43 Failure of southern-yellow-pine pole (Mental Hospital Road) due to rotting at the soil line

44 White rot causes deterioration of wallaba poles starting from the inside

41 Crabbs Complex - gabion cofferdam protecting equipment pit outside of Diesel Power Station (note gap in the wall)

42 Failure of southern-yellow-pine pole due to rotting at the soil line

45 Close-up of failed wallaba pole (Jonas Road) due to white rot

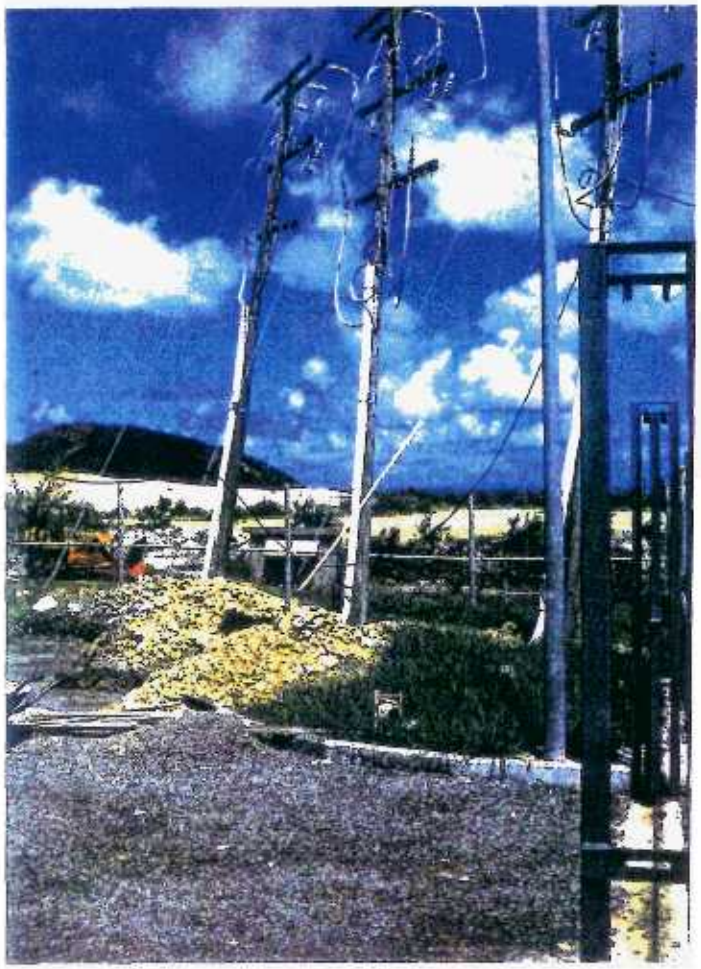
46 Failure of southern-yellow-pine pole due to overstress

47 Failure of new southern-yellow-pine pole due to overstress

48 Failure of braced-pole assembly by uprooting (Jolly Harbour location)

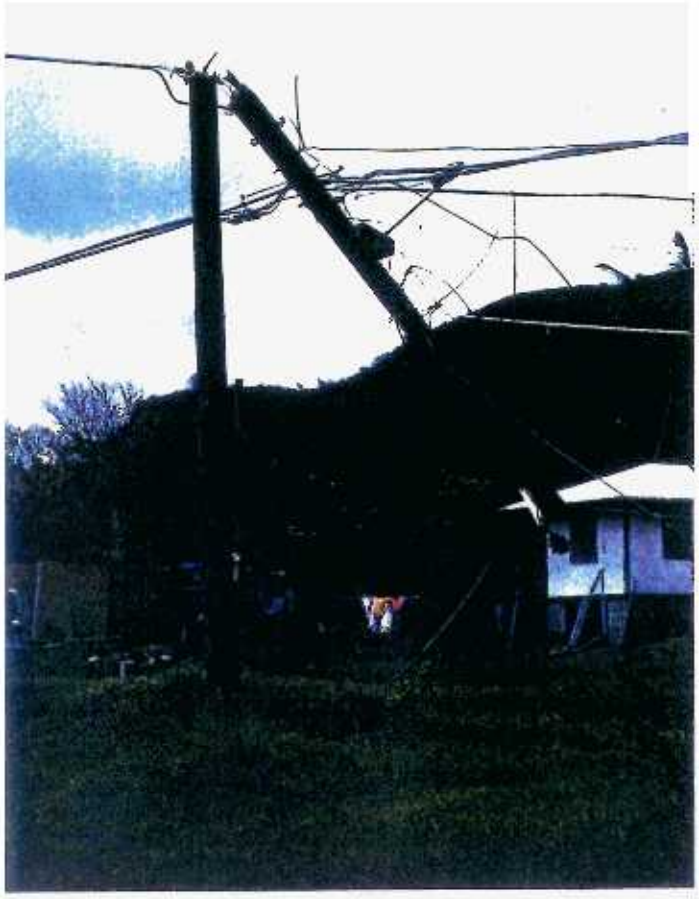
49 Close-up of the failure in No 48

50 Poles are marked with manufacturer's recommendations for embedment



51 End of the line at Five Islands Substation - note the leaning poles indicating incipient failure of the anchorages

52 The leaning poles were planted before the road was excavated (west of Old Road). This led to less eventual foundation depth than was intended.



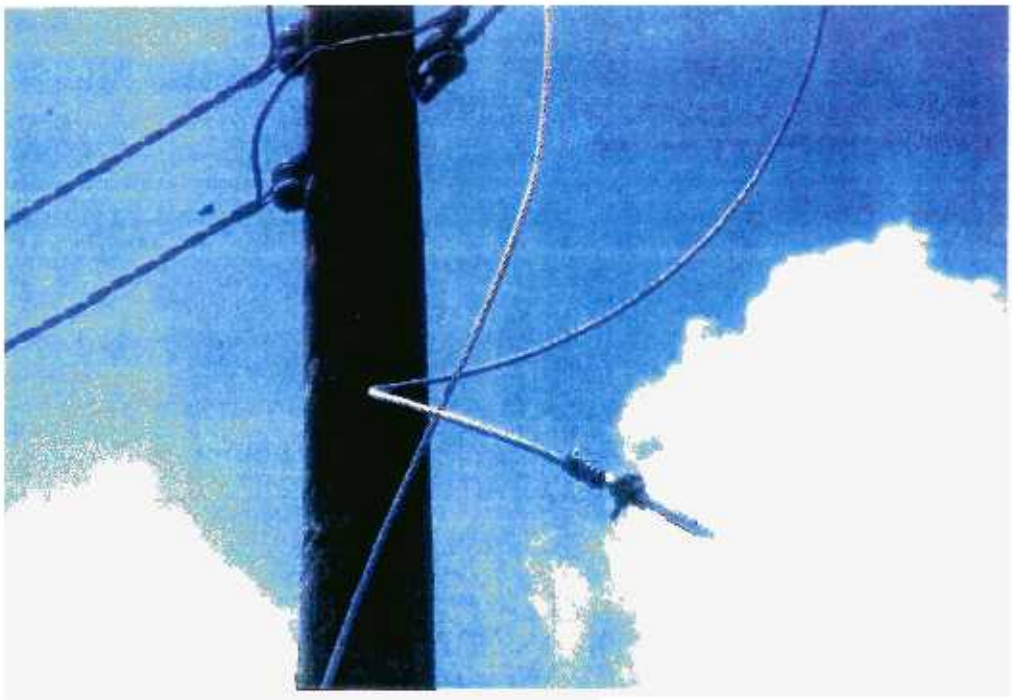
53 The pole broke at the location of a drilled-through tie anchorage

54 Total chaos at the Falmouth-Piccadilly Junction

55 Close-up of broken pole in No 54

56 Many of the poles were overloaded with telephone and television cables (Jonas Road)

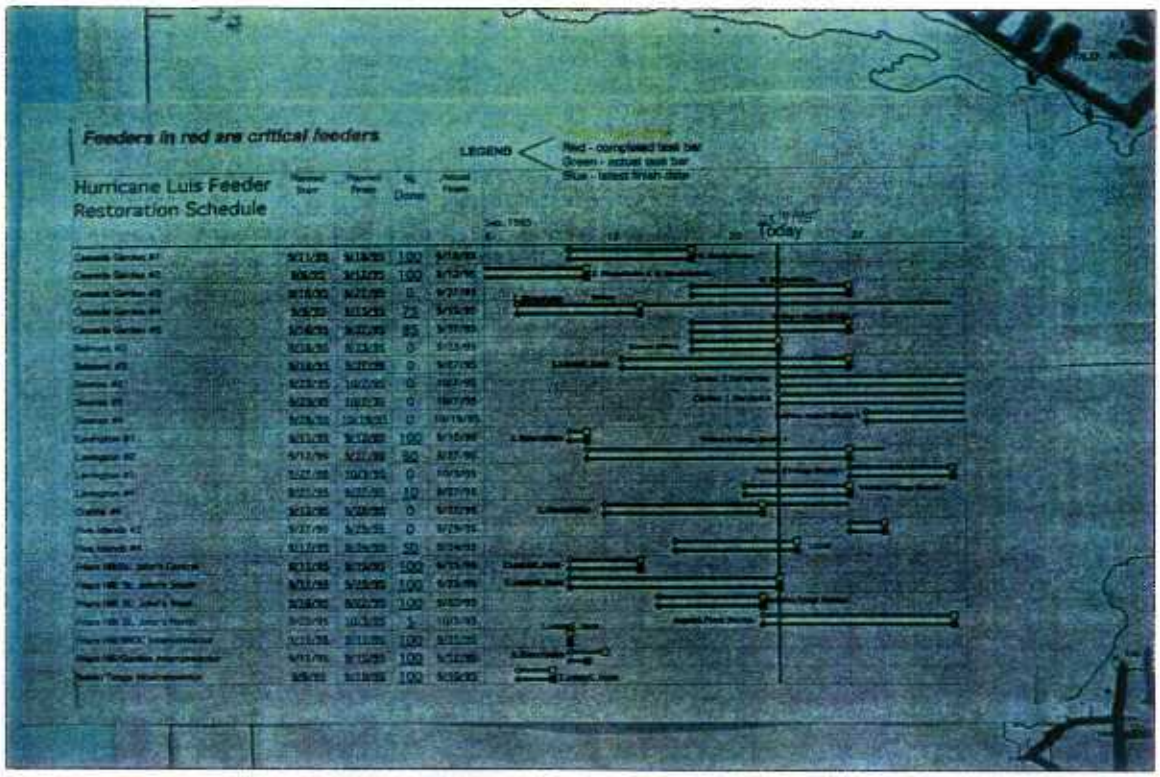
57 Damage due to trees was not common-place in Antigua (John Hughes area)



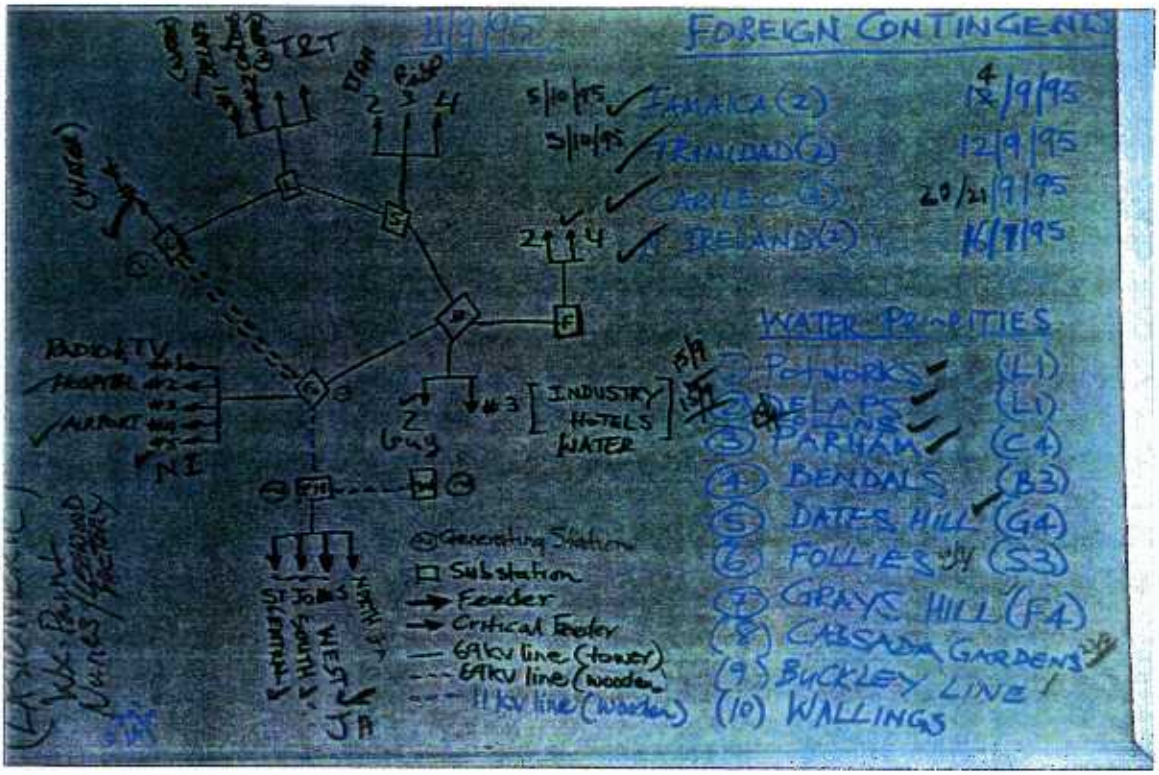
58 There were 160 examples of broken conductors

59 Heavy equipment may not be vulnerable in hurricanes, but need to be anchored for the earthquake hazard.

60 The Barbados Light & Power crew taking a lunch break in Antigua.



61 Progress chart for Feeder Restoration



62 Allocation of foreign resources to the restoration programme

Appendix 5

Barry Pinnock's Report

CEP Survey of
Antigua Public Utilities Authority (APUA)
Power Generating Facilities

Survey was conducted by Barry Pinnock of Consulting Engineers Partnership Ltd (CEP). Those present at all times were Mr A B Segu, Manager of the Electrical Division of AOUA. The survey was carried out on the 30th October, 1995. Transport was provided by Barry Pinnock of CEP. The first installation visited was Friars Hill, the report for which follows:

1. FRIARS HILL

1.1 Main Building Housing Generating Equipment

Only one generator was operating at Mirrlees Blackstone - 4.3w. Other generating equipment was under regular maintenance, which has been further inhibited by the salt spray brought inland by the hurricane windforce contaminating machinery housings and other sensitive parts.

1.2 External Fittings

It was difficult to assess whether the exhaust laggings were damaged as a result of the hurricane, since they appeared well weathered in their damaged state. No other external fittings appeared disturbed.

1.3 The Roof and Cladding Material is a galvanised sheeting

Roof sheets to the south end were lost and are in the process of being replaced. Sheet cladding to the west side, lost, has now been replaced. Sheet cladding to the north elevation, lost, have been replaced.

It is to be noted that fixings holding the cladding have been applied in an irregular manner spacings between fixings appear to be from 9" apart to 14" apart. Sheeting lost appears to have been as a result of high windshear on the smaller panels, located at the bottom of the side cladding, being ripped away, by penetrating wind force allowing further and more severe damage to occur.

It would therefore appear that continuous sheeting from the eaves to the footings with additional angle brackets on the main steel frame placed at closer spacings at footings and eaves may prove more successful should similar circumstance occur again.

Much of the guttering lost with it's fixings has now been replaced but is still insufficient, as it is. Friars Hill Installation includes the APUA main workshop that comprised of both open and closed in facilities, commanding 35/45 metres in length and 10 metres wide approximately. Approximately 70% of the roofing has been lost. Roofing to the open area has been completely lost, leaving the enclosed Stores and parts of areas north and south, partially with without roofing, but which now has a temporary covering, to protect parts and materials.

It was noticed that the roof purlins of timber were light and where intact carried spacings of 24" at the eaves and widened to 48" in the center. Ridge spacings were not evident, having been lost. A more ridged form of construction is recommended. The concrete flooring has not suffered damage from the hurricane and appears to be intact.

With the workshop not functioning as it should, transportation and plant facilities are badly affected, downgrading maintenance services.

Damage and repair costs based on a direct purchasing procedure, free of all duties, taxes and levies appears to be in the amount of EC$950,000.00

2. CASSADA GARDENS

2.1 *Main Building Housing Generation Equipment*

All generating equipment was inoperative due to maintenance. Standby power generated by Cummings alternator plant is available but was not in use.

2.2 The Roof and Cladding material is a galvanised sheeting

Roof sheeting does not appear to have been damaged other than minor superficial loosing of sheet work, now re-secured. Damage has occurred to the side cladding on the south-west elevation, which has been replaced.

The Instrument Workshop suffered damage to its timber framed roof. Construction was limited to the use of light timbers, which collapsed internally causing much water damage to instruments and other sensitive equipment.

2.3 The Control & Systems Room

This building is almost totally undamaged, its construction indicates quality workmanship. The construction was achieved by Italian input. Even with such quality construction, some water damage occurred inside the building, mainly causing rust to the metal duct floor covers and sensitive equipment. This sensitive area operates the 11Kv buss bar conductor system. Some minor outside damage is evident on the west elevation where metal rafters encase in concrete have lifted under pressure, the damage is minor.

It ought to be noted that this important facility is dangerously close to the airport, leaving little room from possible aerial disasters.

Damage and repair costs based on a direct purchasing procedure, free of all duties, taxes and levies appears to be in the amount of EC$76,000.00

3. CRABBS

3.1 Main Building Housing Generating Equipment

This building houses 4 Toshiba generators provided by the Government of Japan. Capable of delivering 18.2 Mw between them. This equipment is powered by steam turbines, which receives its water from the desalinisation plant located in the immediate area. Two of the plants are down and received damage from corrosion as a result of some roof sheeting in the north being detached. Generally, most of the roofing was intact. Side cladding was more seriously damaged in the south and south-west elevations. Much of the damage to this main building has been attributed to the roller shutter doors breaking away at an early stage of the hurricane, causing damage by impact. Little remains of these roller door shutters, a weak link against hurricane pressures.

No 1 and 3 exhaust stacks had lagging torn away possibly by fly debris now mostly replaced.

It should be noted that the desalinisation plant is an integral part of the generating procedure. Any additional fresh water manufactured is collected in two 2.5 m gallon tanks, for distribution through the Water Authority's mains.

Overall contractor was Foster & Wheeler, ex UK.

To the north end of the facility, the cladding remains intact but has been subjected to some considerable sand blasting during the hurricane, removing its protective covering. It would appear that the gabions installed at the north end as a sea barrier was effective against the expected sea surge.

3.3 Administration Buildings & Control Rooms

These areas suffered internal damage as a result of water entering via roof and eaves but outside damage was limited to sheeting being lifted by wind force and allowing water to enter.

Whilst the deslinisation plant did not form part of the survey, it should be noted that the fuel line is a marine fixture to the concrete jetty, which collapsed as a result of the armour rock it was built on shifting from high seas during the hurricane. (Considerable damage was very apparent around the Antigua coast line, as a result of the high seas.) Piling was only evident at the jetty's seaward threshold.

Damage and repair costs based on a direct purchasing procedure, free of all duties, taxes and levies appears to be in the amount of EC$550,000.00.

Jetty rebuild costs will depend on design specifications. An estimate of not less than EC$700,000.00 is envisaged.

CARIBBEAN DISASTER MITIGATION PROJECT

The Caribbean Disaster Mitigation Project (CDMP) is a coordinated effort to promote the adoption of natural disaster mitigation and preparedness practices by both the public and private sectors in the Caribbean region through a series of activities carried out over a five-year period The CDMP is funded by the **USAID Office of Foreign Disaster Assistance (OFDA)** and implemented by the **Organization of American States/Unit of Sustainable Development and Environment (OAS/USDE)** for the **USAID Regional Housing & Urban Development Office in the Caribbean (RHUDO/CAR)**.

The CDMP provides a framework for collaboration with the Caribbean region to establish sustainable public and private sector mechanisms for natural disaster mitigation that will measurably lessen loss of life, reduce the potential for physical and economic damage, and shorten the disaster recovery period over the long term Project activities vary according to location, contents and implementation strategy, but all contribute to attainment of the overall CDMP goal a more disaster-resistant environment for the people who live, work and invest in this hazard-prone region

Project activities include· 1) natural hazard risk audits for electrical utilities and other infrastructure systems and key lifeline facilities; 2) hazard mapping to support improved planning and location of physical development, 3) assisting the insurance industry in improving risk management for insured property, 4) assisting countries to adopt improved building standards and practices and training of builders, architects and artisans in their use; 5) stimulating community-based disaster preparedness and mitigation efforts with support of the private sector, and, 6) post disaster mitigation planning and program design

The Project is being implemented in Caribbean countries where USAID has active assistance programs, i e. the Dominican Republic, the Eastern Caribbean countries which are served by the Caribbean Office of Regional Assistance (CORA) of USAID, Haiti, Belize, and Jamaica The entire region is to benefit from the project through an active dissemination of project information and methods

The CDMP will build on past and ongoing regional initiatives in disaster preparedness and mitigation, and will promote technology transfer and institutional capacity building through direct involvement of professional associations, bankers, builders, insurance companies and reinsurers, NGO's, PVO's, community groups and government organizations in project activities

For further information please contact:

Mr. Jan Vermeiren
Project Manager
OAS/Unit of Sustainable Development and Environment
1889 F Street N.W.
Washington, D C 20006
Phone: (202) 458-3006
Fax: (202) 458-3560
E-mail: vermeiren_jan@oas.org

Ms. Jennifer Worrell
Regional Disaster Advisor
Caribbean Office of Regional Assistance
U.S. Agency for International Development
2 Haining Road
Kingston 5, Jamaica
Phone: (809) 926-4998
Fax: (809) 929-9944
E-mail: jworrell@usaid.gov