PN-ABH-130

RENEWABLE ENERGY RESOURCES
FIELD TESTING

STATEMENT-OF-WORK FOR FIELD TEST # 8
PHOTOVOLTAIC/POWERED DESALINATION PLANT

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FINAL

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STATEMENT OF WORK

Design, Installation and Operating/Maintenance Training for a Photovoltaic/Powered Desalination Plant

TABLE OF CONTENTS

SECTION		PAGE
1.0	PROJECT DESCRIPTION	1
1.1	Background of Renewable Energy Field Testing Project	1
1.2	Summary of Bidder Requirements	2
1.3	Description of Application Site	6
1.4	Summary of Solar, Water, and Ambient Temperature Data	7
2.0	PV/POWERED DESALINATION PLANT DESIGN SPECIFICATIONS	12
2.1	Schedule for Design, Delivery & Installation	12
2.2	General Design Requirements	13
2.3	Technical Design Requirements	14
2.3.1	System Sizing	14
2.3.2	Control System Design	16
2.3.3	PV Array	16
2.3.4	Diesel/Generator Set	16
2.3.5	Battery	17
2.3.6	Reverse Osmosis Desalination Plant	17
2.3.7	Water Storage Tank	17
2.3.8	Pipes	17
2.3.9	Building(s)	18
2.3.10	Additional Equipment	18
2.4	Design Review	19
2.5	Proof of Performance	19
3.0	PV/POWERED DESALINATION PLANT INSTALLATION	21
3.1	Equipment Shipment	21
3.2	Plan and Schedule for Construction	22
3.3	Site Planning and Construction	24
4.0	OPERATION AND MAINTENANCE	26
4.1	Schedule of Energy Production	26
4.2	Guarantee/Spare Parts Requirements	26
4.3	Operations Support	27
5.0	PERFORMANCE MONITORING	28
5.1	Field Test Data Aquisition System	28
5.2	ODAS Installation and Training	29
5.3	Log Sheets/Maintenance Records	29

SECTION PAGE

6.0 TRAINING REQUIREMENTS 30
6.1 Operator Training Program 30
6.2 Maintenance Training Program 31
6.3 In-Factory Training Program 32
6.4 Training Manuals 33

7.0 SYSTEM ACCEPTANCE TEST CRITERIA 34
7.1 Point of Manufacture Testing..... 34
7.2 Field Acceptance Testing 35

8.0 PV/POWERED DESALINATION PLANT OPERATIONS AND MAINTENANCE MANUAL 38
8.1 System Description 38
8.2 System Installation 39
8.3 System Operation 39
8.4 Principals (or Theory) of Operation 39
8.5 Maintenance (Preventive/Corrective) 40
8.6 Parts List 40
8.7 Drawings 41

9.0 SPECIAL PROVISIONS 42
9.1 Site Access and Local Labor 42
9.2 Protection of the Environment & Personnel 42
9.3 Public Release of Information 43
9.4 Pre-Award Survey 43
9.5 Minimum Proposal Requirements 44
9.6 Post-Award Site visit 45
9.7 Summary of Deliverables 45

APPENDICES

A. Available Ground Water Quality Analyses for El Kasr Extension # 3 Wells A-1
B. Easter Mediterranean Water Quality Analysis B-1
C. Instrumentation Requirements & Specifications C-1
D. Daily Solar Insolation & Ambient Temperature Data D-1

EXHIBIT

1. El Kasr Extension # 3 Location 8
2. Water Disalination System Near El Kasr Area 9
3. Site Equipment Layout 10
4. PV Array Performance Verification 37

STATEMENT OF WORK

Design, Installation and Operating/Maintenance Training For a Photovoltaic/Powered Desalination Plant

1.0 PROJECT DESCRIPTION

1.1 Background of the Renewable Energy Resources Field Testing Project

The Government of Egypt herein referred to as (GOE) and the U.S. Agency for International Development (USAID) have initiated a four year renewable energy resource field demonstration project (REFT). The New and Renewable Energy Authority (NREA) and Louis Berger International, Inc. are leading a team of subcontractors in the REFT project activities that encompass solar industrial process heat, wind and photovoltaic system applications.

This specific objectives of the GOE/USAID project are two fold: (1) to demonstrate, analyze and evaluate the viability of commercially available renewable energy technologies in Egypt, (2) to establish the infrastructure necessary to ensure that successful renewable technologies are available for widespread use in-country. Three tasks are planned:

(1) Field Tests - Assessment of some selected renewable energy systems/applications which could be suitable for commercial use in Egypt; develop detailed engineering design hardware specifications and system

performance requirements; prepare RFP packages for procuring equipment; supervise the work of hardware contractors; and collect and evaluate data generated from the field tests.

(2) Supporting Analysis - Conduct technical, social, financial, economic and market analysis of renewable energy systems related to the field tests. Develop a computerized Renewable Energy Information System (REIS).

(3) Training - Improve the skills of the NREA and the GOE sectors in evaluating renewable energy technologies, applications, economics and markets, and provide technical assistance in systems design, installation, operation and maintenance.

The field test task consists of a number of separate renewable energy system application demonstrations. One of the photovoltaic field test is a demonstration of a PV Powered Desalination Plant capable of desalting brackish water and delivering 25 m3 of product water per day. The system will be located at El-Kasr Extension # 3 which is an area composed mostly of farms about 15 kilometers west of Mersa Matruh, west of Alexandria, on the mediterranean sea coast.

1.2 Summary of Bidder Requirements

The tenderer shall submit a complete proposal for a turn-key job for the design, manufacture, supply, instrumentation, installation, testing and performance guarantee of a PV/Powered Desalination Plant. The complete system shall be capable of desalting brackish water delivering 25 m3 of product

water per day. There is also a requirement to supply power for small auxiliary loads such as water pumping and lighting. The proposals shall include on-the-job, class room, and in-factory training programs, including training materials and manuals, according to requirements specified in Section 6.0, for assigned Egyptian engineers and technicians in the operation, maintenance, troubleshooting and repair of both the system and its various related individual components. The Contractor shall support operation of the system for a period of two years after the system is accepted by the NREA/USAID. Each tenderer shall submit a set of qualification documents describing in detail the contractor's and subcontractor's relevant capabilities and experience on similar projects. NREA/USAID reserve for themselves the right to refer to any of the tenderer(s) customers to get more information about the contractor and/or the performance of equipment to be supplied.

The tender shall be made on a turn-key-basis. The tenderer shall define in detail all site preparation procedures. It is anticipated that needed civil works would be performed, financed and supported locally by the NREA/Mersa Matruh Governorate according to the tenderer's specifications and drawings and under the supervision of his representatives.

The presence of airborne sand in the atmosphere, occasional sand storms, marine desert effects and high relative humidity accompanied with high temperature in summer shall be taken into consideration in the design of the offered equipment.

For each component offered, the tenderer(s) shall state in his offer the exact type and model number. He shall also submit a complete set of catalogues and drawings for each hardware item offered indicating its detailed technical specifications. All hardware offered shall be commercially available and proven by reliable use in similar applications. The tenderer shall supply information regarding his system in formats as indicated in Appendix D. If additional information is available it should be included.

The tenderer shall include in his offer a preliminary design; system layout drawing; functional schematic; system electrical circuit diagram including the performance monitoring instrumentation system; typical daily power and load operating curves for the PV, battery, and desalination plant; and maintenance requirements for each major equipment item. In addition, the proposal should include details of the installation design.

Packaging and shipping of all required hardware to Alexandria/Egypt shall be the responsibility of the contractor. Custom clearance and transportation to El Kasr Extension # 3 is the responsibility of the NREA.

The bidder shall furnish at a minimum the following equipment, materials and services:

Hardware

1. One Reverse Osmosis Plant with an Energy Recovery Turbine (ERT).
2. Building(s) to house diesel engine, power conditioning system. desalination systems and battery system.
3. Photovoltaic Array and Support Structure.
4. Diesel/Generator Set.
5. Battery Storage System.
6. Power Control and Conditioning System.
7. Fence around the PV Array.
8. Spare parts for five (5) years.
9. Water Treatment System (if required).
10. Appropriate User's Manuals.
11. Required Operating. Maintenance, Repair Tools, meters, etc.
12. A on-site data acquisition system for performance monitoring.
13. 70 m3 Water Tank.
14. Cast Iron on PVC Pipes.

Services

1. System Design, Instrumentation, Procurement and Shipment.
2. Installation and Operations Support for 2 years.
3. Acceptance Testing (30 days).
4. Training of Egyptian engineers/Technicians (Classroom, in-factory and on-the-job in Operation, Maintenance, Troubleshooting and Repair).

1.3 Description of the Application Site

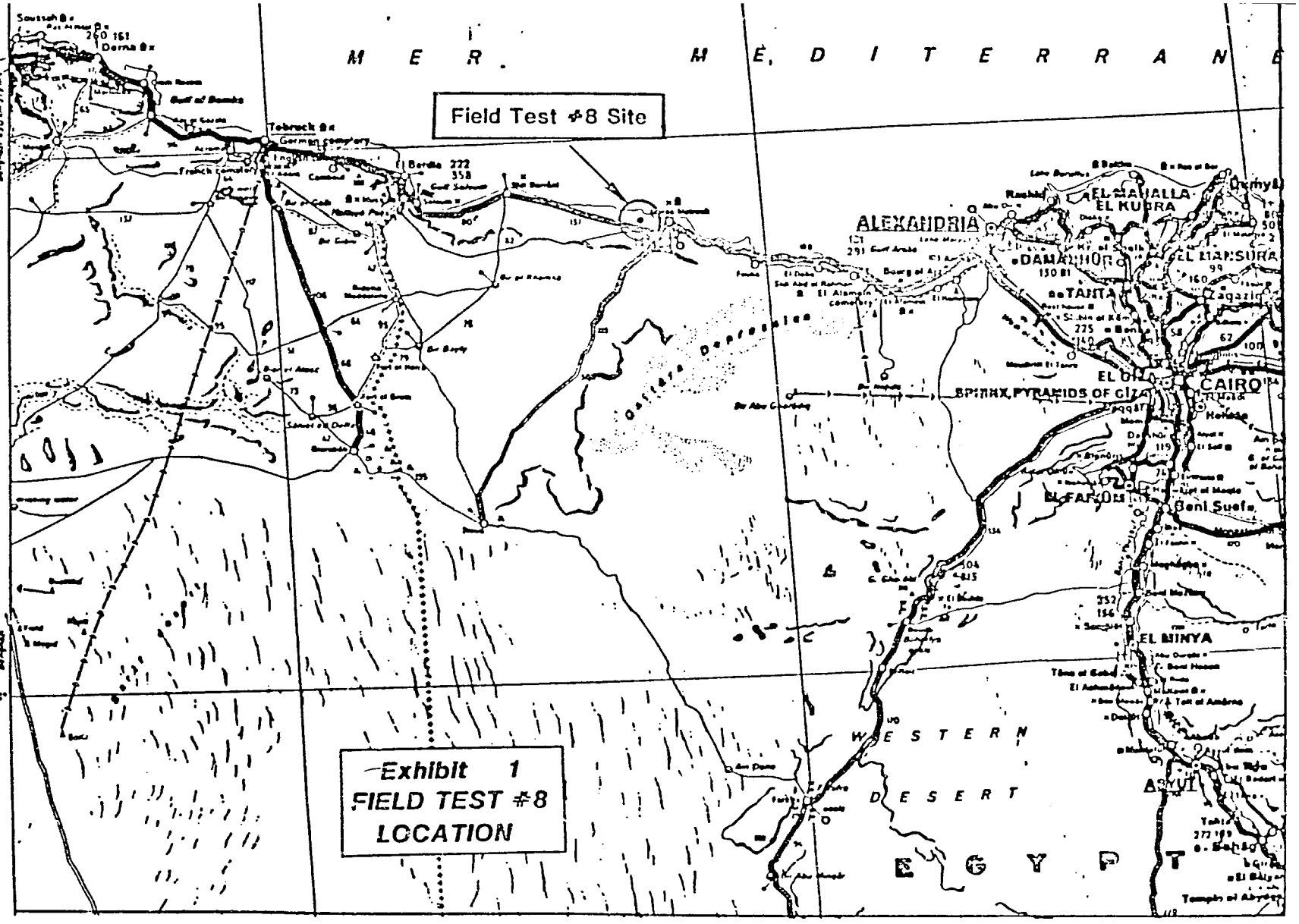
The Governorate of Mersa Matruh, which includes part of the northern coast of Egypt west of Alexandria, has no natural source of fresh water. The wells in the area are brackish, but in the rainy season rain water drains into the wells producing a stratified layer of fresh water. For this reasons, the salinity of the wells depends upon the season and the amount of water taken from a particular well in proportion to its inflow.

The water demand of Matruh (population 70,000), the largest city of the Governorate (population 140,000), is over 2000 m3/day. This demand is only partially met by a small water line from Alexandria with intermittent flow, two water trains per week (500 m3 each) from Alexandria, and a 3-inch brackish water line from the village of El Kasr, 15 kilometers west of Matruh. A multistage flash distillation unit in Mersa Matruh, rated at 2000 m3/day, is old, inefficient, and unreliable. Potable water for the people who live in El Kasr must be transported to the area. This problem will be lessened when two 200 m3/day capacity electrodialysis units are commissioned in the near future at Mowah under a USAID funded project.

The main thrust of this field test is to demonstrate the viability of a PV-powered desalination system. The recommended PV-powered desalination system at El Kasr Extension # 3 is a stand-alone system to produce 25 cubic meters of product water of less than 500 ppm TDS daily from brackish groundwater. The method of desalination is reverse osmosis (RO). This system will use brackish water as feed water.

1.4 Summary of Solar, Water and Ambient Temperature Data

The key site specific parameters that influence the conceptual design for this field test are solar insolation, ambient temperature and water salinity.


Field Test #8 Site
M E R
M E D I T E R R A N E
ALEXANDRIA
EL MAHALLA
EL KUBRA
DAMANHOR
EL MANSURA
TANTA
CAIRO
SPHINX, PYRAMIDS OF GIZA
EL FAYOUM
Beni Suef
EL MINYA
W E S T E R N
D E S E R T
E G Y P T
Tobruck
Derna
El Bardia
Exhibit 1
FIELD TEST #8
LOCATION

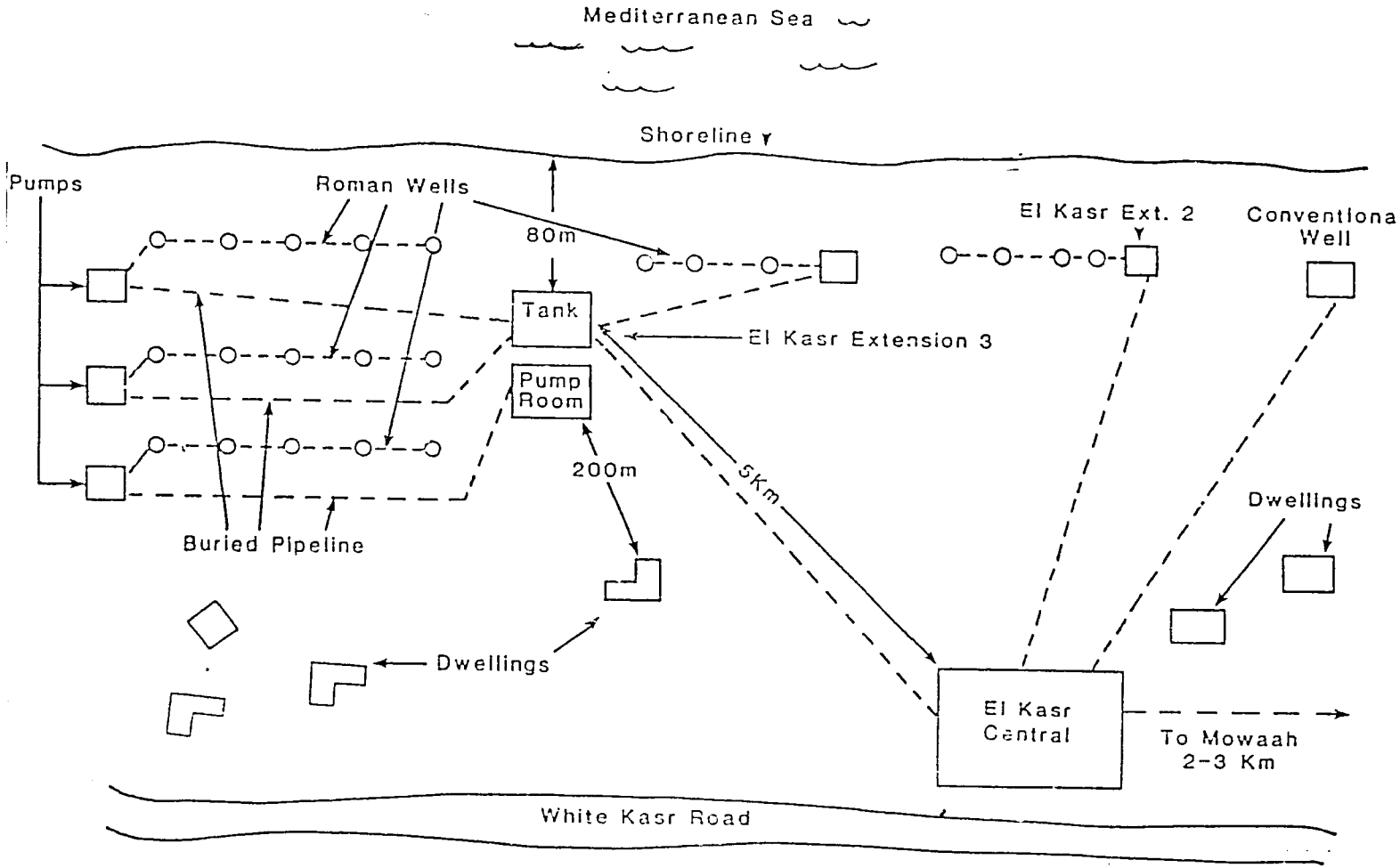


Exhibit 2

SKETCH OF WATER DISTRIBUTION SYSTEM NEAR EL KASR

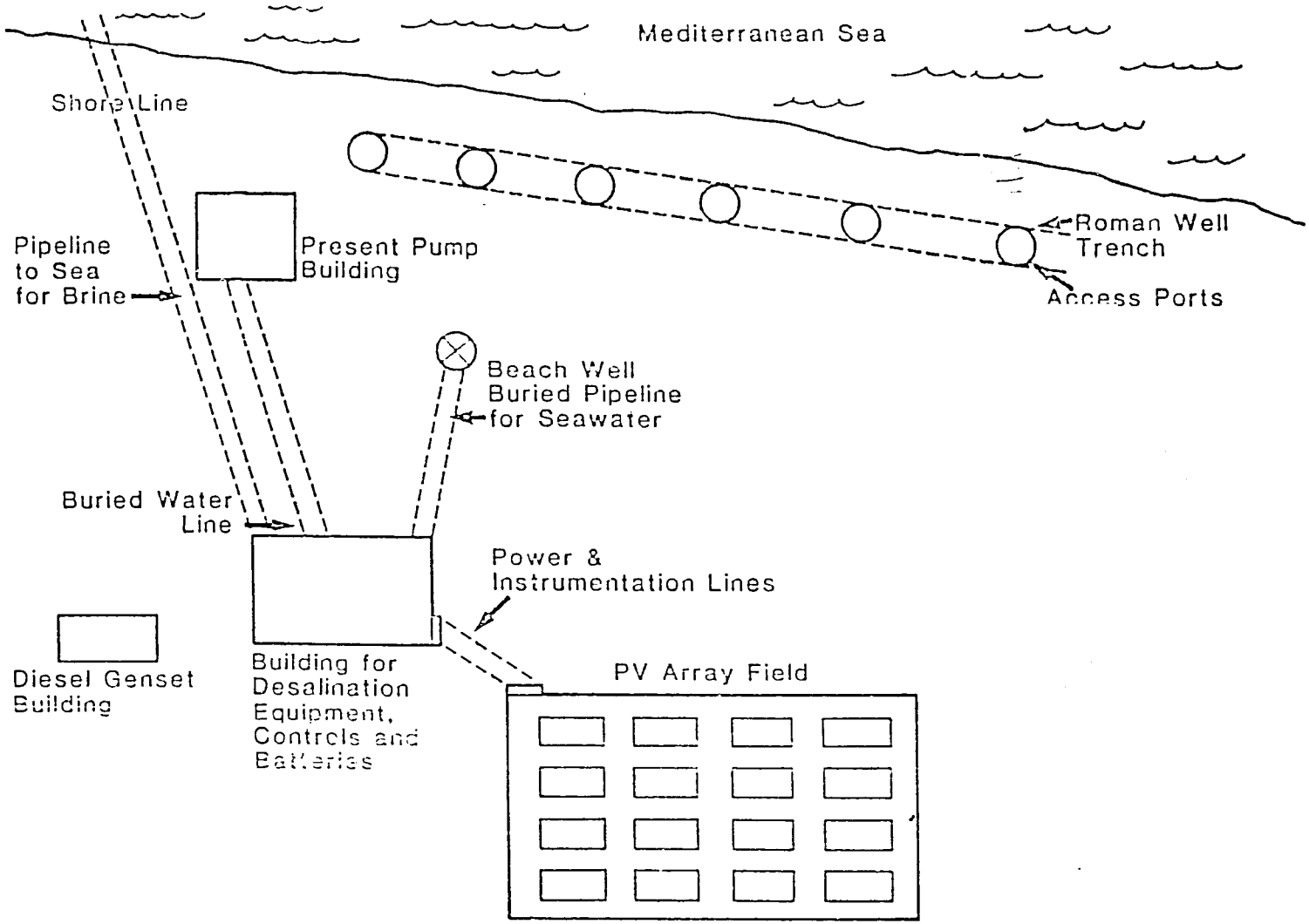


Exhibit 3

SKETCH OF LAYOUT FIELD TEST 8

Insolation on a horizontal surface at the site ranges from a high of 8.4 KWh/m2 in July to a low of 2.9 KWh/m2 in December.

Ambient temperature varies from a high of 25.5 degrees centigrade in August to a low of 12.8 degrees centigrade in January.

Both of these measured values are representative of what can be found throughout Egypt.

A water quality analysis is provided for El Kasr Extension # 3 in Appendix A. It is anticipated that water treatment will be required to ensure low maintenance of equipment. Equipment should be designed to minimize corrosion.

2.0 PV POWERED DESALINATION PLANT DESIGN SPECIFICATIONS

2.1 Schedule for Design, Delivery and Installation

The tenderer shall include in his offer the dedicated time requirements for the design, manufacture, factory testing, procurement, and delivery of the complete system CIF to Alexandria, Egypt. In no case shall the total time exceed 180 days from the date of final design review and approval (Section 2.2). The duration for installation of the system shall also be indicated and in no case shall it exceed 60 days from the date the equipment arrives on the site.

Within 14 days after contract award and a site visit, the Contractor shall submit for NREA/USAID review a detailed project schedule for the design, manufacture, factory testing, installation, instrumentation, startup and acceptance testing of the proposed PV/Powered Desalination Plant. The schedule shall include provision for a final design review and approval by NREA/USAID, or its designated representative, prior to start of manufacture and procurement. The schedule will be approved in writing by the contracting officer within 21 days of receipt in Cairo.

2.2 General Design Requirements

The PV/Powered Desalination Plant design shall conform to U.S. standard specification and practice with all equipment sited and sized for efficient, safe and functional use. The system should be designed for a life of a minimum of 20 years except for the battery system which may be designed for a 10 year life based on one charge/discharge-cycle per day and the Reverse Osmosis membranes which may be designed for a 5 year life under design condition. The power control system, including switches and circuit breakers, should provide for reasonable equipment protection against incorrect procedures for starting, stopping and operating the equipment. A warranty shall be offered, above a standard warrant if required, to guarantee the proper function of all components of the system for a period of 5 years from the date of the approved acceptance test. Operating and maintenance personnel safety shall be an integral part of the system design. All proposed equipment shall be commercially available, to the maximum extent possible, and of demonstrated reliability; the use of prototype or one-of-a-kind hardware is discouraged.

The required level of design detail shall include as a minimum:

- Justification for system sizing and design including all calculations and technical/operational assumptions.
- Justification for component selection.
- Component (product) literature where appropriate.
- General electrical schematics showing junction connections, grounding circuitry, voltage and current limits, etc.
- An installation diagram that includes the relative sizing and location of major pieces of equipment in relation to the site at El Kasr Extension # 3.

2.3 Technical Design Requirements

2.3.1 System Sizing

The PV/Powered Desalination Plant shall be designed to provide 25 cu.m/day of drinking water. Building(s) shall be designed to house diesel engine, power conditioning system, desalination system and battery system.

The proposal shall include the provision of water treatment equipment which may be necessary to produce quality drinking water and to minimize the level of maintenance of the Reverse Osmosis Unit. The proposal should clearly describe any water treatment requirements including needed chemical treatment and disposal of any residues.

The power system shall be designed for the following characteristics:

- Either DC or 50 Hertz AC power is acceptable.
- The diesel/generator shall be able to operate the Reverse Osmosis Plant, independent of the PV/battery power system.
- Battery Storage shall be the minimum necessary to accept the full array charging current rate and operate the load independent of the PV array or diesel.
- The PV array for water desalination shall be sized to meet the average daily energy demand over the year for a 25 m3/day Reverse Osmosis Unit.
- The production and use of PV power shall be maximized.
- The power control system shall be automatic with manual override.

The PV array structure shall be of a manually adjustable tilt design. For example, the array would be capable of being adjusted for different seasons at an angle that maximizes energy production for each respective season. The design and sizing of the power system shall be performed considering the system to be operated in an optimum fixed position.

The diesel should be capable of manual self-starting, independent of the PV array and control system.

2.3.2 Control System Design

The control system design should be kept as simple as possible and should conform to standard industry practice for wiring, environmental protection of solid state electronics, and safety. The control system shall incorporate manual and emergency disconnects for the load and power equipment. NEMA 4 enclosures will be used throughout the system. NREA/USAID, or its designated representatives, has the option to request and to witness the full load testing of the control system at the manufacturer's facility prior to shipment.

2.3.3 PV Array

The PV array shall be made of commercially available flat plate modules of single, poly(multi), or ribbon technology. Grounding of the array and structure shall conform to U.S. standard industry practices, or the equivalent.

2.3.4 Diesel/Generator Set

The diesel/generator shall produce 50 Hertz AC power if AC loads are used. If DC loads are used either an AC or DC generator is permissable. The unit shall be skid mounted and it shall contain standard operating gauges and controls separate from those supplied with the system controls. The diesel generator shall be designed for heavy duty full load operation under environmental conditions specified in Appendix A.

2.3.5 Battery

Lead acid deep cycle batteries, sealed or vented are desired. They could be supplied with recombination caps and an easy method of determining electrolyte level. The proposal shall describe battery operation including required equalization periods and duration and any special procedure for operation in a high temperature environment.

2.3.6 Reverse Osmosis Desalination Plant

The desalination Plant shall include all necessary equipment to provide the required 25 cu.m/day of drinking water. An RO membrane must be chosen that can accommodate the operating pressures required to desalt 12,000 ppm of TDS feedwater while still performing in an efficient manner at the lower salinity levels.

2.3.7 Water Storage Tank

A 70 m3 water tank with accessories should be considered.

2.3.8 Pipes

Cast Iron Pipes or PVC Pipes are recommended.

2.3.9 Building(s)

Prefabricated building(s) shall be supplied by the tenderer and be of a size and construction to permit the storage and maintenance of the desalination system, battery banks, power conditioning system and diesel engine. The building should provide adequate ventilation. An adjoining room should be provided for plant operators. Construction of the building(s) is the responsibility of NREA/Mersa Matruh Governorate based on the bidder's specifications, drawings and under the supervision of his representative.

2.3.10 Additional Equipment

- Inverter (if proposed)

  If inverter(s) are to be supplied they must conform to U.S. industry standard or equivalent and have a demonstrated field performance history. Operating procedures should be simple and clear. NREA/USAID or their representatives reserves the option to request and to witness full load testing of the inverter prior to shipment. Documentation of past experience with proposed inverters is required.

- Battery Charger/Rectifier

  A commercially available battery charger/rectifier is required so that the battery bank can be charged by the diesel.

- Water Treatment

  Equipment that the Contractor believes is required for water treatment shall be included as part of the contractor's proposal and appear as a separate item in the cost proposal.

- Tools

  A set of tools and instruments necessary to troubleshoot usual problems and make repairs utilizing the spare parts supplied shall be provided.

- On-Site Data Acquisition System (ODAS)

  An ODAS shall be designed, purchased and installed by the contractor as specified in Section 5 of this Statement-of-Work.

2.4 Design Review

After Contract Award, the NREA/USAID or its authorized representative shall have the right to review drawings and specifications pertaining to the design of the system and individual components. Submission of the drawings and specifications for review and the completion of the review will be in accordance with the detailed project schedule (Section 2.1) submitted by the Contractor and approved by NREA/USAID. The NREA/USAID shall have the right to require modifications to the design prior to final design approval for specified cause, namely: for minimum safety, prevention of harm to the property or equipment.

2.5 Proof of Performance

The NREA/USAID and/or its appointed representatives reserve the right to witness inspection and performance tests for all hardware equipment at the manufacturer's (or contractor's) facilities prior to shipment. The Contractor

shall provide 30 days notice of performance testing for components. As mentioned under Section 2.4.2 and 2.4.8 the power control system and inverter, if supplied, shall be required to undergo full load testing (burn-in) prior to shipment. The proposal should address this issue by explaining what tests will be performed to assure field and reliable operational performance of components prior to shipment. This testing is the responsibility of the Contractor. It may be witnessed by NREA/USAID or appointed representatives.

3.0 PV POWERED DESALINATION PLANT INSTALLATION

3.1 Equipment Shipment

Packing, insurance, freight and related charges to deliver all equipment items to Alexandria, Egypt is the responsibility of the Contractor. NREA, Mersa Matruh Governorate and/or its appointed agent will receive the equipment, be responsible for custom clearance and transport of the equipment to the site. The Contractor and/or a representative agent is required to witness a receipt inspection at Alexandria and at the site.

The supplier shall send shipping documents, bill of lading, inspection certificates and other related documents to NREA one month prior to the receipt of the equipment at Alexandria.

All equipment shall be packaged or boxed in clearly numbered cartons or boxes. A Box Contents List (BCL) shall be delivered to the USAID contracting officer with a copy to NREA prior to the delivery of any equipment at Alexandria. This is in addition to Bill of Lading documents. The BCL shall identify the numbered contents of each box by the number of the box. Box number shall be grouped by subsystem. For example, PV arrays and related hardware are number series 200, batteries 300, and so forth. Prior to shipment, the tenderer should define in

writing such equipment transport and receipt controls in similar detail as that provided above.

3.2 Plan and Schedule for Construction

The schedule for design, delivery and installation submitted in accordance with Section 2.1 shall include the number and skill level of laborers which will be employed; the duration of the work; and the plans for accommodations for both the labor force and the Contractor's personnel.

The Contractor is required to furnish all installation tools such as shovels, concrete forms, and mechanic's and electrician's tools necessary for the installation, startup and regular operation of the equipment. This equipment shall remain at the job site as part of the deliverable hardware under this contract.

Within two weeks of NREA/USAID approval of the design of the PV/Desalination Plant the Contractor shall submit a "Plan and Schedule for Construction" to the USAID Contracting Officer for approval. The Contracting Officer will approve the Plan/Schedule, or recommend changes required for approval within two weeks of receipt in Cairo. All construction work shall be completed within 60 days of notification to the contractor by

NREA/USAID or its appointed agent that the system hardware is at El Kasr Extension # 3.

The NREA/USAID reserves the right to periodically inspect all phases of the work while in progress or after completion of the whole or any part thereof to insure that the work is performed in compliance with the terms of the contract. If NREA/USAID determines that the work is not performed in accordance with the specifications, they reserve the right to require that the work be corrected of deficiencies or be redone if corrections cannot be made acceptable or are too expensive to economically correct. Any part of the work that is redone shall be at the Contractor's expense. All work related records shall be available at all times for examination by the NREA/USAID Contracting Officer. The Contractor shall provide all necessary facilities for such inspection during contractor's regular working hours, if necessary. It should be clearly understood, except as otherwise provided, that such progress inspection shall not constitute acceptance by the Contracting Officer of any part of the work, but will be for the purpose of coordination and assistance in interpretation of specifications and technical requirements.

3.3 Site Planning and Construction

The Contractor is responsible for the proposed design of the foundations, earthwork, drainage and method to prevent or minimize erosion. The Contractor shall specify requirements for array structure foundations and cost these as a separate item in the cost proposal. In lieu of soil boring data, foundation specifications and cost shall include the minimum and maximum expected based on a range of soil conditions.

Within one month of system acceptance (see Section 7), the Contractor shall enter all changes and corrections to the original system design incurred in the system installation on the original tracings. Changes and corrections so entered shall be indicated by a lettered circle, and noted as "As-Built" in the revision. In the case where no revisions or corrections to an individual drawing were necessary, the notation "As-Built-No-Changes" shall be made directly below the revision block. Where several manufacturers' brands, types or classes of items listed have been used in the project, the specific areas where each item was used shall be designated. Designations shall be keyed to the area and space designations on the contract drawings. Information shall be furnished, typewritten, for the listed materials. Copies of the "As-Built" drawings shall be given to the Contracting Officer.

The Contractor is encouraged to use local Egyptian labor and in-country fabrication of subsystems whenever possible. Low-cost fabrication techniques should be emphasized. The proposal shall discuss the extent to which the proposed system can be constructed and installed by local labor using local materials should the system be replicated elsewhere in Egypt. The Contractor shall indicate where this approach has been taken with this or similar equipment in other developing countries. The Contractor should specify needed facilities for housing local labor installation personnel.

4.0 OPERATION AND MAINTENANCE

4.1 Schedule of Energy Production

The Contractor shall include in the proposal an "Energy Production Plan and Schedule". This document shall contain, but is not necessarily limited to, average daily energy supply and demand projections for twelve months of electrical power generation and drinking water production from the PV/Powered Desalination Plant based on the insolation in Appendix C. A complete description of how these projections were computed, including descriptions of any computer models used, is required. Input parameters to any model shall be given. Planned scheduled outages during the upcoming year and planned changes in equipment, control mode, or operating characteristics significantly impacting the energy production of the system will be given, if applicable.

4.2 Guarantee/Spare Parts Requirements

The Contractor shall provide at least a 5 year guarantee on all parts from the time of NREA/USAID system acceptance. The Contractor shall separately cost an itemized list of spare parts that should be purchased by NREA/USAID and made available to insure trouble-free operation for five years. Any specialized, custom manufactured tools or equipment required

for operation and maintenance of the system shall be specified and provided by the Contractor.

4.3 Operations Support

The Contractor is required to provide technical support of the operation of the system for a period of 2-years after system acceptance by NREA/USAID. The Contractor's proposal shall describe the level of support offered, the procedures for management and control of the technical support and related support issues such as availability of spare parts, anticipated response time to a request for support, etc. This technical support shall be costed as a separate cost item in the Contractor's cost proposal.

5.0 PERFORMANCE MONITORING

5.1 Field Test Data Acquisition System

The Contractor will provide an on-site data acquisition system (ODAS) for monitoring the performance of hardware installed for this field test. This requirement is in addition to any other requirement for system control instrumentation and instrumentation necessary for routine test and maintenance checks as specified in Sections 2.4.2 and 4.2 of this Statement-of-Work.

The ODAS will comply with the specifications listed in Appendix D of this Statement-of-Work and will monitor, as a minimum, the data parameters listed in Appendix D. The Contractor will provide output ports and transducers to sample and measure each data parameter as specified in Appendix D and to insure compatibility with the data storage system proposed. The Contractor will also provide a separate meteorological station to monitor data parameters as specified in Appendix D. The meteorological station will have its own data recording system that is compatible with the ODAS. If an exception must be taken to any of these requirements, the Contractor will clearly note the exception and explain why the exception should be acceptable to the NREA/USAID.

5.2 ODAS Installation and Training

The Contractor will install the ODAS at the same time that the field test hardware is being installed. Training for Egyptian engineers and technicians in the installation and operation of the ODAS will be included in the on-the-job training program described in Section 6 of this Statement-of-Work.

The ODAS instrumentation and installation shall be a separate item in the cost proposal for this field test. The NREA/USAID reserves the right to replace or modify the proposed ODAS during contract negotiation if required to maximize compatibility with other data collection, analysis and storage requirements of the REFT Project.

5.3 Log Sheets/Maintenance Records

The Contractor shall develop, as part of the proposal, a log sheet of pertinent data that should be manually recorded on each major subsystem to document operations and maintenance history. The recommended frequency for maintenance of each item shall be stated. These logs/records should comply with the specifications outlined in Section 8.

6.0 TRAINING REQUIREMENTS

The following training program and materials are required from the Contractor for this project. These training programs fall into three general areas: classroom training in Cairo, in-factory training in the U.S. and on-the-job training at El Kasr Extension # 3, Egypt. Training sessions and materials vary in content and presentation from informal "one-on-one" type instruction to more formal group "lectures and workshops". The sections below describe the training requirements. All training and materials will be written and conducted in English. All emergency start-up and shut-down procedures must be provided in both English and Arabic.

6.1 Operator Training Program

Formal Classroom training will be given in Cairo for NREA and Mersa Matruh Governorate engineering, operating, and maintenance staff in the design of the PV/Powered Desalination Plant. This training is anticipated to be for 20 hours (5 days, 4 hours per day) and intended to provide the NREA and Mersa Matruh Governorate staff with an understanding of the engineering parameters, design process, and decisions which resulted in the final design of the system. This training will be conducted at the start of the installation work and is not intended to require a separate dedicated travel to Cairo.

As part of this proposal, the Contractor shall develop a syllabus that briefly summarizes topics and content of the classroom design training program.

6.2 Maintenance Training Program

Formal classroom training will be given in Cairo for selected NREA and Mersa Matruh Governorate engineering, operating and maintenance staff in the operation, maintenance and repair of the system and individual components. The training is anticipated to be for 20 hours (5 days, 4 hours per day). The training will utilize the actual working drawings for this project to cover such topics as installation procedures, specifications, construction schedule and labor requirements. This training is intended to familiarize NREA and Mersa Matruh Governorate staff with the details of the installation as well as the project management aspect of the project. System installation will begin as soon as possible following this training and the operator training program (Section 6.1).

The Contractor is required to operate the PV/Powered Desalination Plant for a period of 30 days after the system is designated as operational by the NREA/USAID. During this time period the Contractor shall provide an on-the-job training program in the operation, maintenance and repair of the system

and equipment components. The training program shall consist of a minimum of 20 hours of on-site formal classroom training and 80 hours of on-the-job (OJT) field training. As part of the proposal the Contractor shall develop a syllabus for the on-site training program that briefly summarizes the topics, operating and maintenance procedures which will be taught.

It is assumed that the OJT field training will consist of selected NREA and Mersa Matruh Governorate personnel accompanying the contractor personnel during normal daily operational tasks. The Contractor shall briefly describe, as part of this proposal, the itinerary of the PV/Powered Desalination Plant operating personnel over an average day. The itinerary should take into account the demonstration nature of this field test, i.e., the Egyptian engineer must understand the function and operation of any specialized equipment and instrumentation.

6.3 In-Factory Training Program

The Contractor is required to provide and/or coordinate in-factory training on the operation, maintenance and repair of the PV/Powered Desalination Plant system and major equipment components. This training is anticipated to take place at the respective manufacturer's facilities for the following

components; PV array, batteries, diesel engine, RO plant, inverter and system controller. The training should be both classroom and "hand-on". The total number of training days is not expected to exceed 20 days covering all systems. All expenses for the visiting engineers are the responsibility of NREA/USAID. As part of this proposal the Contractor shall develop a syllabus for the in-factory training and suggested itinerary for the program.

6.4 Training Manuals

For each training item the Contractor shall provide a triaing manual for each of the participatns.

7.0 SYSTEM ACCEPTANCE TEST CRITERIA

The Contractor shall include in his proposal a proposed Acceptance Test procedures for "Point of Manufacture Testing" and "Field Acceptance Test" of the system and specific components. At a minimum it shall include the following:

7.1 Point of Manufacture Testing (PMT)

The Contractor shall detail in his proposal the procedures to be followed for the point of manufacture testing of the major equipment items. At a minimum this shall include: diesel, PV modules, PV controller, power system controller, pumps, inverter (where proposed), batteries, and Reverse Osmosis plant. NREA, Mersa Matruh Governorate and USAID or their authorized representative shall have the right to attend and witness component and system performance testing at the manufacturers prior to shipment. NREA, Mersa Matruh Governorate and USAID representatives attending the tests shall have the right to require measures and procedures necessary to ensure that tests comply with contractors proposed testing procedure specifications (JPL, IEEE, ASME, etc.). PMT data and acceptance test certificates shall be assembled into usable formats to constitute baseline acceptance test data for the equipment. The signed (manufacturer) and countersigned (NREA and USAID and/or representative) acceptance test certificates shall be considered part and parcel of the necessary shipping documents.

7.2 Field Acceptance Testing

The Contractor proposal shall provide, in detail, performance guarantees and evaluation procedures for the system and its major components. These shall include at a minimum the following:

- A PV array performance guarantee expressed, in part, as a curve guaranteeing the average daily output of the PV array as a function of the average daily insolation.
- Diesel operating efficiency as a function of load over a sustained running time.
- Battery "round-trip" efficiency as a function of temperature and state of charge.
- Control system full operational performance.
- System performance (drinking water production) by both diesel and PV/battery power systems.

NREA and USAID and/or their authorized representatives shall participate in a 30-day acceptance test conducted by the Contractor at the site The Contractor shall submit in the proposal the guaranteed PV array output power at standard operating conditions (1000 watts/m2, 25 degrees centigrade). The NREA/USAID, or its designated representative, will measure array current-voltage (I-V) curves at a number of daily insolation levels throughout the 30-day acceptance test period. Calibrated pyranometers, curve tracers, and temperature measurement instrumentation will be used. For each I-V curve, the

maximum power point will be corrected (normalized) for temperature. All measured data must be above 95 percent of a straight line drawn from the origin to the guaranteed manufacturer output power value (Exhibit 4).

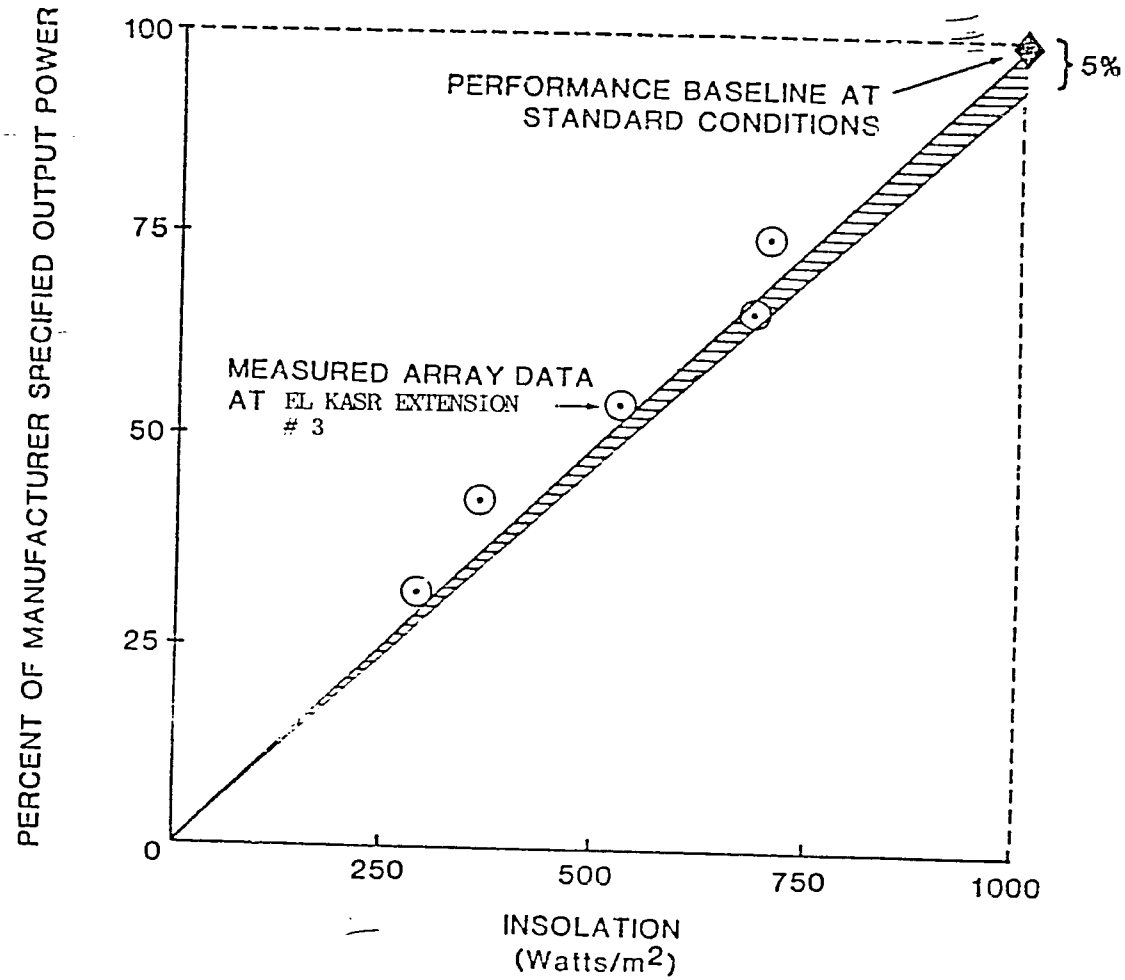


Exhibit 4.
PV ARRAY PERFORMANCE VERIFICATION

8.0 PV/POWERED DESALINATION PLANT OPERATIONS AND MAINTENANCE MANUALS

The Contractor shall provide manual(s) prepared to the minimum content listed below. The manual is to be used for operation, maintenance, repair and logistic support for the PV/Powered Desalination Plant. All manuals shall be delivered to NREA/USAID for review at least 30 days prior to the arrival of equipment at the site. All manuals shall be in English. Manual(s) will be revised as needed and a final set submitted not later than 30 days after the completion of the 30-day acceptance testing period. The minimum requirements for the manual(s) shall include chapters on the following subjects:

8.1 System Description

This chapter shall include but not be limited to the following:

- A full page composite illustration of the PV/Powered Desalination Plant equipment and layout.
- An illustration(s) calling out the major assemblies.
- A basic description of the type of equipment and its purpose.
- A function block diagram.
- Tables listing equipment supplies and equipment required but not supplied, if any.
- Tables of technical, environmental and physical characteristics, as appropriate.

8.2 System Installation

This chapter shall include:

- Information on unpacking and proper location of equipment.
- Interconnections and initial pre-operational adjustments.
- Details of structure, cables and foundation requirements (as applicable).
- Operating ranges (voltage, current for each equipment item and system).

8.3 System Operation

This chapter shall include:

- Step-by-step procedures for starting, operating and stopping the equipment.
- Meter readings and/or results expected from properly adjusted and operated equipment.
- Tables and illustrations calling out all operational controls and indicators and their functions (all references to controls and indicators throughout the manual shall follow these designations).
- Means for adjusting array tilt angle.

8.4 Principals (or Theory) of Operation

This chapter shall include:

- A functional description of the equipment, based on a block diagram.
- For complex mechanical features, a complete explanation, using block diagrams, exploded views or cutaway drawings.
- Major assemblies broken into individual circuits, accompanied by complete circuit analysis keyed to simplified schematic.

- Brief description of conventional circuits.
- Detailed descriptions of complex and novel circuits.
- Typical daily power, load, and state of charge curves for each component.

8.5 Maintenance (Preventive/Corrective)

This chapter shall include:

- A maintenance schedule for all equipment including adjustments and procedures.
- List of recommended test equipment.
- Lubrication data.
- Information that permits a technician to locate trouble and to make replacements, repairs or adjustments to the equipment.
- For complex equipment or where the procedure is not obvious, an outline of disassembly and reassembly procedures (diesel).
- Details of special test procedures.
- Completed adjustment and maintenance information for relays and other electro-mechanical devices.
- Tools required for maintenance.

8.6 Parts List

The parts list shall consist of a tabulation of descriptive data on all electrical components and repairable/replaceable commercial or vendor mechanical components in the equipment. All parts shall be sufficiently described to implement reorder/replacement. the parts list shall contain at least the following information:

(a) Reference designation

(b) Name and description of part

(c) True Manufacturer's code and part number (and list of manufacturer's codes and addresses)

(d) Quantity

8.7 Drawings

In addition to drawings previously specified, the following shall be included:

(a) Schematic diagrams of individual major components, printed wiring boards and, where applicable, or the completed equipment.

(b) Logic diagrams

(c) Interconnection diagrams

(d) Cabling diagrams

(e) Wiring diagrams

9.0 SPECIAL PROVISIONS

9.1 Site Access and Local Labor Provision

Employees and representatives of the Contractor and personnel conducting business with the Contractor relating to this Contract, will be granted a revocable permit to enter the El Kasr Extension # 3 area for the purpose of installation, operation, and/or maintenance of the facilities and equipment providing electrical energy under this Contract. Access to and movement within this area are subject to restrictions and provisions of the security instruction in effect.

It is the Contractor's responsibility to maintain satisfactory labor relations with his employees. Representatives of the Contracting Officer will not participate in labor relations matters unless disputes develop that interfere with the proper performance of the contract, at which time the representative may endeavor to assist in settling the difficulty. The Contractor is encouraged to hire local labor whenever possible.

9.2 Protection of the Environment and Personnel

During all operations, all NREA and local environmental and labor requirements shall be rigorously observed. The NREA will retain the right to suspend any operation judged to present

an imminent threat to the environment or personnel, or a violation of applicable labor laws and regulations or natural resources management agreements, after giving notice to the Contractor.

9.3 Public Release Information

There shall be not public release of information or photographs concerning the aspects of this Contract or other documents resulting from this Contract without prior written approval of the NREA.

9.4 Pre-Award Survey

The NREA/USAID may make a pre-award survey to the facilities of any apparently successful bidder to determine whether or not such bidder is adequately qualified to perform the requirements of any Contract that may be awarded on the basis of this specification. Investigation may be conducted to determine that the Contractor does regularly engage in the performance of work of the type covered by the specification and has a satisfactory record of performance in this field. The bidder is required to submit information, as well as any other related materials, requested by NREA/USAID audit agencies during the course of the pre-award survey.

9.5 Minimum Proposal Requirement

The Contractor is required to submit as part of the proposal the following:

- Organization Chart. Show the organization for accomplishing and managing the project. Explain briefly the responsibilities of each element shown on the organizational chart. Identify key personnel by name in each element and submit their curriculum vitae (resumes). Show the lines of authority within the organization. If important portions of the project are to be subcontracted (e.g., design of the system), identify the subcontracted function, the subcontractor(s), the subcontractor's key personnel, and which elements of the organization will manage the subcontractor(s).

- Key Personnel and Resumes. Provide resumes of key personnel, including those of the subcontractor(s). Be explicit in identifying past training and experience of each individual which qualifies him/her for the position to be held in the organization.

- Staffing Plan. Indicate the type and approximate number of skilled personnel required in each element of the organization chart. State whether or not the required personnel are available within the organization. If not, comment on the availability of needed skilled personnel within the labor force and outline a schedule and plan for recruitment and/or training.

- Related Experience. For each of the categories of experience below, list and describe projects or contracts which have provided your firm or that of your proposed subcontractor with related, qualifying experience. The descriptions should include: (1) dates during which the work was accomplished; (2) the scope and price of the total project or contract; (3) statement of what portion of the total project or contract was accomplished by your firm, i.e., an explicit description of the responsibilities or role of your firm; (4) financing arrangements; (5) references; (6) approximate payment for your service; (7) number of similar projects, location and contact person.

- Construction Projects. List and discuss projects or contracts providing experience in the construction of facilities, particularly those using PV/Powered systems.

- Operation and Maintenance of PV/Powered Desalination Systems. List and discuss project or contracts providing experience in the operation and/or maintenance of PV/Powered Desalination systems. For each of the items listed, state which of the following functions were the responsibility of your firms; (a) start-up of facilities; (b) operation of facilities; (c) routine maintenance; (d) periodic overhaul of facilities. Also, state what type of facilities were included; (e) PV systems; (f) controls; (g) electrical switchgear and protection equipment; (h) other. If "other" is listed, please identify or explain.

9.6 Post-Award Site Visit

Upon contract award, winning contractor personnel are expected to inspect the El Kasr Extension # 3 site to satisfy themselves as to all general and local conditions that may affect the design and installation of the PV/Powered Desalination system. NREA/USAID, and/or authorized representative personnel will be available at that time for detailed discussions prior to initiation by the Contractor of detailed system design.

9.7 Summary of Deliverables

(1) Contract Documentation Schedule

ACTIVITY	WEEKS AFTER CONTRACT AWARD*
(a) Project Schedule	2
(b) NREA/USAID Approval of Project Schedule	5

(c)	Detailed Design Complete	9
(d)	NREA/USAID Design Review Complete (Authorization to proceed)	13
(e)	Written Results of Component/Subsystem In-Factory Testing.....	Within 2 weeks of test completion
(f)	System Operations and Maintenance Manuals	Within 4 weeks of system acceptance
(g)	Unscheduled Maintenance Reports	As required to document unscheduled maintenance throughout the 2-year support period

(2) Contract Hardware Installation Schedule

(a)	Site preparation Complete, Hardware Delivered to Site	Day 0 (D)
(b)	Construction Completed, PV/Diesel Interconnected with the RO Unit.....	D + 60 days
(c)	System Acceptance Test Complete	D + 90 days
(d)	Final System Drawings & System Operations & Maintenance Manual Submitted	D + 120 days

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In this schedule, one week is allowed for transmittal and receipt of documents mailed from either the United States or Cairo.

APPENDIX A

AVAILABLE GROUND WATER QUALITY ANALYSES FOR EL KASR EXTENSION # 3 WELLS

DATES OF SAMPLES

Ground Water Constituents		11/15/85	3/19/86	4/24/86	6/29/86	9/1/86	9/8/86	9/23/86
PH		7.6	7.8	7.8	8.6	7.6	7.4	7.2
Conductivity U - mhos/Cm_2		10,900	13,000	15,000	920	630	20,000	20,000
Partial alkalinity	mg/l $CaCo_3$	0	0	0	17.5	0	0	0
Total alkalinity	mg/l $CaCo_3$	250	300	270	203	180	270	260
Total Hardness	mg/l $CaCo_3$	1,620	1,300	2,000	80	172	2,240	2,090
Calcium	mg/l $CaCo_3$	420	490	600	50	98	260	640
Manganese	mg/l $CaCo_3$	1,200	1,410	1,400	30	47	1,620	1,450
Sodium	mg/l $CaCo_3$	4,130	5,220	5,087	313	94	5,837	5,900
Potassium	mg/l $CaCo_3$	115	155	162	11.5	6	175	173
Manganese	mg/l as Mn			0	.03	.01	.02	.01
Iron	mg/l as Fe		.024	0.1	.45	.013	.006	.01
Chlorides	mg/l as $CaCo_3$	5,052	6,052	5,706	126	53	6,340	6,250
Sulphates	mg/l as $CaCo_3$	877	948	1,317	67	42	1,636	1,661
Total Dissolved Solid (TDS) mg/l		6,540	6,380	10,093	737	359	13,397	12,840
Turbidity (NTU)					84	1.2	2.8	2.2
Suspended Solids	mg/l		60		157	5	7	5

43

APPENDIX B

EASTERN MEDITERRANEAN WATER QUALITY ANALYSIS

Ionic Composition in Seawater (in mg/l)

Constituent	Normal Seawater	Eastern Mediterranean
Chloride (Cl^{-1})	18,980	21,200
Sodium (Na^{+1})	10,556	11,800
Sulfate (SO_4^{-2})	2,649	2,950
Magnesium (Mg^{+2})	1,272	1,403
Calcium (Ca^{+2})	400	423
Potassium (K^{+1})	380	463
Bicarbonate (HCO_3^{-1})	140	--
Strontium (Sr^{-2})	13	--
Bromide (Br^{-1})	65	155
Boric Acid (H_3BO_3)	26	72
Fluoride (F^{-1})	1	--
Silicon (Si^{-4})	--	--
Iodine (I^{-1})	<1	2
Other	1	--
Total Dissolved Solids	34,483	38,600

- Note: -- Means much less than 1 mg/l or not given.
- Assume pH 7.9, 26.4°C.

Reference: The USAID Desalination Manual, August 1980, pg. 2-5. (PN-AAJ-1

APPENDIX C

DAILY SOLAR INSOLATION AND AMBIENT TEMPERATURE DATA

Daily Solar Insolation on a

32 Degree Surface

Month	KW-Hrs/m2 at Mersa Matruh	Mersa Matruh Ambient Temp Degree Centg.
JAN	4.56	12.8
FEB	5.52	13.0
MAR	5.88	15.1
APR	6.16	17.4
MAY	7.17	20.1
JUN	7.35	23.3
JUL	7.41	24.9
AUG	7.26	25.5
SEP	7.04	24.3
OCT	5.98	21.6
NOV	4.92	18.1
DEC	4.28	14.4

APPENDIX D

INSTRUMENTATION REQUIREMENTS AND SPECIFICATIONS

SPECIFICATIONS FOR A FIELD TEST INSTRUMENTATION SYSTEM

The Renewable Energy Field Test instrumentation system will be used to monitor IPH, PV and wind energy system installations at urban and remote desert locations in Egypt. These energy systems include main power sources (solar collectors, PV arrays and wind turbines) as well as ancillary subsystems depending on specific field test applications. These subsystems include ice-making equipment, desalination systems, a variety of load characteristics ranging from small DC loads to grid-connected applications and back-up power systems (diesel engines and batteries).

The instrumentation system must be a stand-alone system. Failure of the instrumentation system must not affect the performance of the field test system that is being monitored. The instrumentation system must have an on-site data storage system that is non-volatile and capable of easy physical removal and transport to another location for data removal and long-term storage. One form of the non-volatile storage system must be a microchip/ EPROM or CMOSRAM - Type system that can be "milked" on site easily and without danger of a loss of data.

The instrumentation system must be a microcomputer based data logger with programmable input channels and output formats both analog and digital. The user must have control over sampling frequency and output period for each channel. The capability to multiplex some of the channels is also required. Primary design objectives for the instrumentation system should be reliability, simplicity, small size, low power and the ability to operate in environmental extremes as specified (especially high temperature, sand/dust and tropical/sea coast). The unit must be capable of stand-alone battery operation for a period of at least one month, preferably for two months.

The following minimum specifications are required for the instrumentation system. If an exception must be taken to one or more of these requirements,

the exception shall be noted and a clear explanation given as to why the bidder believes that the exception should be acceptable to the purchaser.

Physical Specifications

- o Small, stand-alone, self-contained system in an environmental enclosure
- o Desired weight: less than 10 pounds
- o Desired size: less than 10 inches x 10 inches x 6 inches

System Power Requirements

- o Capable of operation using self-contained batteries
- o Capability for the use of an external power source to allow continued data collection while changing batteries is desirable.
- o Capable of transient protection from spurious electrical charges or lighnting.

Environmental Specifications

- o Ambient Temperature: -25 deg. C to +50 deg. C
- o Relative Humidity: 0 to 90 percent non-condensing
- o Impervious to a tropical, oceanside environment with occasional high airborne sand/dust and/or sulphur levels

Analog Inputs

Number of Channels: At least 12 channels

Voltage Measurement Types: Differential or single-ended

Accuracy of Measurements: at least ± 0.5 percent

Range and Resolution: Selectable for any input channel from microvolts to several volts full scale

Sample Rates: At least once per second for each channel

Multiplex Capability: at least four channels

Pulse Inputs

Number of Pulse Counter Channels: at least 4 channels

Analog and Digital Control Outputs: a total of three resettable channels each is desired with a range of 0 to ± 5 volts with a 0.5 volt resolution

Multiplex Capability: at least three channels

Output Signal Interface

Memory: Capable of storing at least 3000 data points per day for a period of one month (two months desirable)

Display: A visual display of stored data is required on-site for data verification before data removal

Peripheral Interface: Downloading of data at the site should be by physical removal of the data storage device or simple, reliable data downloading to a non-volatile storage device. Storage data files shall be IBM-PC compatible on floppy disc either directly from the data logger or through a simple, fast, reformatting technique.

FIELD TEST PERFORMANCE MONITORING DATA REQUIREMENTS

Field Test #8 (PV/Powered Desalination Plant)

Parameter	Channel Type	Output Interval
1/ Array Power (KW)	P	10 min.
Array Voltage (volts)	A	10 min.
Array Current (Amps)	A	10 min.
PV ref. cell temp. (2 or 3) (degrees C)	A	10 min.
Diesel Fuel Usage (Liters)	A	Daily
1/ Diesel Power (KW)	P	10 min.
Diesel Number of on-off Cycles	P	Daily
Diesel Voltage (volts)	A	10 min.
Diesel Current (Amps)	A	10 min.
Battery Charge and Discharge Current (Amps)	A	10 min.
Battery Voltage (volts)	A	10 min.
Battery Temp. (degrees C)	A	10 min.
Feed Water Flow (Liters)	P	10 min.
Product Water Flow (Liters)	P	10 min.
Water inlet Temp. (degrees C)	A	30 min.
High Pressure Pumps Power (KW)	P	10 min.
High Pressure Pumps Voltage (Volts)	A	10 min.
High Pressure Pumps Current (Amps)	A	10 min.

1/ Desired but not required.

Meteorological Station

Parameter	Channel Type	Output Interval
Horizontal Insolation (KW/m2)	A	10 min.
Plane of Array Insolation (if appropriate) (KW/m2)	A	10 min.
Ambient Temp. (degrees C)	A	30 min.
Humidity (%)	A	30 min.
Air Pressure (Kgrm/m2)	A	30 min.
Wind Speed (m/sec)	A	10 min.
Wind Direction (degrees)	A	10 min.