The Post-George Repair and Strengthening of JN France Hospital
(with brief remarks about Cayon Clinic)

Contents

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1 Background

1.1 Georges

On the morning of 21st September 1998 Hurricane Georges struck the island of St Kitts. According to the US National Hurricane Centre the storm was between Category 2 and Category 3 on the Saffir-Simpson Scale at the time it hit St Kitts. This translates to a sustained (1-minute) wind speed of 110 miles per hour.

The only anemometer recordings available for St Kitts were those from a CPACC[1] station in Basseterre. These are reproduced in Figure 1 in the Appendix. They indicate a maximum 15-second gust of 42 metres per second (equivalent to a 1-minute sustained speed of 84 miles per hour. The anemometer at VC Bird International Airport in neighbouring Antigua recorded a maximum (3-second) gust of 89 knots (see Figure 2), which is equivalent to a 1-minute-average speed of just over 84 miles per hour. There is some concern that reliable information on actual wind speeds in hurricanes is rarely available.

Hurricane Georges was a fast-moving system, so that the amount of rainfall accompanying the event was less than might be expected in most well-developed hurricanes. Rainfall figures were not available for St Kitts, but the total precipitation in neighbouring Antigua was 4.95 inches.

1.2 Vulnerability of JN France Hospital and the Effects of Georges

The hospital is located on a man-made shelf on gently-sloping land on the outskirts of Basseterre, not far from the coast. Figure 3 shows the environs of the site.

The structure of the entire hospital was fundamentally vulnerable to hurricanes and earthquakes. It is understood that the hospital has been significantly damaged several times in its 30-year history.

The JN France Hospital is the only secondary-care facility in St Kitts & Nevis. It was opened in 1968 and since then it has suffered significant damage on 10 occasions. Recent damaging events were in 1989 (Hugo), 1993 (an unnamed storm in April) and 1995 (Luis and Marilyn).

During Hurricane Georges the Hospital suffered severe damage to several roofs (Photo 1). In some instances the membrane waterproofing was stripped off the plywood roof deck (Photo 2). This led to water damage to large areas of the hospital. In other cases the plywood deck was removed from the supporting rafters (Photo 3). Plywood sheets were secured by nailing to timber rafters. (Connections by screws are preferable.) In other cases the rafters were removed from the supporting girders and walls (Photo 4).

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[1] Caribbean Planning for Adaptation to Global Climate Change, tel: (246) 417 4580

The roof structure (mainly timber rafters) failed over the private ward (Photo 5), the surgical ward, the medical ward, the paediatric ward (Photo 6), the redundant TB ward (which now houses the laboratory and eye clinic), the service-core wing, the boiler room (Photo 7) and the nurses "office". In a few cases the timber rafters split (Photo 8). In the majority of cases the failure was due to inadequate anchorage. Hurricane clips were used in most cases to secure the rafters to the walls (Photo 9). However, the single nail per clip proved to be insufficient. Also, the nails were generally too close to the ends of rafters (Photo 10). In a few cases *(eg* the paediatric ward) the rafters were secured by "toe-nailing" to timber plates which in turn were bolted to the top flanges of rolled steel joists (Photo 11). (Toe nailing is not a satisfactory connection for hurricane conditions.)

There were isolated instances of debris damage to the roof (Photo 12) and to unprotected windows. There was damage to some of the louvre windows (Photo 13). However, it is understood that most of the windows were protected by timber shutters during the hurricane.

Evidence of absence of vertical reinforcement in walls was provided by several collapsed garden walls (Photo 14) and horizontal cracks in the gate house (Photo 15).

1.3 Emergency Measures

The Hospital staff, with assistance from the Royal Navy, did an excellent job of cleaning up the debris after the hurricane, implementing temporary repairs to several buildings and returning the facility to a state where health care could be provided to the community, albeit under difficult and compromised conditions.

The Royal Navy replaced the waterproofing membrane where the structure had not been removed by the hurricane. The manner of replacing was no better than the manner of the original installation, which was inadequate for high winds. Thus the RN repairs were regarded only as a temporary measure.

Temporary repairs were also carried out by a team from Anguilla.

The Pan American Health Organization (PAHO), through its Emergency Preparedness and Disaster Relief Coordination Program Office in Barbados, offered assistance to the Government of St Kitts & Nevis for the long-term repair and strengthening of three of the wards.

1.4 Cayon Clinic

The only visible damage due to George was the loss of approximately 300 square feet of roof sheeting.

The Government of St Kitts & Nevis decided to increase the size of the facility contemporaneously with the repairs.

The PAHO project provided a review of the Public Works Department's design, funding for the materials for the roof construction and some inspection and certification services during construction.

2 The Project

2.1 PAHO Resource Mobilization

The rehabilitation of the three wards in the PAHO project was funded by the British and Netherlands governments and the European Community. The sums provided for the construction contract were:

Department for International Development (UK)	US$280,000
European Community Humanitarian Office	US$270,000
Netherlands Government	US$124,000

Additional funding from the same agencies was provided for consultancy fees and expenses.

2.2 Physical Scope

The focus of the rehabilitation works undertaken through the agency of the Pan American Health Organization was on the Maternity Ward, the Paediatric/Medical Ward and the Laboratory & Eye Clinic. These three areas are highlighted on the overall plan of the present hospital in Figure 4.

The principal components of the constructed project are described below:

- In the rehabilitation project, all external walls were strengthened (Photo 16). (None of the original internal and external walls had any vertical reinforcement. This made all of the walls vulnerable in earthquakes and all of the external walls vulnerable in hurricanes.)

- In addition, several of the internal walls were provided with resistance against collapse in earthquakes as part of the rehabilitation works (Photo 17 shows the preparation of a partition for strengthening).

- The roofs were replaced in their entirety. The new roofs have:

  - steel trusses (Photo 18) supported on strengthened walls and girders;
  - steel secondary beams or purlins (Photo 19) supported on the trusses;
  - corrugated steel sheets (Photo 20) fastened to the purlins.

  The roofs are of hipped shape (the most favourable for wind resistance) with relatively steep pitch (Photo 21).

  Care was taken to provide extra strength in those parts of the roof surfaces known to experience the highest forces (the ridges and eaves).

- To avoid the need for shutters, all of the windows (Photos 23 & 24) are of polycarbonate material to resist breakage by flying debris in future hurricanes.

Although the main walls for the hospital were not damaged by Georges (or by the moderate

earthquake of 09 October 1974) they were clearly of inadequate strength for a hospital. Most of the walls were of 4-inch concrete block construction. They had only horizontal reinforcement. Nor was that reinforcement substantial. There was no anchorage to the foundations. (An external, decorative-block, screen wall collapsed indicating no reinforcement and no anchorage to very shallow foundations.) Even if reinforced, 4-inch walls could not be regarded as satisfactory for the level of earthquake for which a hospital in St Kitts should be designed and built.

Investigations were carried out to establish the details of construction of the block walls at J N France. Measures were taken to strengthen these walls so that the hospital could be made much safer for earthquakes and hurricanes.

2.3 PAHO Discussions with the Government of St Kitts & Nevis

The scope of the project, project financing, project timing and the selection of the main construction contractor were subjects discussed between the Pan American Health Organization[2] and the Government of St Kitts & Nevis.

Throughout the implementation of the project there was continuous liaison between the two parties.

2.4 Relationship of the Repair/Strengthening Project with the Overall Plan for JNF

Plans for new facilities at the Hospital are well advanced, so that a decision was taken by the St Kitts & Nevis authorities not to repair all of the buildings which were badly damaged. The construction of the new Psychiatric Ward is being expedited as will the project to be funded by the European Union. Two new wards are to be funded by the Caribbean Development Bank and the World Bank. The master plan of the overall development is shown in Figure 5 based on information from Design Collaborative.

3 Design

3.1 Philosophy

The intension was (as far as possible) to provide these buildings with levels of safety against damage by hurricanes and earthquakes consistent with present-day standards. For general hospitals it is appropriate to apply higher standards than the basic norms in recognition that these facilities are post-disaster assets. In this instance it would be appropriate to increase the "normal" design loads for earthquake and wind by about 25 to 50%.

It is considered that the rehabilitated JN France Hospital has a sufficiently low vulnerability that its buildings will not need to be evacuated in the event of a hurricane warning and that the facility

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[2]Emergency Preparedness and Disaster Relief Coordination Program, Barbados Office headed by Dr Dana van Alphen

will be able to function immediately after future hurricanes and earthquakes.

In the repair of the roof structure the connection details were consciously engineered to resist uplift from hurricanes greater than Georges.

Glazed areas of the hospital were designed to resist not only the wind pressures from future storms but also the impact of flying debris. All external doors were checked to ensure that they can withstand the appropriate intensity of hurricane winds. Door security is provided by 3 hinges along one edge and 2 bolts and a lock along the other edge. Thus each leaf is held at 6 locations.

It was evident that the electrical wiring of the hospital had been installed incrementally over the past three decades. A review of the safety of the system was carried out and most of the wiring was replaced.

3.2 Design Criteria for Natural Hazards

For St Kitts & Nevis the appropriate standards are those prescribed in the Caribbean Uniform Building Code (CUBiC). St Kitts & Nevis are regarded as being in earthquake Zone 3 (as defined in most USA codes contemporary with CUBiC) and with a reference 10-minute-average wind pressure of 0.83 kilopascals (equivalent to a 3-second gust speed of 125 miles per hour).

3.3 Constraints

Because of the nature of construction of the original JN France Hospital and the budgetary and time constraints for this rehabilitation project, the design intentions were not met completely. In particular, it was not possible to retrofit all of the internal masonry partitions against earthquake damage.

4 The Construction Phase

4.1 Description of the Contract Works

The scope of works included, but was not limited to, the following activities carried out on three existing wards *viz* the Paediatric Ward, the Maternity Ward (including the Delivery Suite) and the Laboratory/Eye Clinic:

1 The strengthening of existing walls with insitu concrete
2 The erection of a steel-framed hipped roof, clad in pvf2-coated, metal sheeting
3 The electrical re-wiring of the buildings
4 The changing of the windows from louvres to impact-resistant, vertical-sliding, aluminium-framed windows manufactured by Yale Ogron Windows and Doors in Florida and using Lexon MR10 polycarbonate sheeting (An extract from the Lexan brochure is in Figure 6 and a generic shop drawing of the window is in Figure 7.)
5 General refurbishment of carpentry, joinery, wall and floor finishes

6 Plumbing upgrading and maintenance (undertaken by the MoH&WA[3])

4.2 Procurement of Contractors

Contract Documents and drawings were prepared by CEP[4] outlining the scope of works to be done on each of the wards.

A contract sum of US$ 598,011 was negotiated with a contractor nominated by the Government of St Kitts & Nevis. The scope of work was increased substantially during the construction period leading to an adjusted contract sum of US$674,011. The Contractor was Byron and Sons Ltd, New Street, Basseterre, St Kitts & Nevis (acting through the principal Mr Leroy Byron).

Sole-source tenders were received from Structural Systems Ltd of Barbados for the supply of the structural steelwork and sheeting for the roofs.

The Public Works Department of the Government of St Kitts & Nevis was, at the time, negotiating with a supplier in Miami for impact-resistant windows for schools. That order was combined with the Hospital order to secure a minimum acceptable commercial order. A separate quotation was nevertheless obtained from the common suppliers, LBA Associates Inc, for the windows for the Hospital.

Other works associated with this reconstruction/rehabilitation project were funded directly by the Government of St Kitts & Nevis.

4.3 Programme

The programme (Figure 8) was prepared by the contractor with the assistance of CEP. It was accepted by PAHO. There were several deviations from the programme during the course of construction and the original end date of 29th May 1999 was not achieved. The delay was due largely to the late delivery of several items of materials, the contractor's inability to recruit tradesmen due the heightened construction activity in the aftermath of Hurricane Georges and to a substantial increase in the scope of works in the carpentry, plumbing and tiling trades. The achieved completion date was the end of July 1999.

Illustrated interim reports were submitted throughout the project by CEP to PAHO. Photo 22 shows a typical progress illustration and Photo 23 shows the same view after completion.

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[3]Ministry of Health and Women's Affairs

[4]Consulting Engineers Partnership Ltd

4.4 Construction Cost Summary

The final account for the PAHO-administered construction contract is summarised below.

Activity	Total Contract US $
Pediatric Ward	94,984
Laboratory and Eye Clinic	84,945
Maternity Ward	78,069
Delivery Ward	17,688
Supply of structural Steel Work and Sheeting	149,194
Supply of new windows	28,921
Additional Works	44,720
Electrical re-wiring	52,442
Supply and installation of A/C to Lab	6,008
Supply and installation of windows to Maternity and Delivery	18,932
External works	5,078
Supply and install bed pan-washers	13,273
Supply and Installation of internal doors	5.286
Construction of work tops, partitions & joinery	28,645
Preliminaries, overhead and profit	45,824
Final Contract Sum	**$674,011**

5 Appendix

5.1 Figures 1 to 8

5.2 Photographs 1 to 24

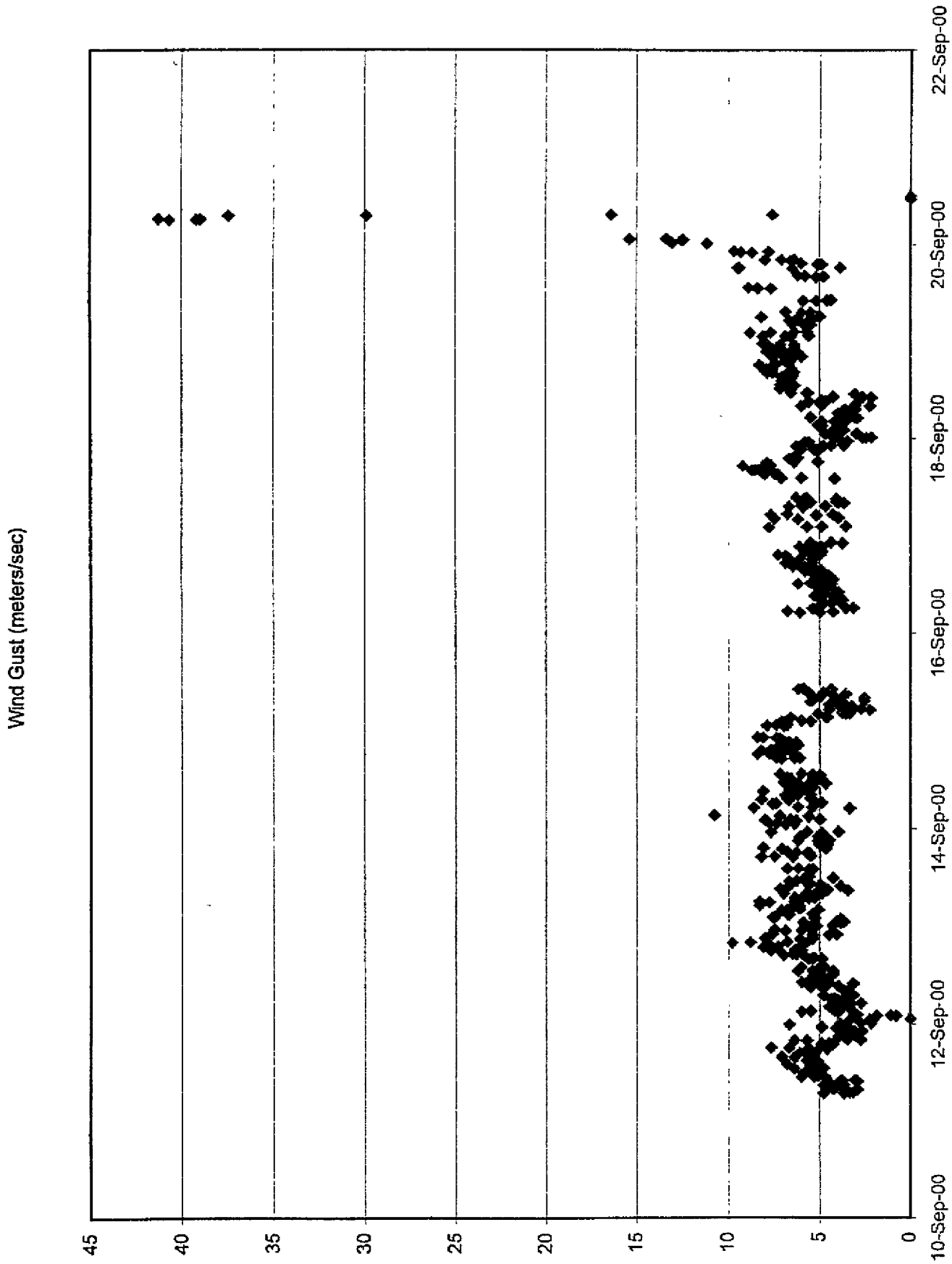

Figure 1
Anemometer readings - CPACC, Basseterre

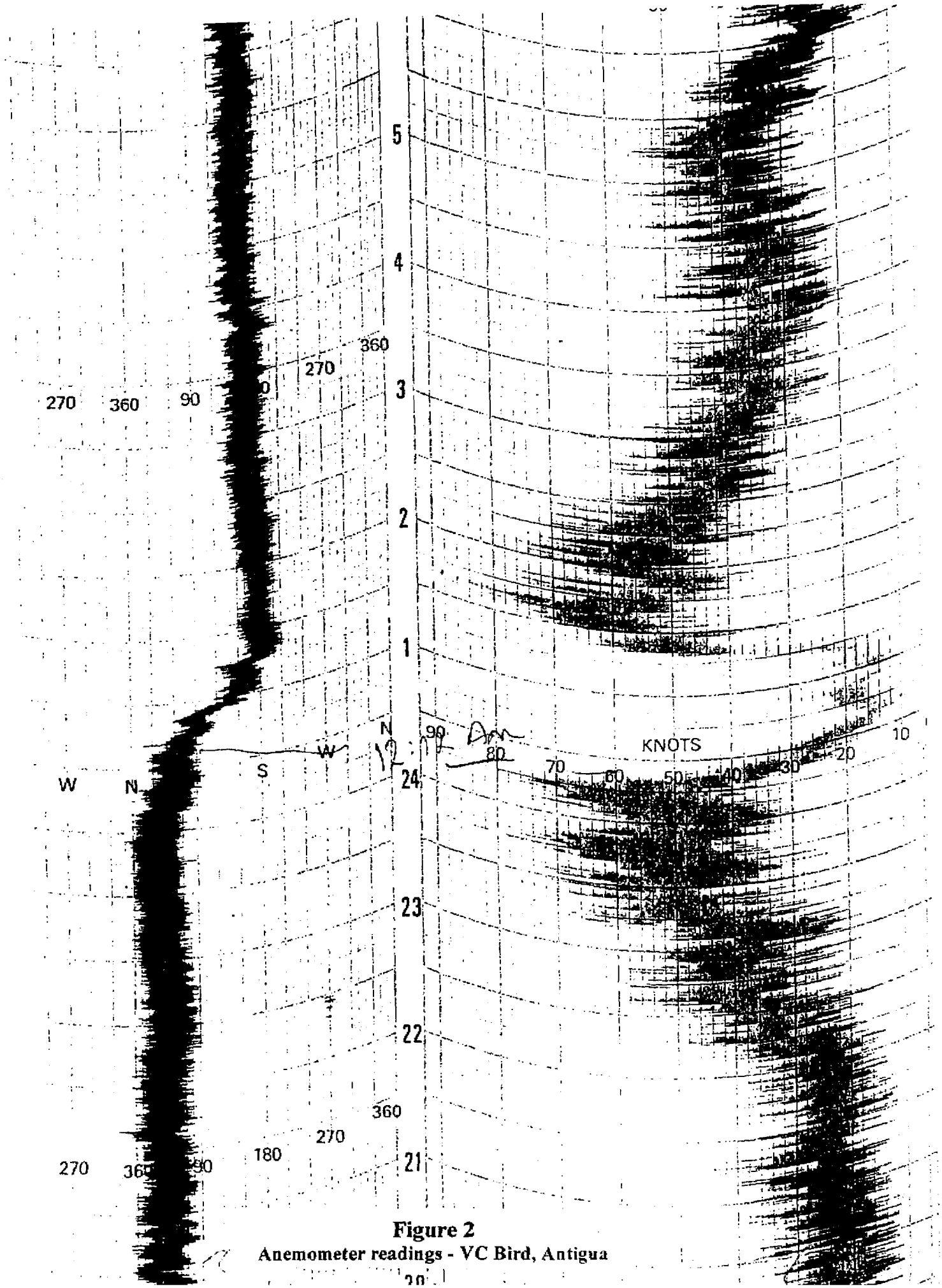

Figure 2
Anemometer readings - VC Bird, Antigua