OF STRAWMAN SYSTEM

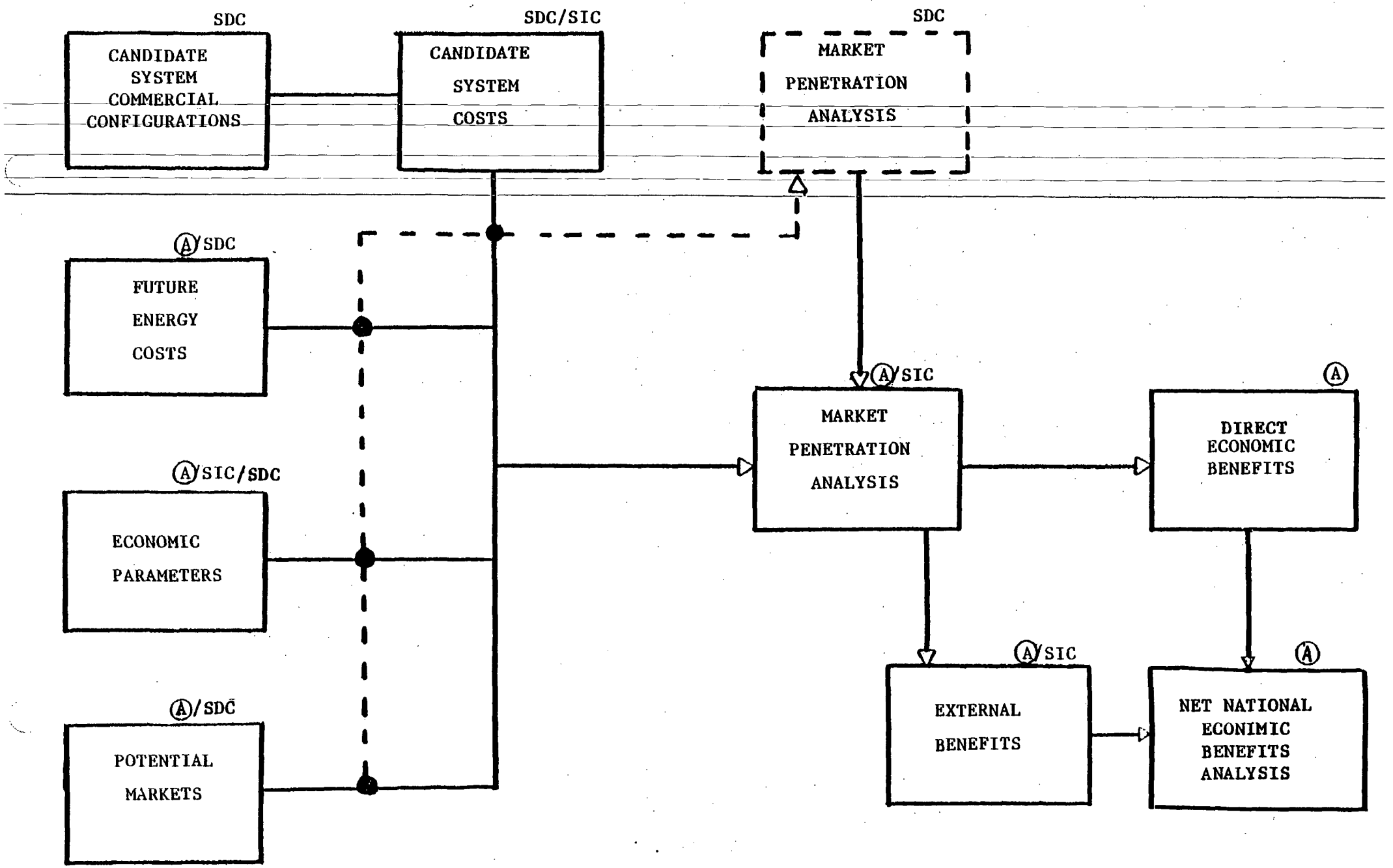
ASSESSMENT OF
MX-RES NATIONAL BENEFITS

- COST
- MARKET PENETRATION
- ECONOMIC EVALUATION

ASSESSMENT OF POTENTIAL NATIONAL BENEFITS OF ACCELERATED RENEWABLE ENERGY SYSTEMS DEVELOPMENT

- ESTABLISHMENT OF SCENARIOS FOR RENEWABLE ENERGY SYSTEM CONFIGURATIONS, FUTURE ENERGY COSTS AND ECONOMIC CONDITIONS
- COSTS OF COMMERCIAL VERSIONS OF CANDIDATE SYSTEMS
- NATIONAL MARKET ASSESSMENT AND MARKET PENETRATION
- CALCULATION OF NET NATIONAL ECONOMIC BENEFITS OF ACCELERATED DEVELOPMENT

NET NATIONAL ECONOMIC BENEFITS OF MX-RES COMMERCIALIZATION



ESTABLISHMENT OF SCENARIOS

RENEWABLE ENERGY SYSTEMS CONFIGURATIONS (COMMERCIAL VERSIONS)

- TYPE OF SYSTEM
- SIZE AND EFFICIENCY
- CONSTRUCTION COSTS
- OPERATION AND MAINTENANCE COSTS

IDENTIFICATION OF APPLICABLE MARKETS AND FUTURE ENERGY COSTS

- REGION
- SECTOR
- ENERGY CATEGORY

FINANCIAL PARAMETERS FOR EVALUATION

- DISCOUNT RATE
- INFLATION RATE
- TAX RATES
- INCENTIVES

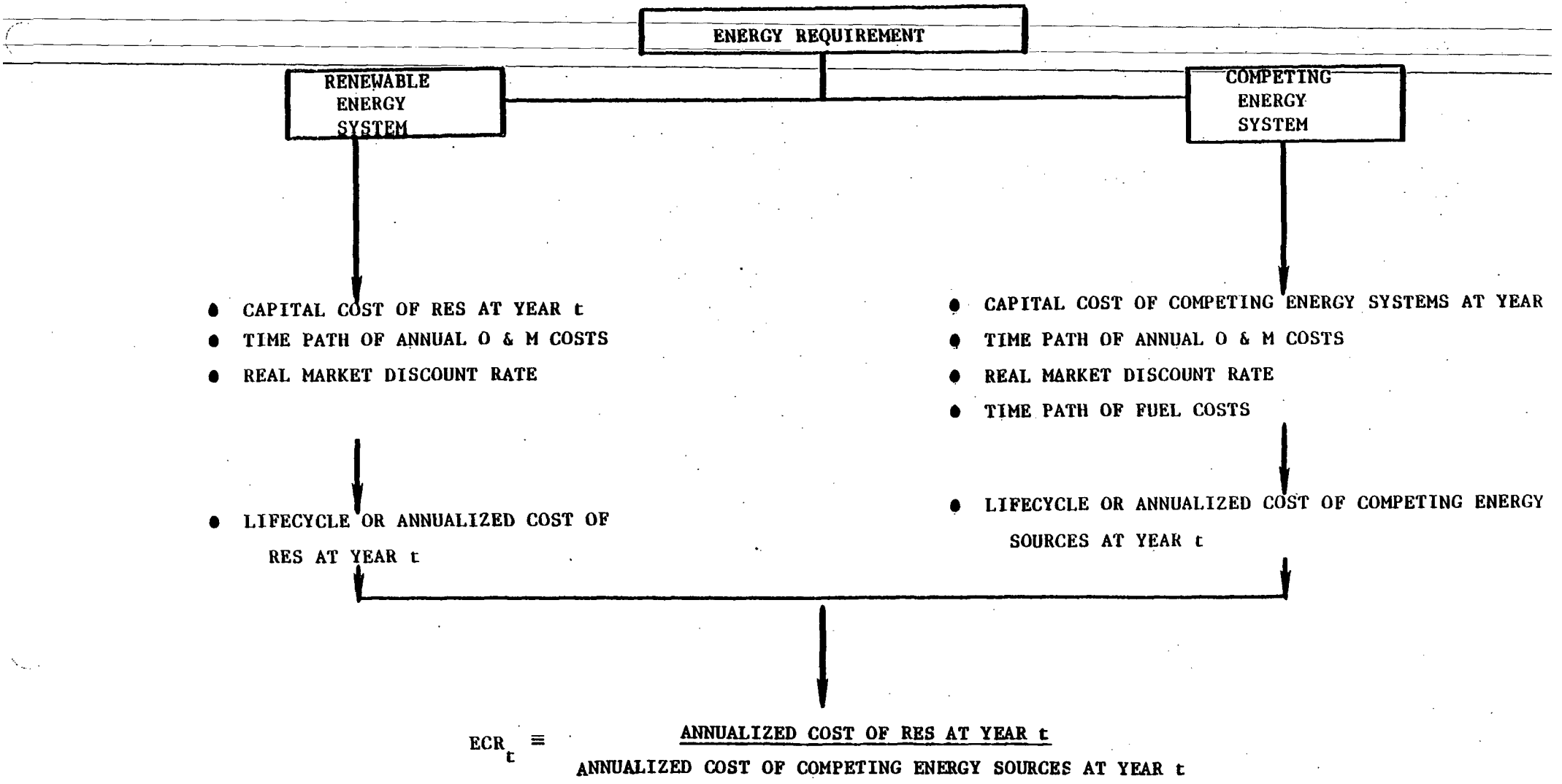
MARKET PENETRATION MODEL

DESIRABLE FEATURES

- ABILITY TO ESTIMATE MARKET SHARE AS INFLUENCED BY INDIVIDUAL CAUSUAL PARAMETERS
- MARKET PENETRATION BASED ON RELATIVE ECONOMIC MERIT TO USER
- PATTERN OF MARKET PENETRATION OVER TIME NOT ARBITRARILY PRE-SELECTED (.E.G., S-CURVE)
- ULTIMATE PENETRATION OF THE MARKET TO BE AN OUTPUT OF ANALYSIS

AEROSPACE SELECTED A VALUE-ORIENTED MODEL WHICH FORECASTS ANNUAL MARKET PENETRATION AS A FUNCTION OF THE APPROPRIATE EQUIVALENT COST RATIOS AND THEIR DISTRIBUTIONS

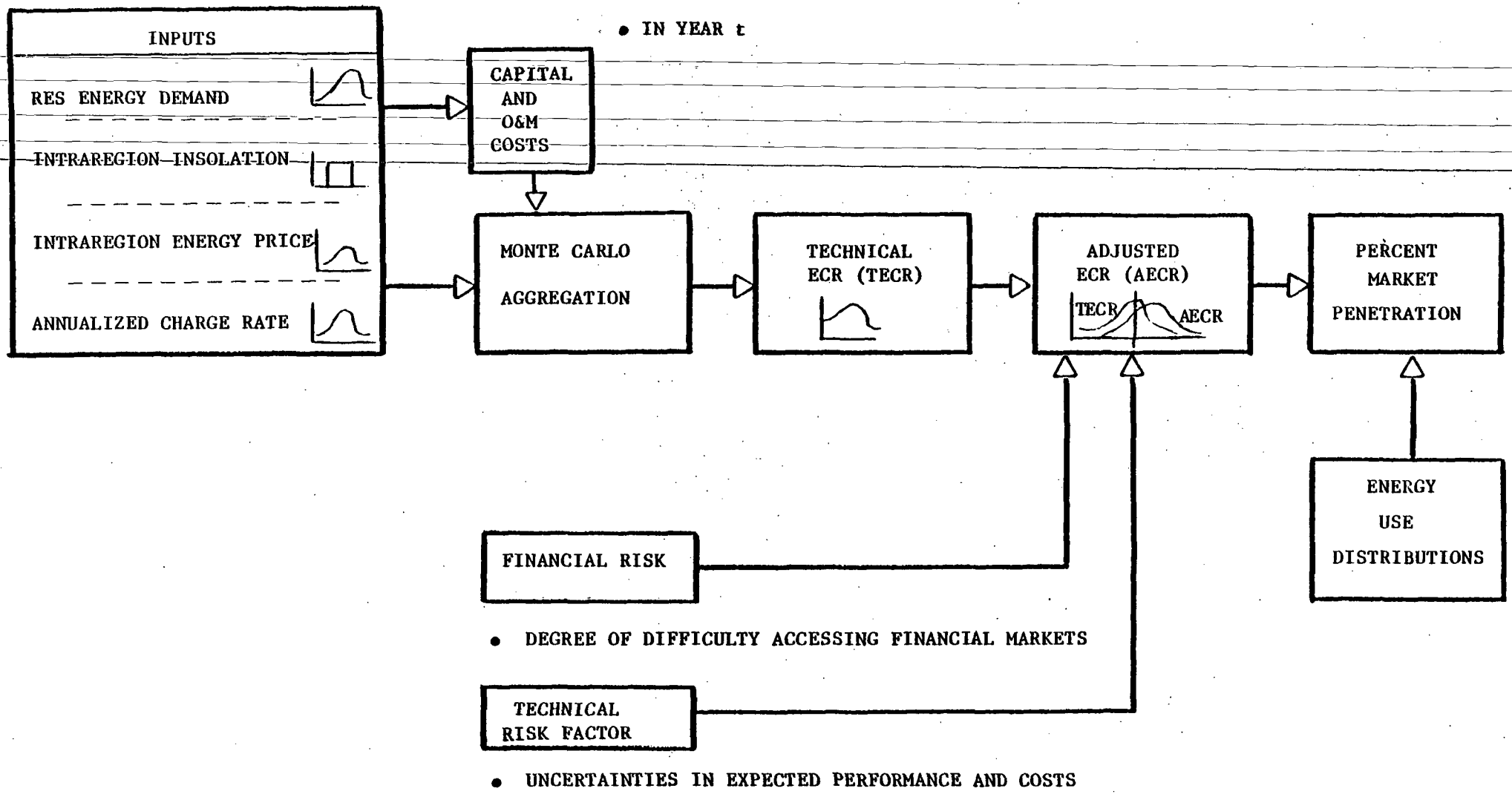
DETERMINATION OF EQUIVALENT COST RATIO



$$ECR_t \equiv \frac{\text{ANNUALIZED COST OF RES AT YEAR t}}{\text{ANNUALIZED COST OF COMPETING ENERGY SOURCES AT YEAR t}}$$

DEVELOPMENT OF PERCENT MARKET PENETRATION

- IN YEAR t



- DEGREE OF DIFFICULTY ACCESSING FINANCIAL MARKETS

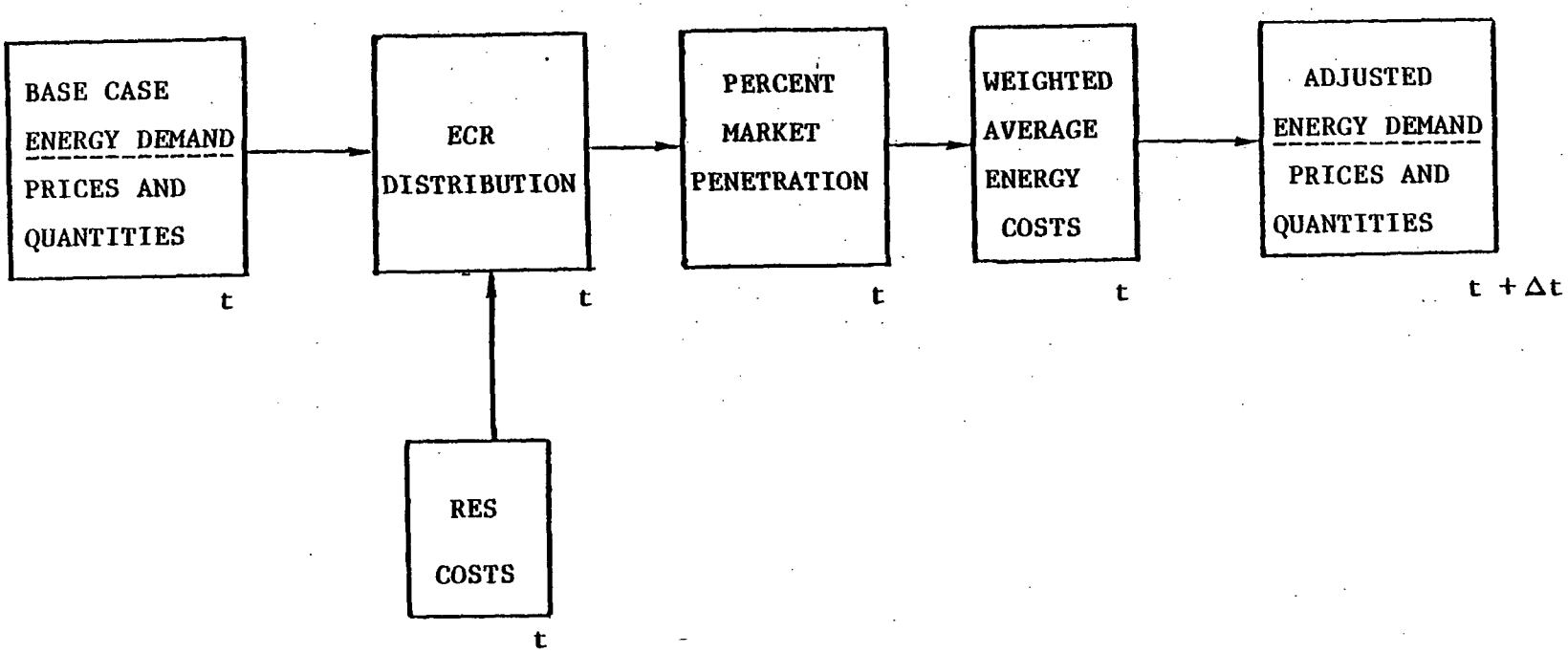
- UNCERTAINTIES IN EXPECTED PERFORMANCE AND COSTS

NATIONAL MARKET ASSESSMENT

BASE CASE TOTAL DEMAND

- CALCULATION OF CURRENT ENERGY CONSUMPTION
  - IDENTIFY NUMBER OF USER UNITS IN EACH STATE (PLANTS, APARTMENT HOUSES, ETC.)
  - DETERMINE AVERAGE ENERGY CONSUMPTION PER END USER UNIT
  - CALCULATE ENERGY CONSUMPTION BY END USER GROUP BY STATE BY FUEL TYPE
- PROJECTIONS OF FUTURE ENERGY USE DISTRIBUTIONS
  - PROJECT GROWTH RATES OF END USER GROUPS
  - ESTIMATE CHANGES IN ENERGY CONSUMPTION PATTERNS OF END USER GROUPS (RESULTING FROM HIGHER ENERGY PRICES, CONSERVATION EFFORTS, ETC.)
  - IDENTIFY DIFFERENCES IN MARKET GROWTH RATES BY GEOGRAPHIC REGIONS AND SUBCATEGORIES OF END USER GROUPS
  - COMPUTE TOTAL ANNUAL MARKET POTENTIALS BY END USE GROUP BY STATE BY TYPE OF FUEL

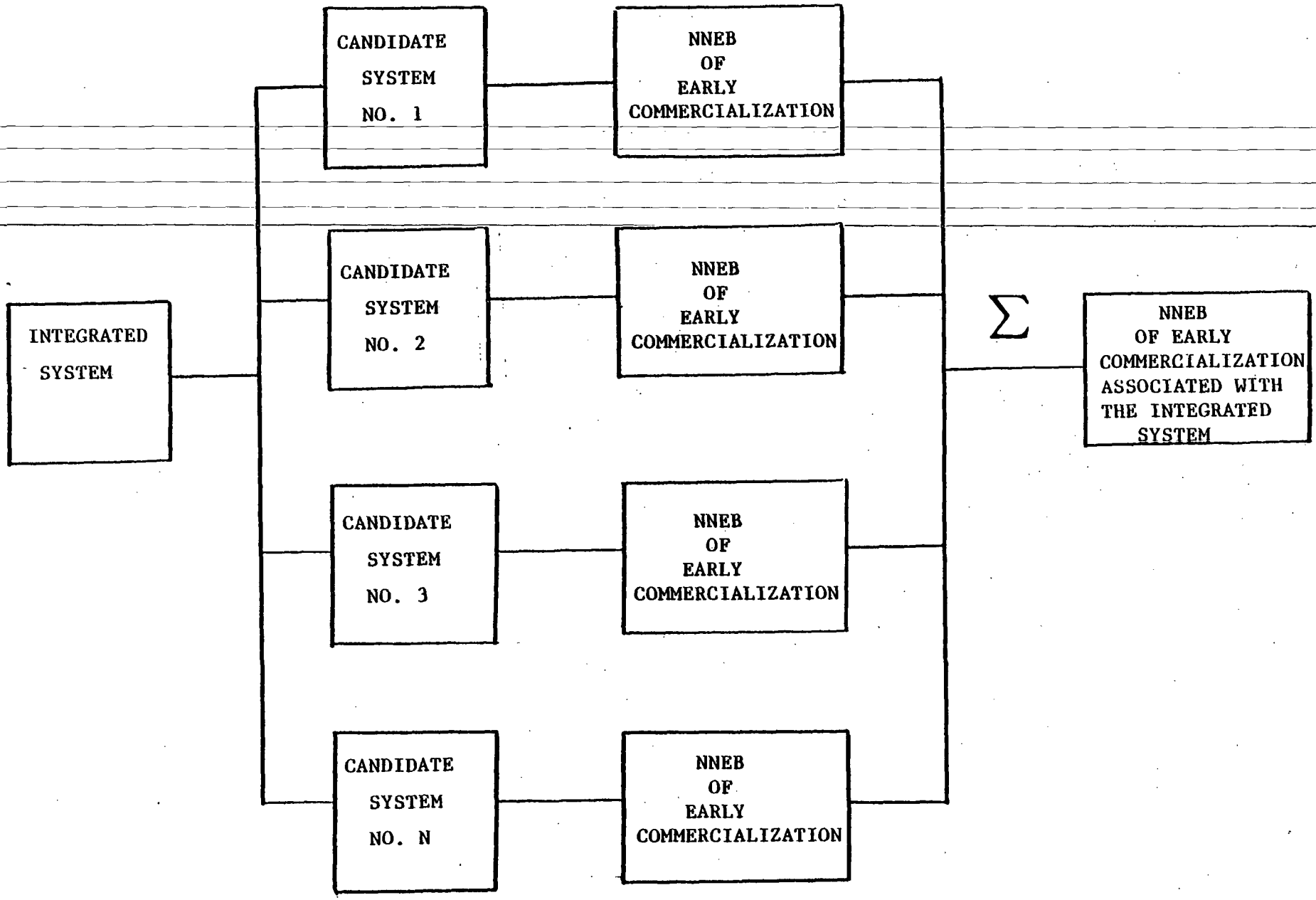
FLOW OF MARKET PENETRATION CALCULATION



RELATIONSHIP OF ECR AND MARKET PENETRATION

IF THE DISTRIBUTION OF ANNUALIZED COST FOR A COMPETING ENERGY SYSTEM IS GIVEN AND IF A DETERMINISTIC COST OF AN RES TECHNOLOGY IS SPECIFIED, THEN A FUNCTIONAL RELATIONSHIP CAN BE DETERMINED WHICH RELATES THE PERCENT OF MARKET PENETRATION TO THE MEAN OF THE ECR DISTRIBUTION. THEREFORE, ONLY A SINGLE MONTE CARLO AGGREGATION IS REQUIRED FOR EACH MARKET AREA BECAUSE THE SHAPE OF THE ECR DISTRIBUTION (ALTHOUGH NOT ITS MEAN VALUE) IS INDEPENDENT OF A SPECIFIC RES TECHNOLOGY. THIS WILL SIMPLIFY CALCULATION BECAUSE THE PENETRATION CAN BE USED REPEATEDLY AS CANDIDATE SYSTEM COSTS ARE FURTHER REFINED.

OVERVIEW OF NET NATIONAL ECONOMIC BENEFITS CALCULATION



MARKET PENETRATION MODEL

APPLICATION OF MPM

TO SOLAR TOTAL

ENERGY SYSTEMS

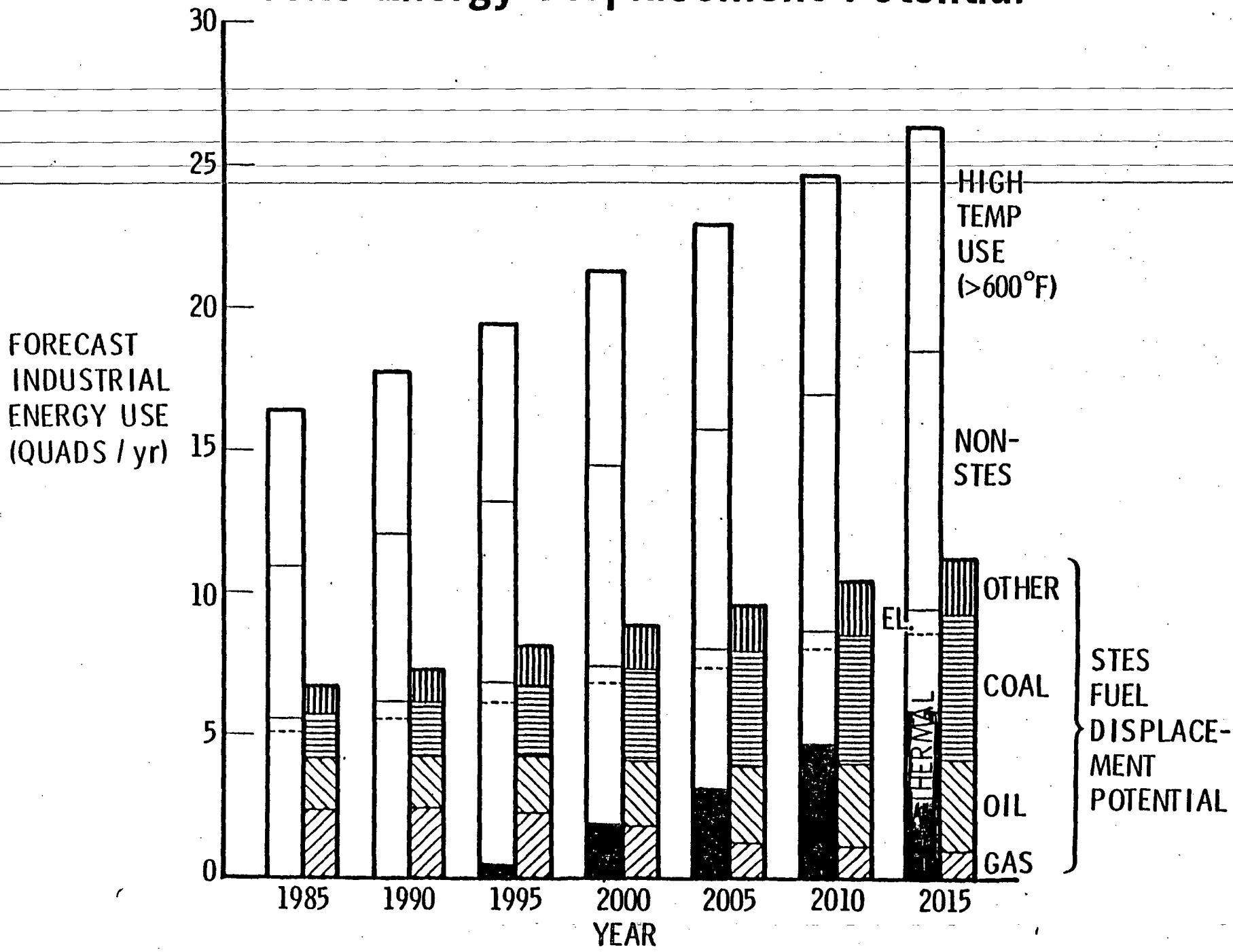
(STES)

STES MISSION ANALYSIS

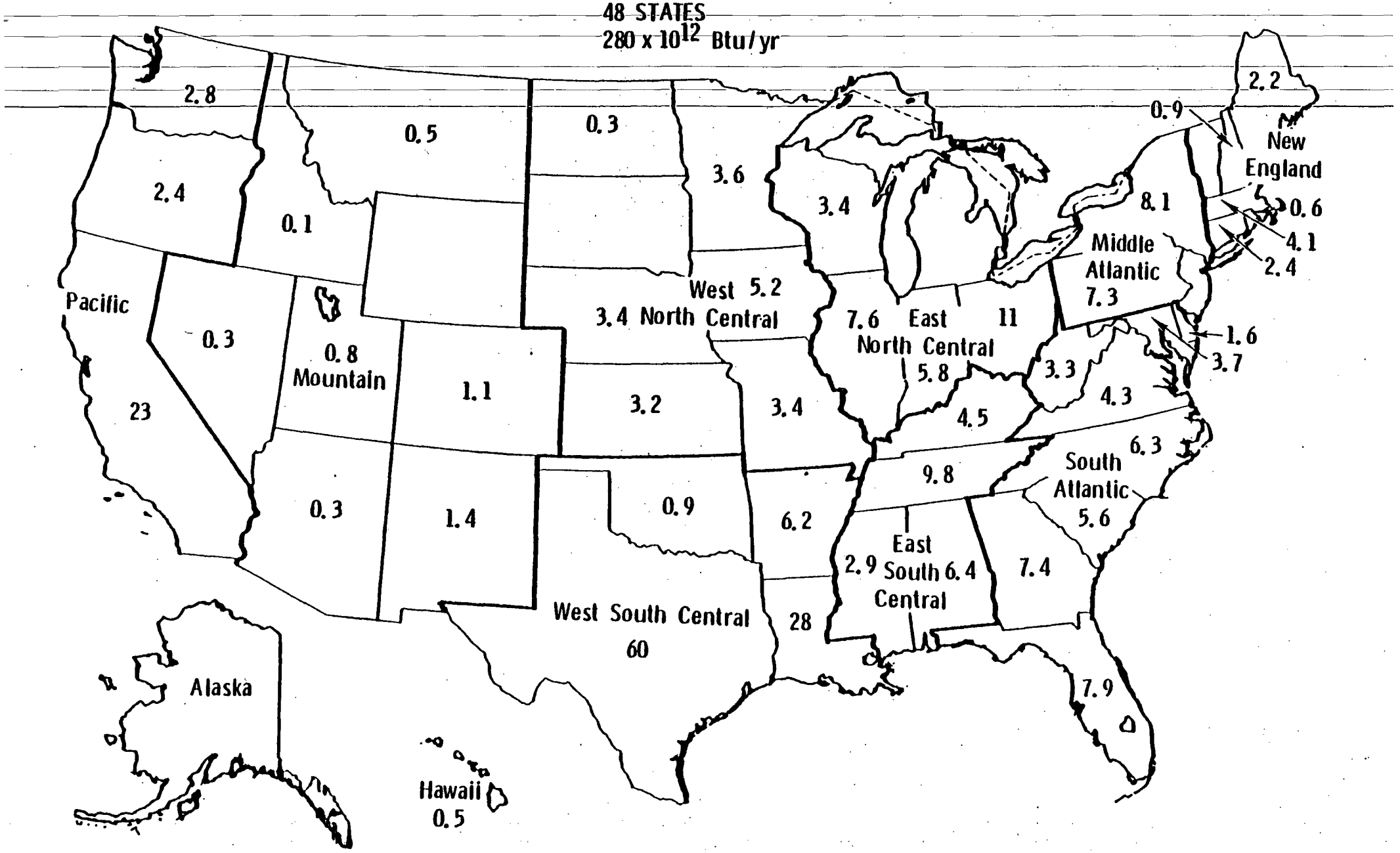
ACCOMPLISHMENTS

- STES APPLICATIONS MODEL (SAM) EXERCISED TO DEVELOP:
  - EQUIVALENT COST RATIOS (ECRs) AND FUEL DISPLACEMENT FOR 1,934 INDUSTRY/STATE COMBINATIONS, FORECAST IN FIVE-YEAR INTERVALS FROM 1985 THROUGH 2015
  - AGGREGATE STES ENERGY DISPLACEMENT POTENTIAL BY STATE, INDUSTRY AND FUEL TYPE
  - REGIONAL AND INDUSTRY DISTRIBUTION OF APPLICATIONS WITH POTENTIAL FOR EARLY ECONOMIC VIABILITY (ECRs $\leq$ 1)
- MARKET PENETRATION MODEL (MPM) CHECKED OUT AND USED TO DEVELOP:
  - FORECASTS OF STES MARKET PENETRATION (NON-RETROFIT) AND NATIONAL ENERGY DISPLACEMENT BY FUEL TYPE
  - DETAILED MARKET PENETRATION FORECASTS BY STATE AND INDUSTRY
  - SENSITIVITY OF FORECASTS TO INCENTIVES AND DATA INPUT PARAMETERS
- FULL DOCUMENTATION PROVIDED TO DOE:
  - COMPLETE PRINTOUTS OF SAM AND MPM PROGRAMS
  - DETAILED FORECASTS OF ENERGY USE AND PRICES BY USER CATEGORY, STATE AND FUEL TYPE, INCLUDING ASSUMPTIONS AND METHODOLOGY USED IN THEIR DERIVATION

STES Energy Displacement Potential



Yr 2000 - STES Market Penetration Rates by State



NATIONAL BENEFIT-COST ANALYSIS

$$\text{NET NATIONAL ECONOMIC BENEFITS} = \sum_{t=o}^{N} (B_t - C_t)\ (1 + k)^{-t}$$

B_t = economic benefits to the nation in year t.

= value of the conventional sources of energy which are displaced

+ benefits of lowering U.S. average price of energy

+ benefits of potential reduction in needed SPR size

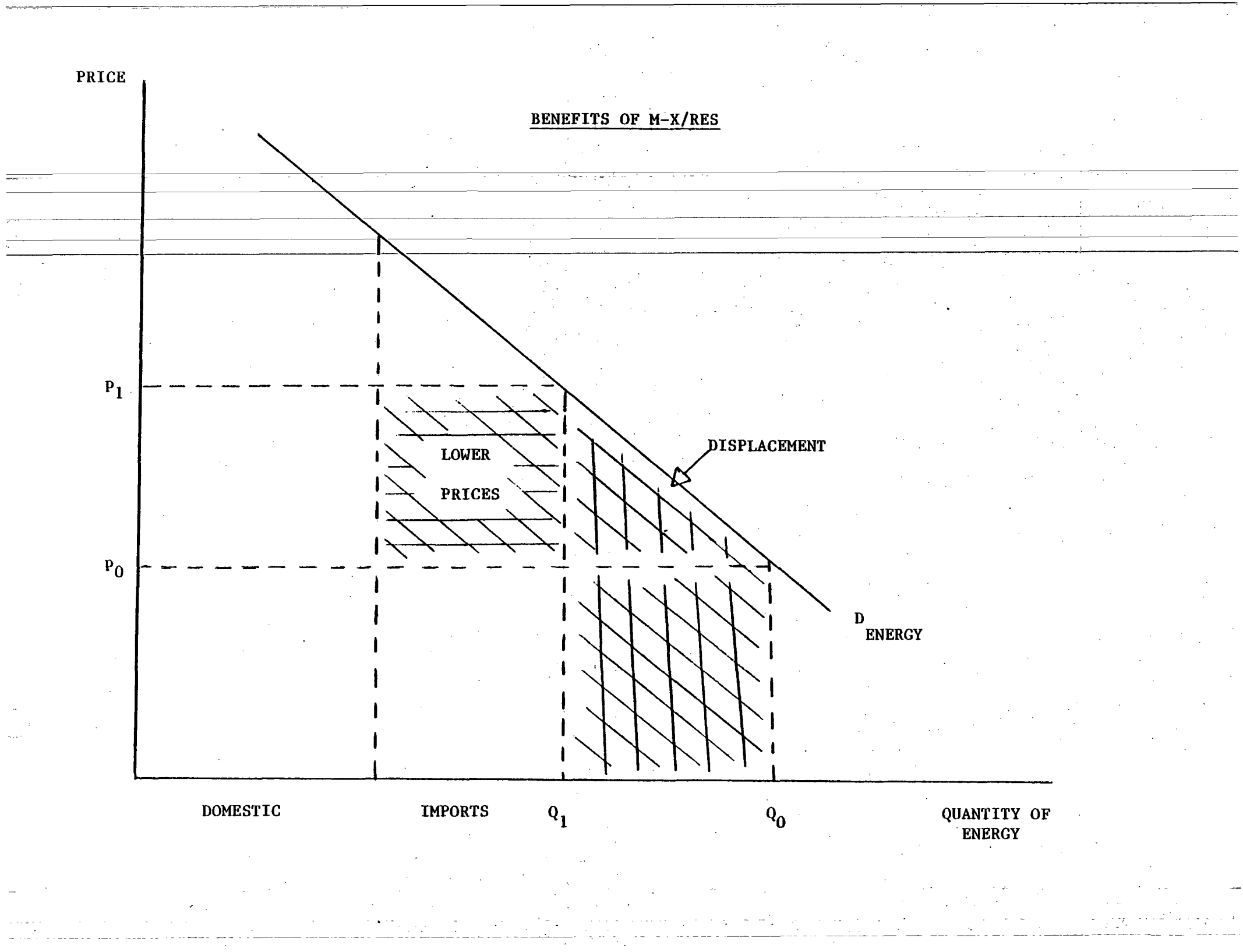
+ benefits of mitigation of environmental externalities arising from use of conventional energy sources

C_t = economic costs to the nation in year t

= annualized capital cost of RES

+ operation and maintenance costs

+ costs of environmental externalities generated by RES


PRICE
BENEFITS OF M-X/RES
P_1
P_0
LOWER
PRICES
DISPLACEMENT
D
ENERGY
DOMESTIC
IMPORTS
Q_1
Q_0
QUANTITY OF
ENERGY

BENEFITS OF POTENTIAL REDUCTION IN SPR SIZE

AS A RESULT OF RES MARKET PENETRATION, A LOWER REQUIREMENT FOR CRUDE OIL STORAGE IN THE SPR MAY BE INDICATED TO ACHIEVE THE SAME LEVEL OF PROTECTION.

QUANTIFICATION

- DECLINE IN IMPORTED INSECURE CRUDE OIL
- REDUCED SPR SIZE
- ANNUALIZED COST OF CRUDE OIL AND FACILITIES NOT NEEDED

ENVIRONMENTAL EXTERNALITIES

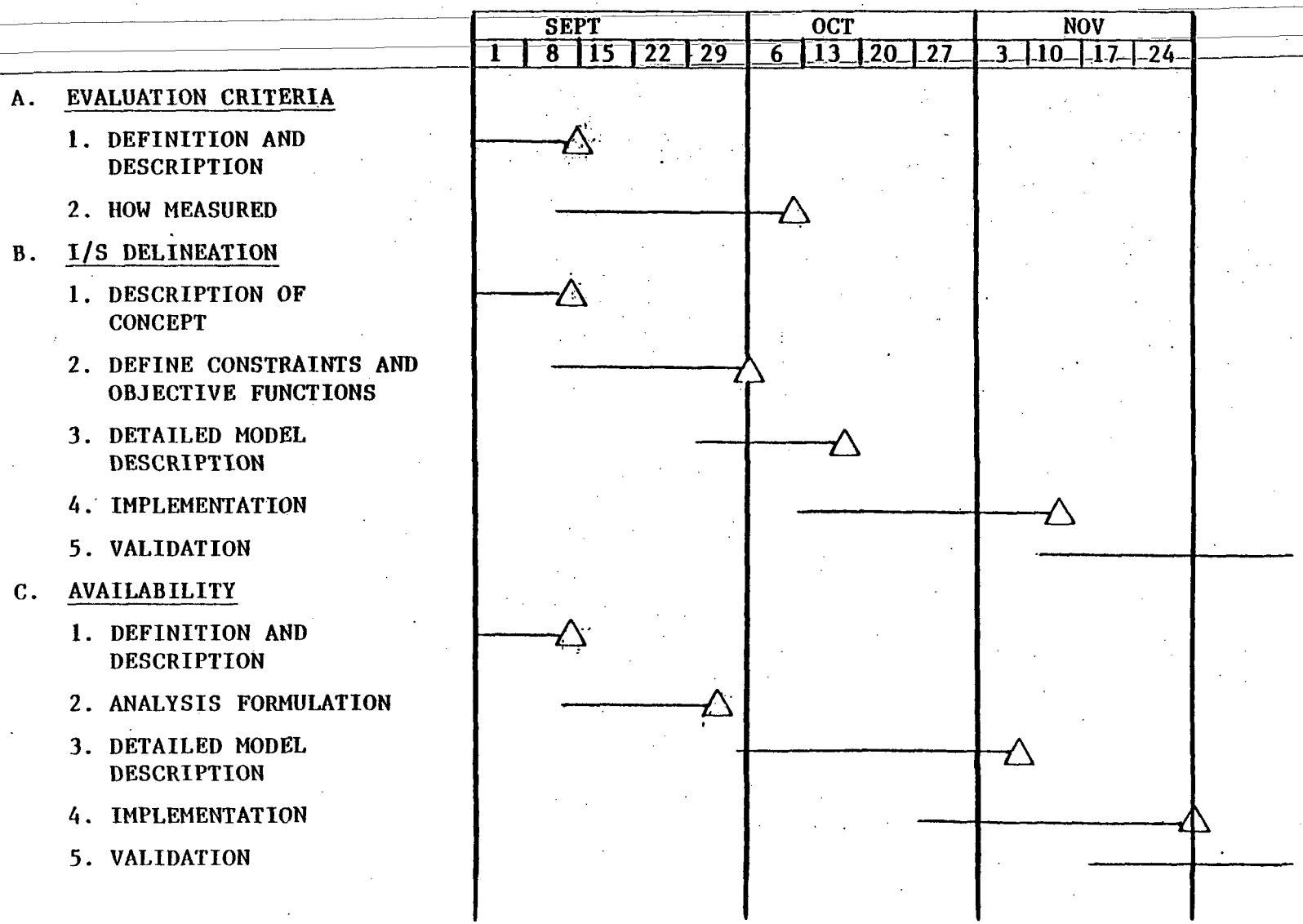
- PROBLEM - MARKET PRICES OF RETAIL ENERGY DO NOT ADEQUATELY REFLECT THE OPPORTUNITY COSTS OF ENVIRONMENTAL RESOURCE USE

- EXAMPLES RELEVANT TO RES/CONVENTIONAL ENERGY SOURCES TRADEOFFS
  - AIR QUALITY PROBLEMS
    - PARTICULATES
    - SO_2
    - HYDROCARBONS
  - WATER QUALITY PROBLEMS
    - THERMAL POLLUTION
    - DISRUPTION OF ACQUIFERS
    - RUNOFF FROM MINE TAILINGS
  - LAND QUALITY
    - PRECLUSION OF ALTERNATIVE PUBLIC USE
    - DESTRUCTION OF UNIQUE FORMATIONS
    - DUMPING OF MINE TAILINGS
  - FLORA AND FAUNA HABITAT DISRUPTION
    - IMPACTS UPON ENDANGERED SPECIES
    - IMPAIRMENT OF SPORT HUNTING AND FISHING

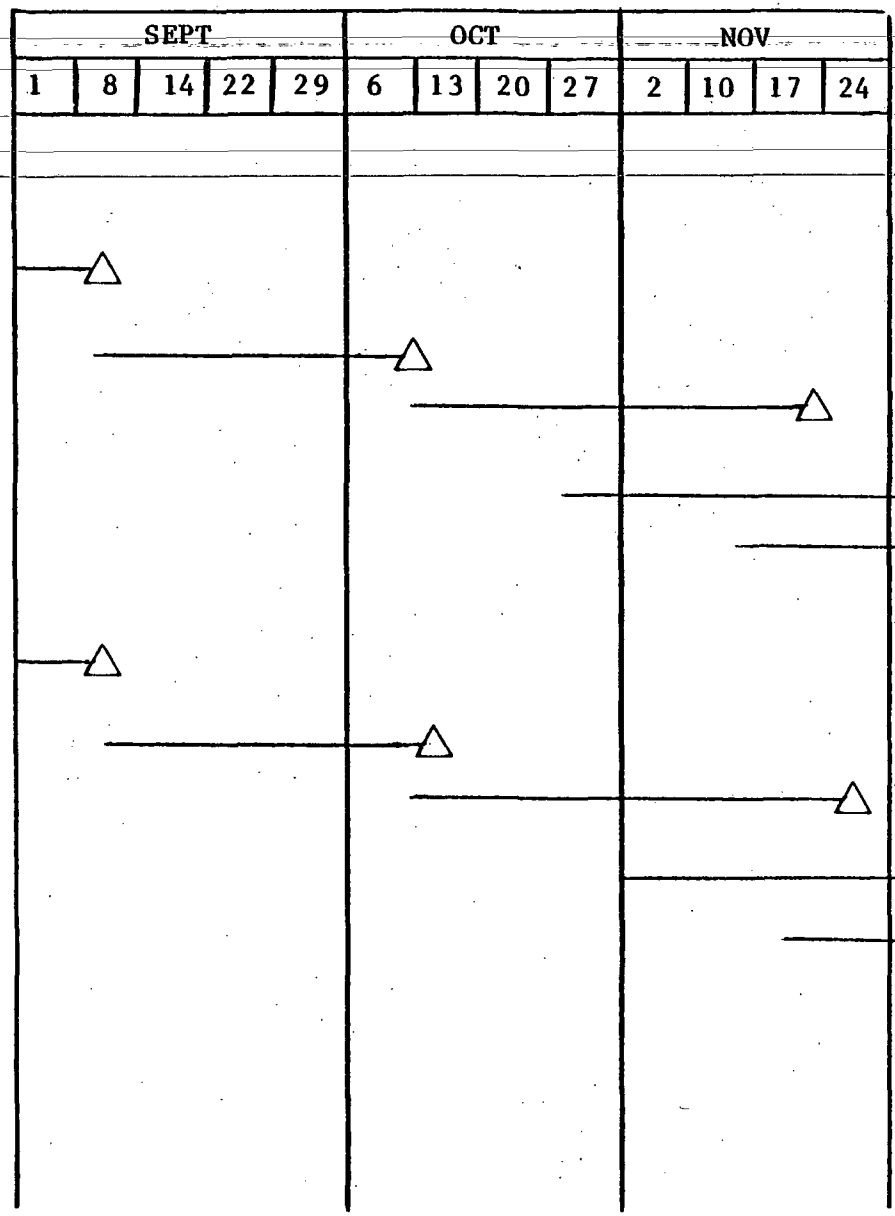
TECHNIQUES FOR ENVIRONMENTAL EXTERNALITIES VALUATION

- ALTERNATIVE COST - DETERMINATION OF COSTS OF MITIGATION
  - LAND QUALITY EXAMPLE - RECLAMATION COSTS
- LOSS AVOIDANCE - DETERMINATION OF OBSERVABLE LOSSES RESULTING FROM EXTERNALITY
  - AIR QUAITY EXAMPLE - HEALTH COSTS OF BREATHING AIR BORNE HYDROCARBON
- INFERRED PRICES - DETERMINATION OF IMPLIED WILLINGNESS TO PAY FOR MITIGATION THROUGH OBSERVATION OF PRICES OF ASSOCIATED GOODS
  - AIR QUALITY EXAMPLE - PORTION OF HOUSING PRICE ASSOCIATED WITH AIR QUALITY IN THE NEIGHBORHOOD
- WILLINGNESS TO PAY - DIRECT ELICITATION OF VALUES THROUGH SURVEYS AND QUESTIONNAIRES
  - WATER QUALITY EXAMPLE - WILLINGNESS TO PAY FOR VARIOUS LEVELS OF TURBIDITY REDUCTION

ANALYSIS METHODOLOGY DEVELOPMENT SCHEDULE



ANALYSIS METHODOLOGY DEVELOPMENT SCHEDULE (CONT)



D. PERFORMANCE

1. DEFINITION AND DESCRIPTION
2. ANALYSIS FORMULATION
3. DETAILED MODEL DESCRIPTION
4. IMPLEMENTATION
5. VALIDATION

E. NATIONAL BENEFITS

1. DEFINITION AND DESCRIPTION
2. ANALYSIS FORMULATION
3. DETAILED MODEL DESCRIPTION
4. IMPLEMENTATION
5. VALIDATION