NOTE

The design of the "self sufficient" module could be accomplished because the technologies recommended already exist on the market. Those considered important for the adequate functioning of the module and described herein are:

1) **Reverse Osmosis (RO) potable water system.**
2) **Photovoltaic solar panels.**
3) **Wind turbine.**
4) **Deep cycling batteries, inverters, and charge controllers.**
5) **Waste water sewage treatment system.**

The descriptions of the recommended equipment for use in the module were obtained from several public sources and are those given by the vendors of the technologies mentioned. The objective of this report is to present a general in-house guide for the construction of the module and not intended for publication.

SUMMARY

Self-sufficient, Hurricane-Combatable Living Module for Coastal Regions

Materials and Size

The module can be constructed of prefabricated cement walls, floor and roof (Emme Due-M2 Advanced Building design) that can be painted any color. It has five windows and two doors. The dimensions of this model are: 30 feet (10 meters) wide, 30 feet (10 meters) long and 8 feet (2.5 meters) high. The furniture (tables, chairs, bunk beds) is made of wood and is fastened to the structure. Based on the location code, the module can be placed on concrete pilings or treated wood pilings and elevated 7 to 10 feet (2.5-3 meters) above the ground. A 6 foot (2 meters) wide porch will form part of the elevated structure. This size can house two people comfortably. Larger sizes can be constructed.

Approximate Cost: $ 20,000

Potable Water System

It consists of a small reverse osmosis desalination plant that can treat 260 to 525 gallons (1000 – 2000 liters) of seawater per day.

Approximate Cost: $5000

Electrical System

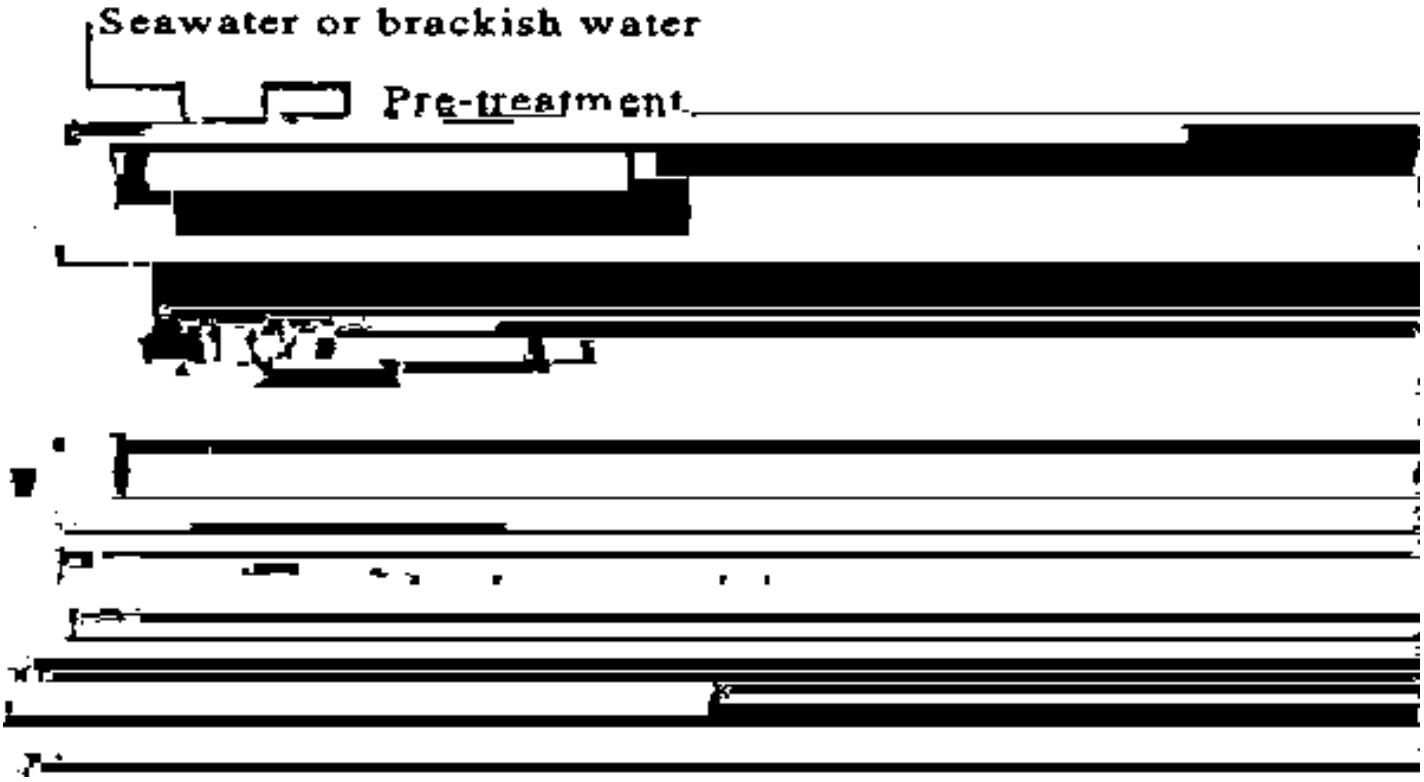
This consists of a hybrid system that includes photovoltaic solar panels on the roof of the module and a 1.5 kW wind turbine that can be mounted on a 30 feet (9 meter) tower near the module. It is a stand-alone system that will generate sufficient power to handle a load of 400 – 500 kW hours per month. It is designed to meet the needs of six points of light, a refrigerator, an electric stove with four burners, an ai39t: $000

Potable Water System

Reverse osmosis, seawater desalination is the separation process that will be used to reduce the dissolved salt content of saline

The product passes through an aeration column in which the pH is elevated from a value of approximately 5 to a value close to 7. This water is discharged to a storage cistern for later use.

Elements of the Reverse Osmosis Desalination Process



Operation and Maintenance

Operating experience with reverse osmosis technology has improved over the past 15 years. Assuming that a properly designed and constructed unit is installed, the major operational elements associated with the use of RO technology will be the day-to-day monitoring of the system and a systematic program of preventive maintenance. Preventive maintenance includes instrument calibration; pump adjustment, chemical feed inspection and adjustment, leak detection and repair, and structural repair of the system on a planned schedule.

The main operational concern related to the use of reverse osmosis units is fouling. Fouling is caused when membrane pores are clogged by salts or obstructed by suspended particulates. It limits the amount of water that can be treated before cleaning is required. Membrane fouling can eaning (about every 4 months), and by replacement of the cartridge filter elements (about every 8 weeks). The lifetime of a has been reported to be 2 to 3 years, although, in the literature, higher lifespans have been reported.

Costs
The most significant costs associated with reverse osmosis plants, aside from the capital cost, are the costs of electricity, membrane replacement, and labor. All desalination techniques are energy-intensive relative to conventional technologies. The Table below gives the a few parameters for 225 and 450 gallons/day systems.

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Model	DROSW-	DROSW-450
Gallon Per Day	225	450
Average Product Quality-ppm	100	100
Recovery-%	35	35
Voltage - VAC	120/240	120/240
Motor- Hp	0.5	1.0
Pre-filter Stages	3	3
Product Flow Meter	Yes	Yes
Drain Flow Meter	Yes	Yes
Re-Circulation	Yes	Yes
Low Pressure Switch	Yes	Yes
High Pressure By-Pass	Yes	Yes
Number of Pressure Gauges	3	3
Length/Width/Height-inches	30/18/24	50/18/24
Shipping Weight-Pounds	60	80
Pump Material	SS	SS
Pump Action	Hydraulic	Hydraulic
Vibration Dampening	Yes	Yes
Tank Pressure Switch	Yes	Yes

Suitability
This technology is suitable for use in tropical regions where seawater or brackish groundwater is readily available.

Advantages

- The processing system is simple; the only complicating factor is finding or producing a clean supply of feed water to minimize the need for frequent cleaning of the membrane.
- Systems may be assembled from prepackaged modules to produce a supply of product water ranging from a few liters per day to 750 000 l/day for brackish water, and to 400 000 l/day for seawater; the modular system allows for high mobility, making RO plants ideal for emergency water supply use.
- Installation costs are low.
- RO plants have a very high space/production capacity ratio, ranging from 25 000 to 60 000 l/day/m^2.
- Low maintenance, nonmetallic materials are used in construction.
- Energy use to process brackish water ranges from 1 to 3 kWh per 1 0001 of product water.
- RO technologies can make use of use an almost unlimited and reliable water source, the sea.
- RO technologies can be used to remove organic and inorgani

Electrical System

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The top layer of silicon is treated to give it an electrically negative character. The back layer is treated to make it electrically positive. Due to these treatments and added elements, the top layer is rich in electrons, and the back layer is relatively electron poor. These two layers are separated by an electrically charged junction, which allows electrons to flow from back to front, but not the other way around. When light strikes the PV panel, the silicon layers absorb some of the photons. The photons cause electrons to be released from the silicon crystal, and those electrons "wander around" looking for somewhere to attach themselves. Some of the electrons are freed from the bottom layer, and they find their way through the junction into the top (electron rich) layer. Some of the electrons are freed from the top layer, and since they cannot travel to the bottom (electron poor) layer, and are being "crowded" by new electrons from the bottom layer, they are left free to be collected by electrical contacts on the surface of the top layer.

Those collected electrons are routed through an external circuit, providing power to the electrical

Wind Turbine

The new 403 AIR that will be installed has become the best selling wind turbine in the world. Still priced about the same as a photovoltaic module, an AIR is capable of producing more than seven times the energy. Maintenance-free performance, easy installation, and high output make it ideal for virtually any remote battery charging application.

- It is designed for use in combination with photovoltaic modules to balance system energy output during times of seasonal fluctuations. If there is no room for a tower, the AIR's compact design makes it ideal for rooftop mounting if necessary.

Features:

Battery Type Needed for Solar Panel/Wind Turbine Use

Deep-cycle solar batteries such as the Trojan L-16H are the most common choice for remote power systems. Originally designed for industrial floor sweepers, but very well suited to remote power use. This is a 6-volt battery with a 5-6 year life expectancy. **Advantages:** good service life, fairly resistant to occasional abuse, reasonable cost. **Disadvantages:** not as resistant to abuse as industrial cells.

Deep cycle batteries like the Trojan L-16 are designed to be discharged down as much as 80% time after time, and have much thicker plates. **The major difference between a true deep cycle battery and others is that the plates are SOLID Lead plates - not sponge.** The popular golf cart battery is generally a "semi" deep cycle - better than any starting battery, **better than most marine, but not as good as a true deep cycle solid Lead plate, such as the L-16 or industrial type**. However, because the golf cart (T-105, US-2200, GC-4 etc) batteries are so common, they are usually quite economical for small to medium systems, but these types of batteries are not recommended for this system.

Many batteries are usually actually a "hybrid", and fall between the starting and deep-cycle batteries, while a few (Rolls-Surrette, Concorde, Trojan L-16) are true deep cycle. In the hybrid, the plates may be composed of Lead sponge, but it is coarser and heavier than that used in starting batteries. It is often hard to tell what you are getting in a "marine" battery, but most are a hybrid. "Hybrid" types should not be discharged more than 50%. Starting batteries are usually rated at "CCA", or cold cranking amps, or "MCA", /f-na cranking amps -

Charge Controller

The charge controller that is required is a regulator that goes between the solar panels and the batteries. Regulators for solar systems are designed to keep the batteries charged at peak without overcharging. Meters for Amps (from the panels) and battery Volts are optional with most types. Some of the various brands and models that can be used are listed below.

Most of the modern controllers have automatic or manual equalization built in, and many have a LOAD output. There is no "best" controller for all applications - some systems may need the bells and whistles of the more expensive controls, others may not.

There are several charge controllers but the Trace C40 is recommended for this system based on the application, system size, and voltage. Others are:

Trace C12, C35, C40, C60
Morningstar Prostar and SunSaver (All)
Pulse
RV Power Products (Solar Boost)
Lyncom

Any of the above will almost always give better battery life and charge than "on-off" or simple shunt type regulators.

A) WASTEWATER/SEWAGE TREATMENT (Headhunter's Design)

There are several wastewater treatment systems on the market. However, for this module the one considered the most practical is Headhunter's Tidal Wave 50B treatment system (TW-50B). It is an aerobic biological sewage treatment system that has been certified by the U.S. Coast Guard as a Type II Marine Sanitation Device (MSD), and is IMO Approved for worldwide compliance. Some of the advantages of Headhunter's TW-50B system are that it is a reliable biological treatment process, it is easy to operate, it is compact, is virtually maintenance free, uses no harsh chemicals, and there are no moving parts in contact with the sewage. Systems coated with tough corrosion resistant material for handling 50-300 gallons per day are ideal for the Tropical Self Sufficient Living Module.

B) WASTEWATER/SEWAGE TREATMENT (Dr. Ralph Portier Design)

Advanced BioSystems "Boss" wastewater treatment system is considered to be the most practical .It is an aerobic biological sewage treatment system that has a reliable biological treatment process, it is easy to operate, it is compact, is virtually maintenance free, uses no harsh chemicals, and there are no moving parts in contact with the sewage. The systems are coated with a tough corrosion resistant material for handling 50-300 gallons per day are ideal for the Tropical Self Sufficient Living Module. The "BOSS" IMBR System presently being tested at Alt. On-Site Septic Technology Center at Otis AFB, a 100% funded EPA test facility owned by Mass. Health Department. Nationwide EPA permit is pending. The system is designed for application as On-Site Wastewater Treatment Plant for

residential or small commercial applications where treatment facilities are not available. Standard design is for 440 gallons per day. System is scalable. System has no pumps and uses one 10v. aerator. Meets 10 – 10 – 10 standard for on-site treatment of domestic waste with no organic waste build-up, clogging or short-circuiting. System is very stable and