2.0 RETROFITTING ACTIONS AND COST ESTIMATES

2.1 Commentary

Table 2 on the following page summarises the vulnerable areas of each structure. These were previously described in detail in the Inception Report and sub-section 1.3 of this document. Table 3 provides rough cost estimates for the proposed retrofitting actions These are only intended to be "order of magnitude" estimates.

Where possible, available contractors' rates for similar work were used (eg, the cost of made-up timber shutters were based on a per square foot rate). For the more labour intensive retrofitting operations (eg installing additional fixings), the emphasis was on time (translated to cost) estimates plus an allowance for material costs. The cost estimates are for actual construction only Hidden costs, such as down time or changes in schedule to allow retrofitting work are not included. All estimates are in US dollars.

It should be noted that the recommendations are based on resistance to winds associated with a category 3 (Saffir-Simpson) storm. Design to resist 1-in-50 year (Category 3) storms is the minimum code requirement. The majority of Lucelec's facilities already exhibit good resistance to Category 3 storms and therefore the costs of this level of retrofitting are relatively low.

For facilities as critical to a small country as LUCELEC's are, serious consideration should be given to providing security against hurricanes of greater than Category 3 destructive potential. For the sake of comparison, the likely costs of retrofitting to resist Category 4 storms are also included in Table 3 Retrofitting to provide this extended level of security would typically require more frequent sheeting fixings, the strengthening of steelwork members and serious attention to the ability of structures such as the exhaust stacks to resist aerodynamic excitation.

It should be noted that the costs quoted for storm shutters in Table 3 are for made-up timber shutters As a result of Hurricane Andrew, the current edition of the South Florida Building Code requires that shutters and/or glazing comply with new impact resistant requirements. It requires that those elements in buildings below 30-ft be able to resist the impact of a large missile (in the form of a 9-pound, 2"x4" timber moving at 34mph). Several purpose-made shutters in aluminium, steel and clear polycarbonate are available which meet this requirement. Appendix C gives information on polycarbonate shutters Comparable costs are US$12 to 15 per square foot (installed) for polycarbonate shutters versus about US$5 per square foot (or less) for made up timber shutters

Ref No.	Structure & Location		Comments on Vulnerable Areas
1	Castries:	Admin Offices	Good resistance to earthquakes (EQ) and Category 3 hurricanes (HC). May be vulnerable to storm surge. Possibility of liquefaction during earthquake. Glass.
2		Sub-Station	Good resistance. to EQ and HC
3	Cul-de-Sac:	Power Stn & Admin. Offices.	Aluminium roof sheets. Roller shutter lack of bottom track, shallow side tracks.
4		Peak Lopping Stn.	Fair to good resistance to EQ & HC
5		Stores	Good resistance to EQ & HC.
6		Workshops	Good resistance generally, but sheeting on mono-pitch garage vulnerable to HC.
7		T&D Buildings	Good resistance to EQ & HC.
8		Garage	Good resistance to EQ & HC.
9		Gate House	Good resistance to EQ & HC.
10		Incinerator	Good resistance to EQ & HC.
11		Fuel Tanks	Fair resistance to EQ & HC
12		Water Tank	Fair resistance to EQ & HC.
13	Soufrière	Power Station	Standby use only. Sheeting & blk wk. walls vulnerable
14	Union:	Power Station	Asbestos sheeting vulnerable. J-bolts. No door at front opening. Tanks not secured.
15		Sub-Station	Good resistance to EQ and HC. Union site may be more vulnerable than others to flooding
16		Old Stores Building	Not usually in use Fair resistance to HC & earthquake.
17	Vieux-Fort	Admin Offices	Fair to good resistance to EQ & HC.
18		Power Station	Poor resistance to HC. Possible storm surge damage. Asbestos sheets & J-bolts.
19		Sub-Station	Good resistance to EQ & HC
20	Telecommunication Antennae (2no.)		Probably poor resistance to HC.

Table 2

Summary of Vulnerability Assessments

Ref No.	Location & Structure		Retrofit Advice for Cat 3 Storm & Earthquake	Cost Estimates	
				Cat 3	Cat 4
1	Castries:	Admin. Offices	Fix rebar anchors into the side of the atrium rafters. Storm shutters & bolts.	*12,000*	*38,400*
2		Sub-Station	Storm Shutters.	*600*	*3,600*
3	Cul-de-Sac:	Power Stn. & Admin Offices	Control room ceiling to be replaced by water-resistant deck *or* tarpaulins to be stowed to protect equipment. Storm shutters required Stays/bolts to roller shutter door. Additional fixings to machinery; pipe modifications.	*24,000*	*96,000*
4		Peak Lopping Station	Fix fuel tanks to frames Strengthen supports. Add roof fixings	*3,000*	*15,600*
5		Stores	Storm stays to roller shutter door. Bolts to external doors. Storm shutters	*600*	*3,600*
6		Workshops	Storm shutters to windows & bolts to doors.	*2,400*	*12,000*
7		T&D Buildings	Storm shutters & bolts.	*2,400*	*12,000*
8		Garage	Storm shutters & bolts	*600*	*3,600*
9		Gate House	Storm shutters & bolts.	*600*	*600*
10		Incinerator	Additional Fixings. Assume incinerator itself not damaged; Stack replaced.	*6,000*	*9,600*
11		Fuel Tanks	Nil.	*	*
	Sub-Total			***$52,200.***	***$195,000.***

Table 3

Schedule of Retrofitting Actions & Costs

(Continued on next page)

(Table 3 cont'd)

Ref No.	Location & Structure		Retrofit Advice for Cat 4 Storm & Earthquake	Cost Estimates	
				Cat 3	Cat 4
12		Water Tank on hill	Nil.	*	*
13	Soufriere	Power Station	Replace corroded sheeting and J-bolt fixings.	**	**
14	Union:	Power Station	Replace J-bolts and sheeting Provide secure door. Anchor stacks and tanks to supporting frames.	*60,000*	*120,000*
15		Sub-Station	Storm shutters and bolts Possible additional flood protection/drainage structures not costed.	*1,200*	*6 000*
16		Old Stores Building	Additional fixings Storm stays.	**	**
17	Vieux-Fort:	Admin. Offices	Storm shutters and bolts. Additional screw fixings to roof.	*1,200*	*6 000*
18		Power Station	Repair bottom of roller shutter door. Replace J-bolts and sheeting Secure stacks to supports	*18,000*	*36,000*
19		Sub-Station	Construct ceiling under canopy roof area. Storm shutters and bolts	*1,200*	*6,000*
20	Telecommunication Antennae (2no) & repeater building		Keep antennae spares handy.	*c/u*	*c/u*
	Current Sub-Total:			***$81,600.***	***$174,000.***
	Sub-Total (from previous page).			***$52,200***	***$195,000***
	ESTIMATED TOTAL RETROFIT COST			***$133,800***	***$369,000***

Table 3

Schedule of Retrofitting Actions & Costs

Notes:

Costs include a 20% allowance for consultants' fees and expenses

* Insufficient information currently available for accurate costing

** Not costed. Building to be phased out.

c/u cost unknown

3.0 PROPOSED DESIGN & CONSTRUCTION STANDARDS

3.1 Background

Section 2 0 of the Inception Report outlined the types of natural hazard likely to affect St Lucia. These were:

1. Earthquakes
2. Hurricanes
3. Torrential Rains
4. Tsunamis
5. Storm Surges

The review of Lucelec's construction standards revealed that there was no consistent application of appropriate design criteria for natural hazards, although proposals for the new 7MW set at Cul-de-Sac do outline requirements for earthquake and windstorm.

The vulnerability assessment of the existing structures indicates that most of the buildings are capable of resisting (with relatively little modification) a Category 3 storm and that these structures also show moderate to good resistance to earthquakes. The majority of Lucelec's facilities are not likely to be seriously affected by tsunamis or storm surge and, with the possible exception of Union, torrential rains should also lead to little damage.

In light of the above, the following criteria are therefore proposed for all new construction

3.2 Earthquakes

Generally, all buildings/structures should be designed in accordance with the provisions of the Caribbean Uniform Building Code (CUBiC) using an Importance Factor of 1.5. Comments on earthquake detailing are contained in Section 3 6

3.3 Hurricanes

Design for wind loads should be carried out in accordance with the provisions of the 1981 BAPE/NCST/OAS Code of Practice for Wind Loads for Structural Design Normally, an S_3 factor of 1.0 is used (The S3 factor is based on statistical concepts and takes account of the degree of security required and the return period of the wind speed under consideration) Because a greater level of security is appropriate for LUCELEC's facilities, a greater S_3 factor, 1.1, is recommended. For St. Lucia, this approximately represents a storm of return period 1-in-100 years.

It is also recommended that the windows and doors of all new structures comply with the impact requirements of the 1994 South Florida Building Code.

3.4 Torrential Rain

It is proposed that drainage systems be designed for the 1-in-100 year storm, and that careful consideration be given to identifying areas (such as Union) that are susceptible to serious flooding as a result of topographical conditions.

3.5 Tsunamis & Storm Surge

It is recommended that in the design of any future facilities in low-lying coastal areas (particularly on the east coast) consideration be given to the possible effects of the 1-in-100 year storm surge event In addition, allowances should be made for the tsunami hazard Shepherd and Smith predict a surge of 1.7 m on St. Lucia's west coast from a realistic event of the submarine volcano, "Kick 'em Jenny," which is located north of Grenada.

3.6 Construction Standards

General guidance on the quality of work required may be provided by appropriate technical specifications. These should be tailored to the needs of the individual project and may cover areas such as·

- inspection and testing procedures,
- instructions on permissible deviations and construction tolerances,
- identification of critical elements and their requisite structural performance,
- construction techniques

In addition, there are many international standards which cover construction, from analysis and detailing to quality of materials. Most of LUCELEC'S recent buildings have generally been constructed in accordance with British Standard Codes of Practice However, earthquake resistant design and detailing is not specifically referenced in the British Standards BS8110 and BS5950 which cover concrete work and steel work respectively. In order to achieve satisfactory ductility levels, the detailing of all structures should be carried out in accordance with the requirements of the Structural Engineers Association of California (SEAOC).

Designers should be requested to ensure that there is consistency between the standards adopted for various aspects of work.

3.7 Maintenance

Maintenance in this context is not only intended to mean the upkeep of the physical facilities, but also identifies the need to keep abreast of changes in construction standards; especially in relation to design criteria. As more information on phenomena such as earthquakes and windstorms becomes available, there are likely to be changes in the requirements for the design of buildings/structures to resist these hazards. Perhaps even changes in the minimum design forces. Construction professionals employed by LUCELEC should always be required to employ standards which reflect best international practices relevant to LUCELEC's natural environment and in accordance with the company's design criteria.

APPENDIX A

Report On Damage To Lucelec System Caused by TS Debbie (Lucelec)

FLOOD DAMAGE TO LUCELEC SYSTEM CAUSED BY TROPICAL STORM DEBBY

The major damage to Lucelec's system occurred at Union 66/11KV Substation where the building housing the 11KV switchgear, the 415/240V switchgear, the 66KV and 11KV and bus zone relay panels, the tap changer control panels, the fibre optic protection/communication panel and the 110 volt battery and charger was submerged to a dept of 5' above floor level. Virtually everything was submerged except for the 11KV relay panel mounted above the 11KV switchgear.

There were extensive deposits of mud in the building, the cable trenches and in the 11KV switchgear and panels.

Virtually the same damage occurred to a similar set of new equipment stored in the adjacent Union Stores building. This equipment was for use in the new Castries 66/11KV Substation currently under construction.

The adjacent 66KV switchgear compound was flooded to between 3 and 6 feet with water ingress into marshalling cubicles circuit breaker mechanisms, tap changers and other auxiliary equipment.

As soon as the flood subsided an extensive clean up and preservation exercise was put into place. This will be virtually complete by Saturday 17th and re-testing and re-commissioning of the equipment will start on Sunday 18th.

There was also considerable damage to the 11KV and 415/240 volt networks throughout the island, breifly summarized below.

In the Roseau Valley some 29 new poles were erected, 4 poles straightened and 24 spans of new conductor run out.

On the road to the Roseau Dam some 11 poles were replaced or re-erected and 8 poles straightened.

In the Ravine Poisson area some 7 poles were replaced or straightened and large amounts of debris removed from the lines.

In the Bocage/Babonneau Marchand and Ti Rocher areas 15 poles were replaced and 4 straightened.

In the Castries area some 6 new poles were erected and 2 others straightened.

.../2

In the Soufriere area some 8 new poles were erected and two straightened.

There were also numerous service calls, problems with debris and street lights.

The estimated cost of the damage exceeds EC$500,000.

The Generation Department suffered relatively minor damage, Union Power Station was flooded to floor level and had extensive mud deposits. The fence was damaged, and some auxiliary electrical equipment was damaged.

There was considerable surface water flowing through Cul de Sac Power Station which damaged the emergency black start diesel, fencing and caused minor flooding in the power station basement.

The main effect on generation has been caused by the loss of the Union 66/11KV Substation and with it the 66KV link between Cul de Sac and Union Power Stations. This has necessitated a re-distribution of 11KV loads which has given generation some problems in meeting them although this generally has been over shadowed by 11KV feeder loading problems. It has also delayed maintenance on sets 1 and 2 at Cul de Sac.

C.J. MITCHELL
CHIEF ENGINEER

APPENDIX B

Borehole Logs: Peak Lopping Station & Administrative Offices

TEST BORINGS
LAND & MARINE

33 Bombay Street,
St James
Trinidad W.I.
Tel: 622 - 1070

Date 29 Oct. 1993 Job No L 96

Job Address LUCELEC COMPOUND - CUL DE SAC - ST. LUCIA

Fixed Datum used is _____ Ground Surface this boring is _____

All Measurements in Feet / ~~Metres~~.

DEPTH BELOW SURFACE	SAMPLE NUMBER	SAMPLE DEPTHS	BLOWS ON SAMPLER S.P.T.			PROFILE CHANGE DEPTH	FIELD IDENTIFICATION OF SOILS REMARKS	CASING BLOWS
						2'	Green & grey sand gravel silt, clay & stones Fill	
	1	2.5 - 4.0	8	6	12		Fine - med. br. silty sand	
						5'		
	2	5.0 - 6.5	4	6	20		Fine - Med. green & br. sand silt gravel & stones	
						7'		
	3	7.5 - 9.0	4	4	5		Fine grey sand & gravel	
10'	4	10.0 - 11.5	8	6	19	10'		
							Coarse br. sand gravel & stones	
	5	12.5 - 14.0	22	15	10	14'		
	6	15.0 - 16.5	9	6	12		Fine - coarse br. & grey silty sand & gravel	
						18'		
20'							Coarse - med. light grey silty sand & gravel	
	7	20.0 - 21.5	7	4	7			
						23'		
							Compact br. cemented sand	
	8	25.0 - 26.5	13	23	21	26.5'		
							End of Boring.	
30'								

Notes: Natural water level is 4'
After drilling, water came up to one foot below surface.
This was probably drilling water.

Ground Surface to 20' used 2½" casing Foreman Basanta

Water level is 4' Below Ground surface ~~hrs. after completion~~ Boring No 2 Sheet _____

Note S P T Blows are 3 counts of 152 mm each Driving a 508 mm O D split spoon, using a 63 5 kg weight dropping 762 mm

TEST BORINGS
LAND & MARINE

33 Bombay Street,
St James
Trinidad W.I.
Tel: 622 - 1070

Date 28 Oct. 1993 Job No L 96

Job Address LUCELEC COMPOUND, CUL DE SAC, ST. LUCIA

Fixed Datum used is _____ Ground Surface this boring is _____

All Measurements In Feet ~~Millimetres~~

DEPTH BELOW SURFACE	SAMPLE NUMBER	SAMPLE DEPTHS	BLOWS ON SAMPLER S.P.T.			PROFILE CHANGE DEPTH	FIELD IDENTIFICATION OF SOILS REMARKS	CASING BLOWS
							Fine green brown & grey silty sand, gravel, little clay Fill.	
	1	2.5 - 4.0	3	4	5	5'		
	2	5.0 - 6.5	12	27	17	7'	Med. - coarse br. & grey sand, gravel & stones	
	3	7.5 - 9.0	8	5	4	10'	Med. br. & grey sand & gravel	
10'	4	10.0 - 11.5	10	9	11		Coarse - med. br. & grey sand gravel & stones	
	5	12.5 - 14.0	11	17	17	15.5'		
	6	15.0 - 16.5	10	6	3	18'	Light grey sand, silt gravel & stones	
	7	17.5 - 19.0	5	16	17		Coarse grey sand , silt & gravel	
20'	8	20.0 - 21.5	10	8	10	22'	Compact br. cemented sand	
	9	25.0 - 26.5	15	18	23	26.5'	End of Boring.	
30'								

Notes: Sampler used was a standard 2" OD Split Spoon.

The presence of stones explains the erratic blow counts.

The natural water level is about four feet.

On completion, the water was at ground level.

Ground Surface to 20' used 2½" casing. Foreman Basanta

Water level is 4' Below Ground surface ~~hrs after completion~~ Boring No 1 Sheet _____

Note, S P T Blows are 3 counts of 152 mm each Driving a 508 mm O D split spoon, using a 63 5 kg. weight dropping 762 mm.

TRINTOPLAN CONSULTANTS LTD.

POWER STATION AND SUB-STATION - ST. LUCIA

SHEET ___ OF ___

PROJECT NO. 8618

RECORD OF BOREHOLE HEAD OFFICE NO. 1

ENCLOSURE

LOCATION: SAN SOUCIS

BORING DATE: 06/12/20

DATUM: .....

SAMPLER HAMMER WEIGHT / PENETRATION TEST HAMMER WEIGHT: 140 LB, DROP 30 IN.

BORING METHOD: DRY SAMPLING 0.0m to 2.7m; WASH BORING 2.2m to 5.5m

DEPTH ft	SAMPLE NUMBER	SAMPLE TYPE	STRAT PLOT	SOIL PROFILE DESCRIPTION	BULK DENSITY γ_B kN/m³	PENETRATION RESISTANCE BLOWS/ft: N-VALUE (N) CONE PENETRATION (C) 25 50 75 100 125; UNDRAINED SHEAR STRENGTH kN/m² 20 40 60 80 100	WATER CONTENT, PERCENT: W_P W W_L 20 40 60 80	ADDITIONAL TEST AND REMARKS
0.0				**GRAVEL** Fill Material, crushed Rock. Very Dense.				
2.0	1			**CLAYEY SANDY GRAVEL** Layers of Peat. Grey. Loose				G.W.T. at 2.1m
4.0								
5.0	2							
8.0	3							
8.0								
3.1								
10.0	4			**CLAYEY SANDY GRAVEL** Weathered Rock. Greyish Brown changing to Reddish Brown with increase in depth. Very Dense.				
15	5							
	6							
5.1				END OF BOREHOLE AT 5.5m (UNABLE TO PENETRATE FURTHER)				
20.0								

DEPTH TO WATER TABLE 2.1 m

SPLIT SPOONS; DISTURBED BULK; SHELBY TUBE; SAMPLE LOST

W_L - LIQUID LIMIT; W - MOISTURE CONTENT; W_P - PLASTIC LIMIT; O ORGANIC CONTENT

NATURAL VANE +; REMOULDED VANE ⊕; UNCONFINED ○; TRIAXIAL QUICK △; TORVANE ●; PILCON VANE X

CLAY; SILT; SAND; GRAVEL; METAMORPHIC; TOP SOIL; ORGANIC

BH. No. H.O.1

ENCLOSURE 2-22

TRINTOPLAN CONSULTANTS LTD.

POWER STATION AND SUB-STATION) - ST. LUCIA

SHEET — OF —
PROJECT NO. 8648

RECORD OF BOREHOLE HEAD OFFICE BH. 2

ENCLOSURE

LOCATION SAN SOUCIS BORING DATE 86/12/31 DATUM

SAMPLER HAMMER WEIGHT — PENETRATION TEST HAMMER WEIGHT 140 LB, DROP 30 in

BORING METHOD DRY SPLITTING 0.0m to 5.0m
WASH BORING 5.0m to 6.2

DEPTH m	SAMPLE NUMBER	SAMPLE TYPE	STRATA PLOT	SOIL PROFILE DESCRIPTION	BULK DENSITY kN/m³	PENETRATION RESISTANCE BLOWS/ft N-VALUE (H) CONE PENETRATION (C) 25 50 75 100 125 / UNDRAINED SHEAR STRENGTH kN/m² 20 40 60 80 100	WATER CONTENT, PERCENT Wp W WL 20 40 60 80	ADDITIONAL TEST AND REMARKS
0.0				GRAVEL Fill Material, crushed Rock. Very Dense.				G.W.T. 3.9m
2.0	1	BS		CLAYEY SANDY GRAVEL Layers of Peat. Grey Loose.				
4.0	2							
6.0	3							
8.0	4							
10.0	5			CLAYEY SANDY GRAVEL Weathered Rock. Greyish Brown changing to Reddish Brown with increase in depth. Very Dense.				
20.0	6			END OF BOREHOLE AT 6.2m (UNABLE TO PENETRATE FURTHER)				

DEPTH TO WATER TABLE 0.0 m / 3.0 ft

SPLIT SPOONS DISTURBED BULK
SHELBY TUBE SAMPLE LOST

W_L - LIQUID LIMIT W - MOISTURE CONTENT
W_p - PLASTIC LIMIT % ORGANIC CONTENT

CLAY GRAVEL ORGANIC
SILT METAMORPHIC
SAND TOP SOIL

NATURAL VANE +
REMOULDED VANE ⊕
UNCONFINED ○
TRIAXIAL QUICK △
TORVANE ●
PILCON VANE X

BH. No. 2

ENCLOSURE 223

APPENDIX C

Polycarbonate Hurricane Shutters

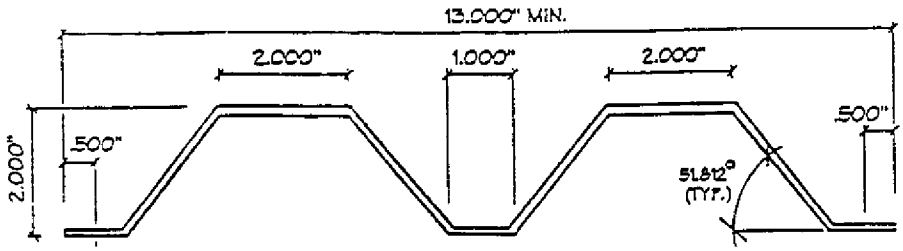
ADDITIONAL INFORMATION

Shutters may be mounted Horizontally as well as vertically, observing the maximum allowance span.

STANDARD SIZES (PANEL HEIGHTS)

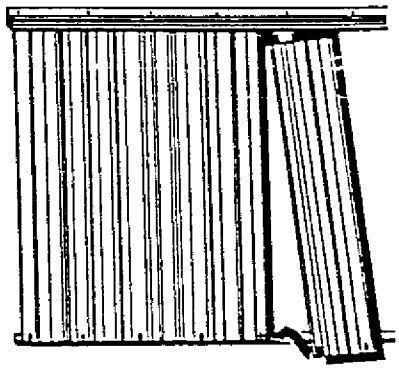
33" • 45" • 57" • 70" • 84" • 87"

TECHNICAL DRAWINGS

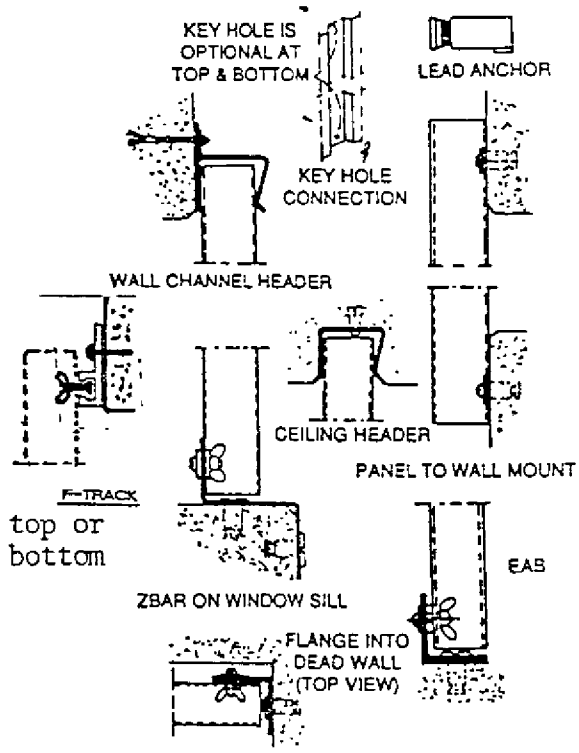


ALL PANEL DIMENSIONS MINIMUM.

Ⓜ POLYCARBONATE PANEL SECTION



TYPICAL WALL MOUNT EAB INSTALLATION



KATHY WELLS
General Manager
Dealerships

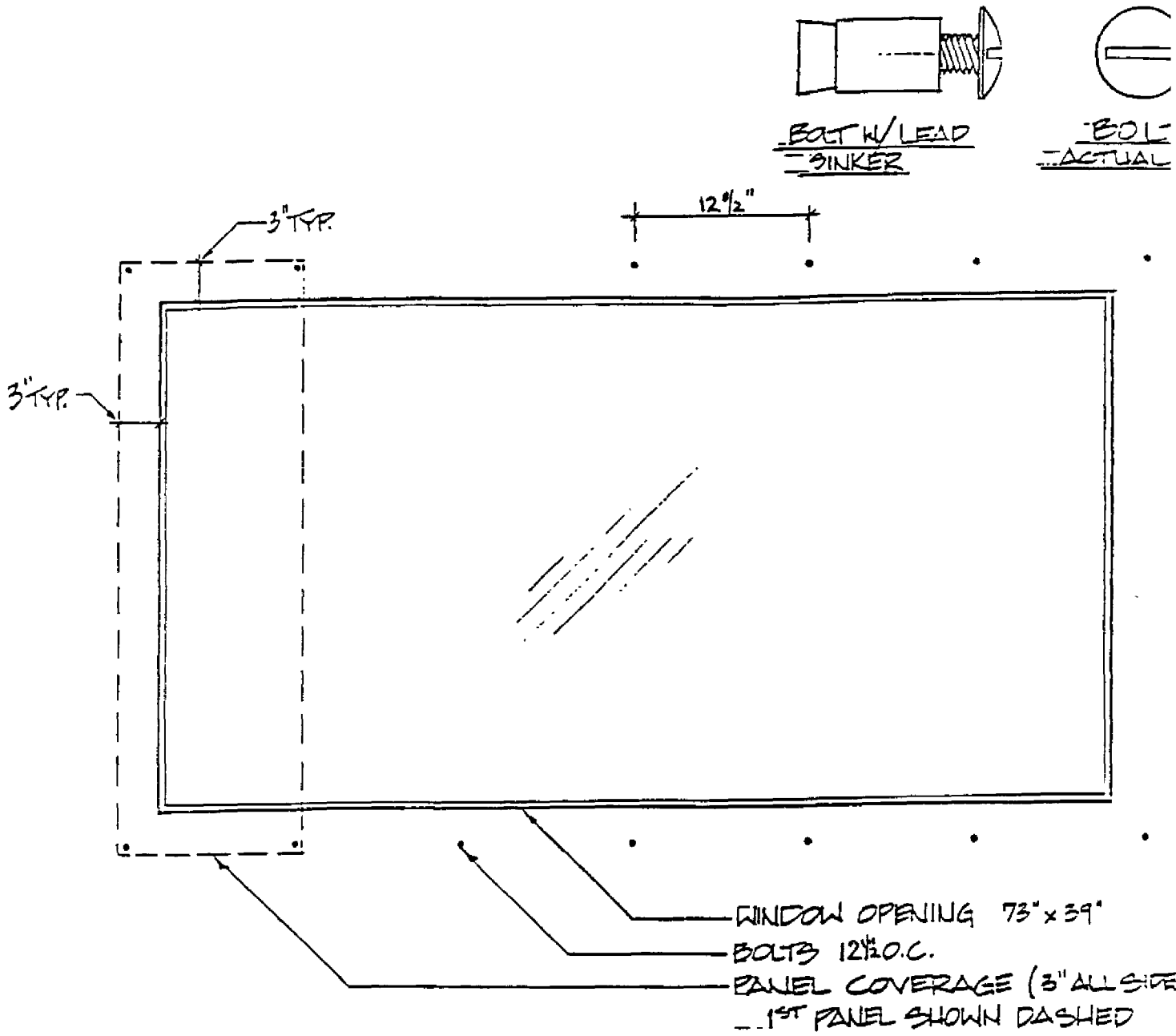
"The Difference Is Clear"

CLEARShield™
Manufacturing Corp.
HURRICANE PROTECTION

(800) 973-3331
(407) 840-8683
(407) 844-6732 Fax

4900 Dyer Blvd.
Riviera Beach, FL 33407

CLEARShield™
HURRICANE PROTECTION
"The Difference is Clear"



HURRICANE PANEL INSTALLATION DIAGRAM

SCALE 1" = 1'-0"

CLEARShield™ MANUFACTURING CORP. • 4900 Dyer Blvd • Riviera Beach, Florida 33407
Tel (407) 840-0923 • Natl 1-800-385-1335 • Fax (407) 844-6732

CLEARShield (TM) Manufacturing Corp.

MANUFACTURER'S EXPRESS LIMITED WARRANTY

CLEARShield(TM) warrants that all new CLEARShield(TM) hurricane panels are manufactured by CLEARShield(TM) Manufacturing Corp. free from defects in material and workmanship under normal use and service, and when used in accordance with the CLEARShield(TM) Owner's and Maintenance Manual, for the lifetime of the original purchaser from the date of purchase by the consumer. This Warranty covers all new CLEARShield(TM) brand hurricane panels and each of their componet parts, except steel and aluminum hardware provided with the system.

CLEARShield(TM) warrants that all new CLEARShield(TM) brand hurricane panels conform to Dade County, Florida Ordinance No. 93-141, the September 1, 1994 Dade County, Florida Building Code requirements, and the specifications set forth by Dade County, Florida Building Code Compliance Protocol Nos. PA 202-94, PA 203-94 and PA 301-94.

IN THE EVENT OF DEFECT, MALFUNCTION, OR OTHER FAILURE OF ANY NEW CLEARShield(TM) BRAND PRODUCT NOT CAUSED BY MISUSE OR DAMAGE TO THE PRODUCT WHILE IN POSSESSION OF THE CONSUMER, CLEARShield(TM) WILL REMEDY THE FAILURE OR DEFECT, WITHOUT CHARGE TO THE CONSUMER. THE REMEDY TO THE CONSUMER WILL SPECIFICALLY BE LIMITED TO THE REPAIR OR REPLACEMENT OF THE CLEARShield(TM) PRODUCT, OR REFUND OF THE PURCHASE PRICE FOR THE DEFECTIVE PRODUCT, AT THE OPTION OF CLEARShield(TM) MANUFACTURING CORP. THE REMEDY OF THE CONSUMER DOES NOT INCLUDE INCIDENTAL OR CONSEQUENTIAL DAMAGES, NOR DAMAGES ARISING FROM THE CONSUMER'S IMPROPER USE, INSTALLATION OR REMOVAL OF CLEARShield (TM) BRAND HURRICANE PANELS, NOR DAMAGES RESULTING FROM FAILURE OR MALFUNCTION OF ANY NEW CLEARShield(TM) BRAND PRODUCT DUE TO HURRICANE FORCE WINDS EXCEEDING THE TESTING STANDARDS SET FORTH IN THE DADE COUNTY, FLORIDA AND SOUTH FLORIDA BUILDING CODES.

LOSS OF LIGHT TRANSMISSION BY EXCESSIVE YELLOWING will be warranted for a period of seven (7) years from the date of purchase by the consumer. This warranty is subject to the owner's care and maintenance of the product in accordance with the CLEARShield(TM) owners and maintenance manual. CLEARShield warrants the Yellowness Index to be less than 10 within the seven year period as measured per ASTM D 1925 with a Hunter Ultrascan specirophotometer.

To obtain performance of any obligation under this Limited Warranty, the consumer may contact CLEARShield(TM) at 4900 Dyer Blvd, Riviera Beach, Florida 33407 or call (407) 840-8683.

This Limited Warranty extends only to the consumer of the CLEARShield(TM) brand hurricane panels, and may not be relied upon by any sales distributor, dealer, retailer or contractor, and shall not be transferrable by the original consumer. This Limited Warranty gives the consumer specific legal rights. The consumer may have other legal rights under the laws of the State of Florida.

Clearshield Manufacturing

ACCEPTANCE NO.: 94-0531.05

APPROVED : July 25, 1994

EXPIRES : July 25, 1997

NOTICE OF ACCEPTANCE: SPECIFIC CONDITIONS

1. DESCRIPTION

1.1 This approves a corrugated transparent polycarbonate storm panel designed to comply with the South Florida Building Code Impact Test Requirement and ASCE 7-88 "Minimum Design Loads for Buildings and Other Structures", for the following locations:

a.) Non-coastal building zone

b.) Coastal building zone.

2. MATERIAL CHARACTERISTICS

2.1 The storm panels shall be constructed as indicated on approved drawing No. A-5, using CALIBRE 302-E Polycarbonate Resin by Dow Plastics or Makrolon polycarbonate grade 3103 color 1112, to meet ISO 9002, panel thickness is 093".

2.2 Panels have a nominal width of 12.00" and a total width of 13.00", forming 2.00" deep ribs with punched slots at every valley, at top and bottom.

2.3 Components shall be aluminum alloy 6063-T5, 2" x 2" x 1/8" inset bar, 1 1/4" x 1 1/4" x 1/8" mullion bar and 4" x 2" x 1/8" inset bar; and an 18 ga. galvanized steel 3" x 3" x 1 1/2" Z bar.

3. LIMITATIONS

3.1 The design will be dependent on the maximum panel high of 8'- 4" or 100", to be installed only as outlined on drawings No. C-1, C-2, A-1 thru A-8 and A1A thru A4A.

3.2 Minimum separation to existing glass to protect shall be 3.00".

3.3 Special Requirement:

Reinforcing mullion bars, consisting of 1 1/4" x 1 1/4" x 1/8" angles of aluminum alloy 6063-T5 must be used across all intermediate panels within the openings, shall cross every panel web and lip, including the first and last lip, fastened with a 1/4" -20 x 3/4" press studs w/polycarbonate washer and 1/4" wing nut spaced at a max. distance of 6" on center

a.) For Projected and Inset Mount: Use two bars, dividing the span in three equal parts, spaced at not more than 33 1/4" o.c and

b.) For Flush Mount: Use four bars, two spaced at 12" from each end, and two more spaced at 20" from the first, with the remaining span of not more than 33".

4. INSTALLATION

4.1 The panels shall be installed only in the following condition:

a.) Projected Mount

The panels are fastened to a 3" x 3" x 1 1/2" galvanized steel Z bar around the full perimeter, which in turn is anchored to the wall, giving a maximum separation of 3" from wall, two horizontal mullion bars are attached to the vertical Z bars, each at 1/3 the panel span, as shown on approved detailed drawing No A-2 and A2A, bearing the Dade County Product Control stamp.

Gil Diamond, P.E.
Supervisor
Product Control Division

Clearshield Manufacturing

ACCEPTANCE NO.: 94-0531.05

APPROVED : July 25, 1994

EXPIRES : July 25, 1997

NOTICE OF ACCEPTANCE: SPECIFIC CONDITIONS

7. TESTS PERFORMED

TESTS: RESULTS:

TEST	TEST LOAD	DESIGN LOAD	Deflection
LARGE MISSILE IMPACT TEST SFBC PA 201-94	SATISFACTORY HTL-94-0502	———	Max.. 2 3/8"
CYCLIC WIND PRESSURE TEST SFBC PA 203-94 POSITIVE	+110.5 PSF HTL-94-0502	+85.0 PSF HTL-94-0502	———
CYCLIC WIND PRESSURE TEST SFBC PA 203-94 NEGATIVE	-110.5 PSF HTL-94-0502	-85.0 PSF HTL-94-0502	———
UNIFORM STATIC AIR PRESSURE TEST SFBC PA 202-94 POSITIVE	+127.5 PSF HTL-94-0411	+85.0 PSF HTL-94-0411	Max.. 1 3/4"
UNIFORM STATIC AIR PRESSURE TEST SFBC PA 202-94 NEGATIVE	-127.5 PSF HTL-94-0411	-85.0 PSF HTL-94-0411	———
DESIGN PRESSURE RATING	———	+85.0 PSF -85.0 PSF	———

8. EVIDENCE SUBMITTED

8.1 Tests:

8.1.1 Test report on Large Missile Impact Test and Pressure Cycling Spectrum Test of Polycarbonate storm panels, prepared by Hurricane Test Lab, Report No.HTL-94-0502, dated May 6, 1994, signed and sealed by Richard Boyette, P.E.

8.1.2 Test report on Uniform Static Air Pressure Test of Polycarbonate storm panels, prepared by Hurricane Test Lab, Report No.HTL-94-0411, dated May 6, 1994, signed and sealed by Richard Boyette, P.E.

8.2 Drawing:

8.2.1 Drawings No. C-1, C-2, A-1 thru A-8 and A1A thru A4A, prepared by Clearshield, Inc , dated May 23, 1994 and July 7,1994, all signed and sealed by Lisa Anne Tropepe, P.E.

8.3 Material certification:

8.3.1 Specification Sheet, prepared by The Dow Chemical Co. Product #14655 dated June 6, 1994 for CALIBRE 302-6 transparent Bisphenol A Polycarbonate.

8.3.2 Specification Sheet, prepared by Miles, Inc. Polymers Division, dated June 6, 1994 for Makrolon polycarbonate grade 3103, color 1112, ISO 9002 certified

Gil Diamond, P.E.
Supervisor
Product Control Division