ST. PETERSBURG PIER DESIGN COMPETITION
METOCEAN AND STRUCTURAL CONCEPT LEVEL DESIGN BASIS

Prepared for:

CITY OF ST. PETERSBURG

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Table of Contents

1. Introduction 1

2. Codes and Standards 1

3. Design Requirements 2

   Seismic Design 2

   Thermal Design Loads 3

   Load Combinations 3

   Metocean Conditions 3

   Scour 7

4. Construction Materials 7

5. Limits of Data Collection and Study 8

6. References 8

1. INTRODUCTION

The City of St. Petersburg (CoSP) requested Moffatt & Nichol (M&N) prepare a concept level design basis for the St. Petersburg Pier. This design basis will be used by finalists of the pier design competition to provide consistency between the competitors and to assist CoSP in their evaluation of concept submittals. These design criteria include typical codes and standards, material requirements, and design requirements for marine construction. Final detailed design criteria for elements of the concepts to be constructed on the pier, including buildings, features, or structures, are the responsibility of the design team proposing them. This design basis also includes metocean conditions (winds, waves, and water levels) at the pier.

2. CODES AND STANDARDS

Components of the Pier structure shall conform at a minimum to the latest editions of the following codes and standards:

1. Building Codes – IBC (International Building Code)
2. Florida Building Code
3. FDOT Standard Specifications for Road and Bridge Construction
4. City of St. Petersburg Engineering Design Standards
5. City of St. Petersburg Codes and Ordinances
6. FAA Height Restrictions Associated with Albert Whitted Municipal Aiport
7. Occupational Health and Safety Regulation
8. Design of Steel Structures – AISC
9. Design of Concrete Structures – ACI
10. Design of Pier and Wharf Structures – Unified Facilities Criteria (UFC)
    - UFC 3-220-01N, Geotechnical Engineering Procedures for Foundation Design of Buildings and Structures
    - UFC 3-300-10N, Design: General Structural Requirements
    - UFC 3-310-01, Design: Structural Load Data
    - UFC 4-151-10, General Criteria for Waterfront Construction

- UFC 4-152-01, Design: Piers and Wharves
- UFC 4-152-07, Design: Small Craft Berthing Facilities

11. Design of Coastal Structures – USACE CEM
12. Standard Specification for Highway Bridges – AASHTO
13. Wind Design – ASCE 7
14. Florida Fire Prevention Code (NFPA 101, NFPA 1, FL 44 Rules, FSS 633)
15. National Electrical Code - NFPA 70
16. Fire Alarm Code - NFPA 72
17. Fire Sprinkler Code - NFPA 13
18. Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves - NFPA 307
19. LP Gas Code - NFPA 58
20. Americans with Disabilities Act

Additional codes and standards relating to structures (buildings, features, structures, etc) on the pier are to be determined by the designer. In the event of codes with conflicting criteria, the code with the most recent publication date shall be used.

3. DESIGN REQUIREMENTS

The pier shall be designed to meet the following criteria:

- Functional design life of 75 years
- 100-year return period design storm event (wind, water level, wave, etc)

The pier shall also meet the following design requirements.

Seismic Design

The following data is based on IBC 2003.

I = 1.0

Ss =0.10g

S1 = 0.04g

Seismic Use Group I (IBC 1616.2)

Seismic Design Category A (IBC 1616.3)

Thermal Design Loads

Thermal strains are to be applied at the deck level using a temperature range of ΔT = 70 degrees F (21 degrees C).

Load Combinations

Load factors to be used for each load combination shall be according to Section 3-5 of UFC 4-152-01. Piers should be proportioned to safely resist the load combinations represented in Tables 3-6 and 3-7 in UFC 4-152-01. Each component of the structure and the foundation elements should be analyzed for all the applicable combinations.

Load Factor Design (UFC 4-152-01 Table 3-6)

Concrete structures for piers may be proportioned using the LRFD (ultimate strength) method; however, they should be checked for serviceability and construction loads.

Service Load Design (UFC 4-152-01 Table 3-7)

Concrete and steel structures may be proportioned using the service load combinations and allowable stresses. The service load approach should also be used for designing all foundations, for checking foundation stability, and for crack control.

Metocean Conditions

Metocean conditions, including water levels, wind speeds, and wave heights and periods, in the vicinity of the existing pier are as follows. The values are determined for a location with approximately 14 ft (4.3 m) water depth at NAVD88.

Water levels

Tides in the Tampa Bay region are mixed semi-diurnal tides, which means that water levels may exhibit one high and low tide (diurnal) or two high and two low tides (semi-diurnal) in any given

day or cycle. Tidal information was obtained from NOAA Station 8726520 located near the St. Petersburg U.S. Coast Guard station. The following table provides a summary of tidal datum elevations at Station 8726520 based on the current tidal epoch (19 years of measurements from 1983 to 2001).

Tidal Datum	Elevation (Feet)
Highest Observed Water Level (08/31/1985)	4.80
Mean Higher High water (MHHW)	0.80
Mean High Water (MHW)	0.52
North American Vertical Datum (NAVD88)	0.00
Mean Sea Level (MSL)	-0.26
National Geodetic Vertical Datum (NGVD29)	-0.88
Mean Low Water Level (MLW)	-1.08
Mean Lower Low Water (MLLW)	-1.46
Lowest Observed Water Level (01/16/1972)	-3.93

The City of St. Petersburg uses a local datum for City projects that relates to the tidal datum as follows:

97.0 ft City Datum = 0.0 ft NGVD (1929) = -0.88 ft NAVD88

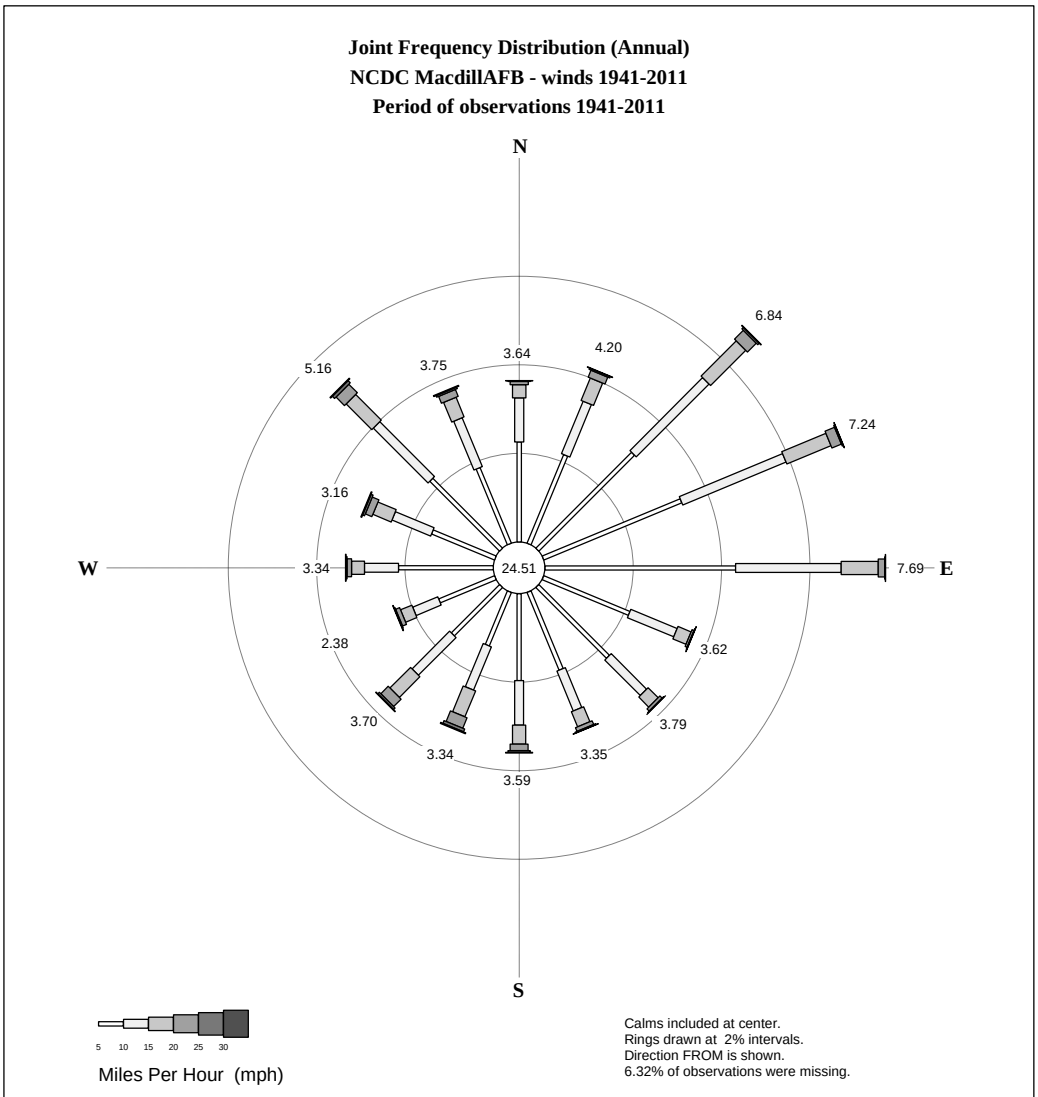
Storm surge data from the most recent FEMA Flood Insurance Study (FIS) for Pinellas County (2003) lists the following storm surge water levels for the project vicinity.

Return Period (years)	Water Level (NAVD88)
25	5.7 feet (1.7 meters)
50	7.0 feet (2.1 meters)
100	8.3 feet (2.5 meters)

The storm surge values listed do not include the effects of tides or wave set-up.

Winds

Winds recorded at MacDill Air Force Base from 1941 through 2011 are depicted in the wind rose in Figure 1.



PERCENT OCCURRENCE: Miles Per Hour (mph)
LOWER BOUND OF CATEGORY

DIR	5	10	15	20	25	30
N	2.25	0.99	0.30	0.07	0.02	0.01
NNE	2.16	1.28	0.54	0.17	0.03	0.01
NE	3.06	2.32	1.12	0.28	0.04	0.01
ENE	3.37	2.53	1.08	0.23	0.03	0.00
E	4.30	2.38	0.84	0.15	0.02	0.00
ESE	2.11	1.13	0.32	0.05	0.01	0.00
SE	2.25	1.13	0.32	0.07	0.01	0.01
SSE	1.90	0.97	0.37	0.09	0.02	0.00

TOTAL OBS = 615836 MISSING OBS = 38927

PERCENT OCCURRENCE: Miles Per Hour (mph)
LOWER BOUND OF CATEGORY

DIR	5	10	15	20	25	30
S	1.96	1.00	0.43	0.15	0.04	0.01
SSW	1.30	1.06	0.63	0.26	0.07	0.03
SW	1.54	1.20	0.66	0.24	0.05	0.01
WSW	1.37	0.61	0.28	0.10	0.02	0.01
W	2.14	0.77	0.29	0.10	0.02	0.01
WNW	1.54	0.94	0.45	0.16	0.05	0.02
NW	2.23	1.75	0.82	0.27	0.07	0.03
NNW	1.85	1.19	0.48	0.17	0.04	0.02

CALM OBS = 150955 PERCENT CALM = 24.51

Figure 1: Wind Rose for the MacDill AFB NCDC Station 747880.

Extreme value analysis of historical wind speeds recorded at MacDill Air Force Base from 1941 through 2011 indicates the following wind speed return periods.

Return Period (years)	10-Minute Wind Speed (mph)
25	74
50	83
100	92

Extreme wind speeds were analyzed without consideration for direction. The recurrence of directional extreme winds should be further evaluated for final design.

Waves

Design waves at the pier were analyzed using numerical wave models for both locally generated wind waves and offshore swells. Analysis shows that wave height due to offshore swells reaching the site is negligible. Wind waves were hindcast over Tampa Bay to the project site for a water level of 0.0 feet NAVD88 and for storm surge conditions with corresponding return periods (i.e. 25-year surge with 25-year wind). Hindcasted wind-generated waves at the site are as follows:

Return Period (years)	No Storm Surge		
	H_{mo}	H_{max}	T_p (sec)
25	2.62 feet 0.8 meters	5.25 feet 1.6 meters	2.7
50	4.59 feet 1.4 meters	7.87 feet 2.4 meters	4.2
100	4.92 feet 1.5 meters	8.2 feet 2.5 meters	4.2

Return Period (years)	With Corresponding Storm Surge		
	H_{mo}	H_{max}	T_p (sec)
25	6.23 feet 1.9 meters	10.83 feet 3.3 meters	4.7
50	6.56 feet 2.0 meters	11.81 feet 3.6 meters	4.8
100	7.22 feet 2.2 meters	12.47 feet 3.8 meters	4.9

H_{mo} represents the significant wave height with wave breaking included. H_{max} represents the average of the highest 1% of wave heights. T_P represents the peak wave period.

Scour

Scour at the structure foundation varies depending on the structure type and dimensions. Each design team should evaluate the depth and design impact of scour on the proposed structure for the 100-year return period event.

4. CONSTRUCTION MATERIALS

Materials for the project shall be chosen to provide a long service life and performance consistent with the design requirements, along with providing adequate structural capacity to support the anticipated loads for this type of facility. In general, concrete is highly durable in a marine environment. Where steel is used, consideration will be taken as to whether to use stainless steel, hot-dipped galvanizing, epoxy coatings, and/or some type of cathodic protection system.

Material used in the pier structure shall meet the following criteria:

1. Steel pipe shall be to ASTM A 501 and A 53.
2. Structural Steel shall be as follows:
    a. Rolled Sections, Plates and Angles: ASTM A 36, ASTM A 572 and/or ASTM A 992
    b. Hollow Structural Sections: ASTM A 500, Grade B

3. Coating System for Structural Steel: Zinc-coated or galvanized by the hot-dipped process in accordance with the requirements of ASTM A 123 and/or A 153 as applicable, after fabrication.
4. Structural Bolts, Nuts and Washers: ASME/ANSI B 18.2.2 and ASTM A 325.
5. Anchor Bolts: ASTM A 307, A 449, or ASTM F 1554.
6. Marine Concrete: 5,500 psi minimum at 28 days FDOT Class IV Portland cement concrete with calcium nitrate for superstructure and silica fume for substructure for an extremely aggressive environment with a maximum water cement ratio of 0.40.
7. Reinforcing Steel: ASTM A 615, A 616, A 617 and A 706 as applicable.
8. Stainless Steel: ASTM Type 316L Stainless.

5. LIMITS OF DATA COLLECTION AND STUDY

This metocean and structural design basis is for concept design only. Additional data collection and analysis including detailed bathymetric and topographic surveys, benthic surveys, and geotechnical investigations are required for permitting and detailed design development. In addition, a detailed evaluation of shoreline processes may be required for permitting as well as refined extreme water level and wave analysis reflecting the final pier concept alignment and structure type.

6. REFERENCES

DHI, 2011. MIKE 21 SW (Spectral Wave) FM Module User Guide. DHI, Hørsholm, Denmark.

Harris, D.L., 1963. Technical Paper: Characteristics of the Hurricane Storm Surge, No. 48, United States Weather Bureau, Washington, D.C., 139 p.

Kamphuis, J. William. Introduction to Coastal Engineering and Management, 437 pp. 200 Singapore; River Edge, N.J. World Scientific, c2000. Advanced series on ocean engineering; v. 16.

National Oceanic and Atmospheric Administration (NOAA), National Weather Service, 1993. "Hurricane!" A Familiarization Booklet, NOAA PA 91001, 36 p.

Organization of American States (OAS). Caribbean Disaster Mitigation Plan - Atlas of Probable Storm Effects in the Caribbean Sea. 1999.

Simpson, R.H., 1971. Minutes of the Eighth NOAA, NWS Hurricane Conference, Miami, Florida. A Proposed Scale for Ranking Hurricanes by Intensity.

USACE. Coastal Engineering Manual (CEM), U.S. Army Corps of Engineers document reference EM 1110-2-1100. 2004.

Wikipedia. http://en.wikipedia.org/wiki/Storm_surge.