Final Independent External Peer Review Report

Independent Peer Review of Greater New Orleans Hurricane and Storm Damage Risk Reduction System Design Guidelines:

Aberrant Barge Impact Loads on Hurricane and Storm Damage Risk Reduction System Floodwalls

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U.S. Army Corps of Engineers
Coastal Storm Damage Reduction Planning Center of Expertise
Baltimore District

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for the

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ACRONYMS

ASCE	American Society of Civil Engineer
CEO	Chief Executive Officer
CFD	Computational Fluid Dynamics
DrChecks^{SM}	Design Review and Checking System
EC	Engineer Circular
ER	Engineering Regulations
FEA	Finite Element Analysis
GNOHSDRRS	Greater New Orleans Hurricane and Storm Damage Risk Reduction System
HPO	Hurricane Protection Office
IEPR	Independent External Peer Review
ITR	Independent Technical Review
PDT	Project Delivery Team
PRO	Protection and Restoration Office
PRQCP	Peer Review Quality Control Plan
psf	Pounds Per Square Foot
USACE	United States Army Corps of Engineers
WRDA	Water Resources Development Act

Final Independent External Peer Review Report for the Independent Peer Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System Design Guidelines Aberrant Barge Impact Loads on Hurricane and Storm Damage Risk Reduction System Floodwalls

Executive Summary

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (GNOHSDRRS). A vital component of this system is the guidelines used to inform and guide the project designers. During the original Independent External Peer Review (IEPR) of the GNOHSDRRS Design Guidelines (hereinafter referred to as the Design Guidelines), the reviewers determined that more information was needed about the potential impacts from loose barges. In response to these reviewer comments, the USACE developed a report entitled "Aberrant Barge Impact Loads on Hurricane and Storm Damage Risk Reduction System Floodwalls" (hereinafter referred to as the Barge Impact report), which is intended to be used in the design of floodwalls and structures throughout the GNOHSDRRS.

Numerous aberrant barges have been documented during recent hurricane events (e.g., Katrina (2005) and Gustav (2007)) around the New Orleans navigation areas. Aberrant barges become loose from their moorings due to high winds, surge, and/or waves from these hurricanes. The kinetic energy released upon impact creates the potential for damage to levees, floodwalls, and other hurricane protection structures. These impacted structures could cause significant consequences if they are near critical population, property, or infrastructure in the New Orleans navigation area.

The barge impact loads provided in the existing GNOHSDRRS guidelines were not developed using specific analytical or numerical methods, and an independent technical review of the loads questioned their validity for use in GNOHSDRRS designs. The Barge Impact report quantifies the motions and impact forces of an aberrant barge due to winds and waves for three structures: (1) a typical Hurricane Protection Office (HPO) floodwall, (2) a Protection and Restoration Office (PRO) floodwall, and (3) PRO fronting protection. The barge impact loads were determined through the use of physical laboratory modeling, computational fluid dynamic models, and dynamic structural finite element models.

Battelle Memorial Institute (hereafter Battelle), as a non-profit science and technology organization with experience in establishing and administering independent external peer reviews, was engaged to conduct the IEPR of the Design Guidelines and the Barge Impact report. The IEPR followed the procedures described in the Department of the Army, USACE guidance *Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008; CECW-CP Memorandum dated March 30, 2007; *Engineering and Design, Quality Management* (ER 1110-1-12) dated July 21, 2006; and *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001. This final IEPR report describes the IEPR process followed by the external panel of

experts, summarizes final comments of that IEPR panel, and describes the panel members and their selection.

The purpose of an IEPR is to strengthen the quality and credibility of the USACE's decision documents in support of its Civil Works program. The Barge Impact report review was conducted under a contract modification to the Design Guidelines review, which originated in August 2008. This IEPR panel reviewed the 75% and 100% versions of the Barge Impact report.

The two independent external peer reviewers (i.e., panel members) contracted to perform the Barge Impact report review were identified and selected from the structural and geotechnical members of the original ten-member panel that performed the initial Design Guidelines review. The panel members were selected for their technical expertise, their confirmed availability, lack of potential conflicts of interest, and knowledge of the Greater New Orleans area.

For each review, the IEPR panel members focused on the following tasks:

- Conducting a broad overview of the Barge Impact report in the panel member's area of expertise and technical knowledge.
- Identifying, explaining, and commenting on assumptions that underlie the engineering or scientific analyses.
- Evaluating whether the interpretations of the analyses and conclusions are reasonable.
- Reviewing scientific information, including factual inputs, data, the use and soundness of models, analyses, assumptions, and other scientific and engineering matters that inform decision makers.

In order to maintain independence and control, the IEPR panel members were not permitted to have direct or unmonitored e-mail or phone contact with the USACE Project Delivery Team (PDT). All interaction between the IEPR panel and USACE either occurred in DrChecks (Design Review and Checking System), a web-based tool for facilitating design reviews, or via teleconference with Battelle and a USACE Baltimore representative present.

Below is a description of each review that was conducted.

75% Barge Impact Report Review

The 75% Barge Impact report IEPR began on January 13, 2010, when the panel members were provided with hard and/or electronic copies of the file "Aberrant_barge_impact_report_-_75_review.pdf." The panel members developed 74 comments on the 75% version and entered their comments into DrChecks by January 26, 2010. On February 23, 2010, USACE completed its initial Evaluator responses and the panel members conducted an initial round of Backcheck responses (e.g., responding to USACE Evaluator responses) and comment resolution (e.g., comment close out). A teleconference to discuss some of the comments and possible changes was held on March 4, 2010. USACE provided additional evaluation responses through June 8, 2010 and the panel members entered their Backcheck responses in DrChecks through June 15, 2010.

100% Barge Impact Report Review

The 100% Barge Impact report IEPR review began on March 23, 2010, when the panel members were provided with hard and/or electronic copies of the three files that made up the 100% version (final_report_-_march_23.pdf; hpo_wall_pushover_analysis_calcs.pdf; and pro_calculations_and_staad_results.pdf).

The panel members developed 69 comments on the 100% version and entered them into DrChecks by April 1, 2010. A teleconference to discuss the comments and possible changes was held on April 22, 2010. On April 22, 2010, the USACE completed its initial evaluations. USACE provided additional evaluation responses through June 7, 2010, and the panel members entered Backcheck responses in DrChecks through June 15, 2010.

Comments from the Reviews

Throughout the comments on the two reviews, the IEPR panel members recommended various additional details/clarifications be added to improve the design guidance and future use of the Barge Impact report. Below are those items noted by the panel as being most important:

- Aberrant barges can occur during hurricane and other weather-system events that can impact various types of GNOHSDRRS structures in the New Orleans area.
- The study only addressed (i) dolphins, (ii) PRO floodwalls and structures, and (iii) HPO floodwalls and structures; thus the findings may not be applicable to other structures in the GNOHSDRRS.
- The previously designed and/or constructed GNOHSDRRS floodwalls and fronting structures should be evaluated in light of the results of this study, and if necessary, modifications should be made.
- Although the numerical modeling and analytical results concerning pile loads and impact forces caused by barge impacts were found to be relatively insensitive to the soil properties, accurate characterization of the soil stratigraphy and measurement of the engineering properties of the soils should be used for design and analysis efforts.
- New U.S. Coast Guard regulations concerning barge placement during hurricane and storm events should be implemented carefully so as not to move the risk from the lower, lesser-populated areas of New Orleans to the upper, more highly populated areas of the City.

The remaining comments focused on offering recommendations to clarify the Barge Impact report.

In total, across the two reviews, the USACE PDT evaluated and responded to 143 comments: concurring with 77 comments; agreeing to provide additional information in support of 2 comments; stating they needed to check and resolve issues raised on 56 comments; and non-concurring with 8 comments, for which an explanation was provided with each. Upon review of the USACE PDT responses, the IEPR panel members determined that some comments needed further discussion as the comments were inadequately addressed. Two IEPR teleconferences were conducted throughout the two reviews for the IEPR panel and USACE PDT to discuss those comments that were either identified by the panel as being inadequately addressed or for which the USACE PDT

needed further explanation. Upon completion of the IEPR teleconferences and subsequent evaluations by the USACE PDT, the IEPR panel members considered the comments adequately addressed and closed all of the comments. In general, the IEPR panel members agreed that the physical and numerical modeling results developed for and provided in this document have resulted in barge impact values that are based on actual analytical data, and that are greater and more realistic than what now exists in the GNOHSDRRS Design Guidelines (June 2008). However, the panel members' noted that the barge impact values are subject to the following limitations:

- The study was based only on a single empty aberrant barge and barge impact values for a fully loaded barge have yet to be developed.
- The results are based on a single one-time impact when the possibility of multiple barge impacts during a slow-moving or a stalled hurricane exists.
- The study addressed and focused only on PRO floodwalls and structures, HPO floodwalls and structures, and dolphin structures.

1. INTRODUCTION

1.1 Background of Program

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (GNOHSDRRS). A vital component of this system is the guidelines used to inform and guide the project designers. During the original Independent External Peer Review (IEPR) of the GNOHSDRRS Design Guidelines (hereinafter referred to as the Design Guidelines), the reviewers determined that more information was needed about the potential impacts from loose barges. In response to these reviewer comments, the USACE developed a report entitled "Aberrant Barge Impact Loads on Hurricane and Storm Damage Risk Reduction System Floodwalls" (hereinafter referred to as the Barge Impact report), which is intended to be used in the design of floodwalls and structures throughout the GNOHSDRRS.

Numerous aberrant barges have been documented during recent hurricane events (e.g., Katrina (2005) and Gustav (2007)) around the New Orleans navigation areas. Aberrant barges become loose from their moorings due to high winds, surge, and/or waves from these hurricanes. The kinetic energy released upon impact creates the potential for damage to levees, floodwalls, and other hurricane protection structures. These impacted structures could cause significant consequences if they are near critical population, property, or infrastructure in the New Orleans navigation area.

The barge impact loads provided in the existing GNOHSDRRS guidelines were not developed using specific analytical or numerical methods, and an independent technical review of the loads questioned their validity for use in GNOHSDRRS designs. The Barge Impact report quantifies the motions and impact forces of an aberrant barge due to winds and waves for three structures: (1) a typical Hurricane Protection Office (HPO) floodwall, (2) a Protection and Restoration Office (PRO) floodwall, and (3) PRO fronting protection. These barge impact loads were determined through the use of physical laboratory modeling, computational fluid dynamic models, and dynamic structural finite element models.

Battelle Memorial Institute (hereafter Battelle), as a non-profit science and technology organization with experience in establishing and administering independent external peer reviews, was engaged to conduct the IEPR of the Barge Impact report. The IEPR followed the procedures described in the Department of the Army, USACE guidance *Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008; CECW-CP Memorandum dated March 30, 2007; *Engineering and Design, Quality Management* (ER 1110-1-12) dated July 21, 2006; and *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001.

This final IEPR report describes the IEPR process followed by the external panel of experts, summarizes final comments of that IEPR panel, and describes the panel members and their selection.

1.2 Project Description

The Design Guidelines document is a compendium of design guidance and standards for engineers and designers engaged in work for the U.S. Army Corps of Engineers New Orleans District. This IEPR reviewed the 75% and 100% versions of the Barge Impact report, which will be used in conjunction with the Design Guidelines to determine design barge impact loads on structures throughout the New Orleans area.

1.3 Purpose of the Independent External Peer Review

The purpose of an IEPR is to strengthen the quality and credibility of the USACE's decision documents in support of its Civil Works program. To help ensure that USACE documents are supported by the best scientific and technical information, a peer review process has been implemented by the USACE. This process utilizes an IEPR to complement the agency technical review, as described in the Department of the Army, USACE guidance *Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008, and CECW-CP Memorandum dated March 30, 2007. In this case, the IEPR of the Barge Impact report was conducted and managed using contract support from Battelle, an independent 501(c)(3) organization, to ensure independent objectivity, along with a high degree of flexibility and responsiveness, which was essential for the USACE to meet deadlines.

2. INDEPENDENT EXTERNAL PEER REVIEW PROCESS

This section describes the methodology followed in selecting IEPR panel members, and in planning and conducting the IEPR. The IEPR followed the process described in the Peer Review Quality Control Plan (PRQCP), which Battelle developed in August 2008 for the original Design Guidelines review. It also was conducted following procedures described in the USACE's guidance cited above (Section 1.1) and in accordance with the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*, released December 16, 2004. In addition, supplemental guidance on the evaluation of conflicts of interest from the National Academies' *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports*, dated May 12, 2003, was followed.

2.1 Planning and Schedule

The Barge Impact report review was conducted under a contract modification to the Design Guidelines review, which originated in August 2008. Table 1 defines the schedule followed by Battelle in executing the IEPR for each respective review version of the Barge Impact report.

Table 1. Schedule

Activities	75% Review	100% Review
Documents Received	January 13, 2010	March 23, 2010
Review Start Date	January 13, 2010	March 23, 2010
Review End Date/ DrChecks Comments Entered	January 26, 2010	April 1, 2010
Number of DrChecks Comments Entered	74	69
Teleconference Call(s)	March 4, 2010	April 22, 2010
USACE Complete Comment Evaluation	June 8, 2010	June 7, 2010
Panel Members Complete Backchecks	June 15, 2010	June 15, 2010
DrChecks Comments that Remain Open	0	0

2.2 Identification and Selection of Independent External Peer Reviewers

The two independent external peer reviewers (i.e., IEPR panel members) contracted to perform the Barge Impact report review were identified and selected from the structural and geotechnical members of the ten-member panel that performed the original Design Guidelines review. The panel members were selected for their technical expertise, their confirmed availability, lack of potential conflicts of interest, and knowledge of the Greater New Orleans area.

The two reviewers selected for the final IEPR panel were independent engineering consultants. Corresponding to the technical content of the Barge Impact report, the areas of technical expertise of the selected panel members included geotechnical engineering and structural engineering (see Section 3 for names and biographical information on the selected panel members). Battelle established subcontracts with the panel members after they had indicated their willingness to participate and reconfirmed the absence of conflicts of interest.

2.3 Review

Two separate reviews of the Barge Impact report were conducted. Reviews of the 75% and 100% versions each resulted in comments, which were entered separately into DrChecks^{SM} (Design Review and Checking System) under the Design Guidelines project. For each review, the IEPR panel members focused on the following:

- Conducting a broad overview of the Barge Impact report in the panel member's area of expertise and technical knowledge.
- Identifying, explaining, and commenting on assumptions that underlie engineering or scientific analyses.
- Evaluating whether the interpretations of the analyses and conclusions were reasonable.

- Reviewing scientific information, including factual inputs, data, the use and soundness of models, analyses, assumptions, and other scientific and engineering matters that inform decision makers.

To maintain independence and control, the IEPR panel members were not permitted to have direct or unmonitored e-mail or phone contact with the USACE Project Delivery Team (PDT). All interaction between the IEPR panel and USACE occurred either in DrChecks or via teleconference with Battelle and a USACE Baltimore representative present.

Below is a description of each review that was conducted.

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100% Barge Impact Report Review

The 100% Barge Impact report IEPR review began on March 23, 2010, when the panel members were provided with hard and/or electronic copies of the three files that made up the 100% version (final_report_-_march_23.pdf; hpo_wall_pushover_analysis_calcs.pdf; and pro_calculations_and_staad_results.pdf).

The panel members developed 69 comments on the 100% version and entered them into DrChecks by April 1, 2010. A teleconference to discuss the comments and possible changes was held on April 22, 2010. On April 22, 2010, the USACE completed its initial evaluations. USACE provided additional evaluation responses through June 7, 2010, and the panel members entered Backcheck responses in DrChecks through June 15, 2010.

Critical Comments

In total, the panel members produced 143 individual comments across the two reviews. Of these, the peer reviewers developed ten comments that they considered critical. Critical comments are defined by the Water Resources Development Act (WRDA) 2007 (Public Law 110-114), Section 2035 (i.e., Type II IEPR), as being associated with issues that address public safety, health, and welfare. Figure 1 shows an example of a critical comment from the review. Note that the name of the IEPR panel member, the USACE PDT member who provided the response, and names provided within the response have been removed in this example .

2.4 IEPR Teleconferences

Battelle led two IEPR teleconferences between members of the USACE PDT who responded to the DrChecks comments and the IEPR panel members. Each IEPR teleconference provided an

interactive, real-time forum for a discussion of those comments that the IEPR panel members considered inadequately addressed, or for which the USACE requested further discussion. These teleconferences also provided an opportunity for the IEPR panel members to understand some of the responses from the USACE PDT. Overall, the teleconferences were successful in clarifying and resolving many of the issues. The USACE had some comments that needed further response, but in general, at the conclusion of the teleconferences, the IEPR panel members considered most of their comments adequately addressed.

Figure 1. Example of a Critical Comment from the Review

3172605	Geotechnical	"Chapter 6 REFINE BARGE EMPTY/FULL COUNT FOR RISK	Page 103	n/a
(Document Reference: Aberrant Barge Impact Loads on Hurricane and Storm Damage Risk Reduction System (HSDRRS) Floodwalls, 100% Submittal -- Draft) In the reviewer's opinion, the following statement is significant and should be emphasized in the abstract/executive summary and in the conclusions: "Given that there are a number of floodwalls that surround the downtown New Orleans area that have not been designed for any hurricane barge impact loads, this new USCG regulation should be carefully implemented so as not to move the risk from the lower areas to the upper areas, which are nearer to the higher-populated areas." Submitted On: 01-Apr-10				
1-0	Evaluation **Concurred** The PDT agrees and this will be strongly emphasized as part of the executive summary. Submitted On: 20-Apr-10			
1-1	Backcheck Recommendation **Close Comment** Closed without comment. Submitted On: 22-Apr-10			
	Current Comment Status: **Comment Closed**			

2.5 IEPR Final Report

After concluding the 75% and 100% reviews, Battelle prepared this final report on the overall IEPR process and the IEPR panel member's findings. This report was reviewed by each IEPR panel member and Battelle technical and editorial reviewers prior to its submission to the USACE.

3. IEPR PANEL MEMBER SELECTION

At the USACE's request, Battelle identified and selected two of the original Design Guidelines panel members to serve as reviewers of the two Barge Impact report versions. One geotechnical engineer out of the three geotechnical engineers on the original panel and one structural engineer out of the two structural engineers on the original panel were chosen. Both IEPR panel members met the following minimum requirements:

- Registered professional engineer (or equivalent in home country)
- Masters degree
- 15 years of experience with responsibilities for project engineering work

Panel members in each discipline also were required to have specific technical experience in the areas of expertise specified in the scope of work. This expertise and the panel members chosen

are summarized in Tables 2 and 3 below. A summary of the credentials of the two reviewers selected for the IEPR panel and their qualifications in relation to the technical evaluation criteria is presented below. Resumes including more detailed biographical information for each reviewer and his technical areas of expertise are presented in Appendix A.

Table 2. Required Technical Experience for IEPR Panel Members

Discipline (# of Reviewers)	Required Experience
Geotechnical Engineer (1)	• Very soft Louisiana-type clay soil foundations • Large diameter pile design • Axial and lateral load testing for piles • T-wall and L-wall design • Subsurface investigations in very soft soil • Seepage design • Wave impact/armoring • Slope stability analyses for very soft soils • Pile foundations
Structural Engineer (1)	• Sector gates and/or lift gates subject to high wind and wave loading • T-wall and L-wall floodwall design • Welding

Table 3. Final List of IEPR Panel Members

Discipline/Name	Affiliation	Location	Education	Years of Experience
Geotechnical/Civil Engineer				
David E. Lourie	Lourie Consultants	Metairie, LA	BSCE, MSCE	30
Structural Engineer				
Jay Jani	Engineering Consulting Services, Inc.	Metairie, LA	BECE, MSCE, PhD (Ocean Engineering)	25+

Dr. Jay Jani, P.E., is a licensed Professional Engineer. He has worked as a structural engineer and has over 25 years of design experience in civil and marine/offshore engineering industries. Dr. Jani founded his firm, Engineering Consulting Services, Inc., in 1990. Since then, Dr. Jani has served as the President and Senior Structural Engineer of Engineering Consulting Services, Inc., and has worked on a variety of structural design and assessment projects, as well as performed independent technical reviews (ITRs) for several structural design projects in the New Orleans area. For example, Dr. Jani performed the ITRs of the structural design of T-walls for several pumping stations in New Orleans, as well as reviews of the Inner Harbor Navigational Canal Replacement Lock, Riverside Gatebay Module and the Harvey Canal Flood Wall Design in New Orleans. Dr. Jani has also performed the structural design of weather station equipment support structures and lateral support systems at various canals in New Orleans, Louisiana. Dr. Jani served as Chairman and Vice Chairman of American Society of Civil Engineer (ASCE)-Structural Engineering Institute, New Orleans Chapter, during the 2008-2009 and 2007-2008 terms, respectively. He also served as an adjunct faculty in the Civil Engineering Department at University of New Orleans.

David E. Lourie, P.E., D.GE, is a practicing engineer with 30 years of consulting experience. He has expertise in South Louisiana soil conditions, local area geology, and geotechnical design and construction. He has performed complex geotechnical investigations for the petrochemical industry, airports, ports, State and Federal agencies, and others in the region. Before forming Lourie Consultants in 1992, he spent nine years directing the technical and financial operations of Fugro-McClelland (Southeast), Inc., and McClelland Engineers in Louisiana. Before that, he worked as an onshore and offshore geotechnical engineer for McClelland Engineers in Houston, Texas, and as a soil and materials engineer for STS Consultants in Chicago, Illinois. He has served as a Liaison to the Peer Review Committee of ASFE/The Geoprofessional Business Association and is ASFE's immediate past president. Mr. Lourie has been an adjunct associate professor at Tulane University, a visiting professor at McNeese State University, and a guest lecturer at Louisiana State University and the University of New Orleans. He is an active member of numerous professional and technical societies, including the Louisiana Engineering Society (LES), ASCE, Geo-Institute (G-I), ASCE Geotechnical Activities Group of New Orleans, American Council of Engineering Companies (ACEC), and ASFE. The Association of Geoprofessionals (AGP), an ASCE affiliate, recently elected Mr. Lourie a Diplomate, Geotechnical Engineering.

4. RESULTS – SUMMARY OF REVIEW

The IEPR panel members followed the processes described in Sections 2.3 through 2.5 to conduct their review, execute the IEPR teleconferences, and to finalize remaining comments in DrChecks. These processes were in accordance with all USACE guidance documents. Listed below are summaries of how the IEPR panel experts in the different disciplines approached their reviews, comments that the panel members made, and the status of any open issues including critical items.

4.1 Overall Review Approach

This section describes how the IEPR panel members in the different disciplines approached their reviews and documented their comments in DrChecks. The IEPR panel members were encouraged to work individually according to their assigned expertise and to contribute to the reviews being conducted by the reviewer in the other discipline, as appropriate based upon their experience. In general, each of the reviewers worked individually in reviewing the 75%, and 100% IEPR review versions, although there were occasional discussions between IEPR panel members. IEPR panel members were able to discuss their comments with the other panel member if they determined that this was appropriate prior to input of their comments in DrChecks or before IEPR conference calls.

Geotechnical Engineering Review Approach
During the review of the documents, the geotechnical engineer focused on the following:

- Assessing the degree to which the study considered the "lessons learned" about aberrant barges from recent hurricane and storm events in the New Orleans area;
- Understanding the issues associated with using piles as deep foundation elements for structures subjected to loads from marine vessels, such as barges, based on his knowledge

and experience, as well as independent research and the information presented in the document;
- Identifying critical issues that could be associated with barges impacting pile-supported structures;
- Understanding the various aspects of the physical and numerical models used to determine barge impact loads, and assessing the ability of the models to provide the information necessary to answer questions about barge impact loads on pile-supported structures;
- Assessing the degree to which soil conditions in the New Orleans area were taken into account in the models;
- Seeking to identify and quantify the limitations of the models and their influence on the data obtained;
- Reviewing the data from the models and the USACE's interpretations and conclusions derived from the data;
- Making an independent interpretation of the data to the extent necessary to evaluate the USACE's conclusions and develop his own opinions and conclusions; and
- Assessing the degree to which the final document completely and clearly describes the study and its findings.

Structural Engineering Review Approach

The primary objective of the structural engineer was to assess the structural integrity of the proposed floodwalls subjected to realistic barge impact loading conditions. The structural engineering review mainly focused on the following major areas:

- Assessing the extent to which the "Barge Impact" experimental conditions (including set-up, data collection, results, etc.) were based on the realistic conditions expected in a hurricane storm situation;
- Ensuring the "Barge Impact" analytical models (Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA)) were based on the realistic conditions expected in a hurricane storm situation;
- Advocating that the final results from the study should determine and recommend specific values of Barge Impact loadings for the design of flood protection structures such as dolphins, floodwalls, etc., so that they can be incorporated into an updated GNOHSDRRS Design Guidelines document; and
- Checking the clarity, accuracy and completeness of the report.

4.2 Summary of IEPR Panel Comments

The comments made during the Barge Impact report reviews have been placed into one of four categories based on the response provided by the USACE PDT. These categories include:

- For Information – comments for which the IEPR panel member either (1) requested a clarification narrative from the USACE, or (2) received further explanation or additional documents that allowed the IEPR panel member to agree with the USACE approach;

- Suggestion for Clarification – minor, but important suggestions to improve the document's completeness and/or clarity;
- Value Added – comments that resulted in a significant impact or change that would not have happened without the IEPR review;
- Open Comments – issues that the IEPR panel and USACE PDT could not come to resolution about.

Table 4 provides a summary of the number of comments in each of the above categories.

Table 4. Categorized DrChecks Comments

Review	Total Comments	Initial Critical Comments	For Information	Suggestion for Clarification	Value Added	Open Comments
75%	74	4	28	21	25	0
100%	69	6	28	23	18	0

Following are summaries of the types of comments provided in DrChecks for each of the reviews and the resulting USACE evaluations (i.e., concurred and non-concurred).

75% Barge Impact Report Review

During review of the 75% version, the panel developed 74 comments. In general, the comments requested additional information, identified spelling or grammatical errors, or requested clarification of a specific topic.

The geotechnical engineer provided 26 of the 74 comments during the review. USACE initially concurred with 24 of the geotechnical comments, non-concurred with 1 comment, and provided a "For Information Only" response to 1 comment.

The following are examples of the types of comments that USACE concurred with:

- Add a member of the IEPR team that has a background in hydraulic modeling and numerical simulation.
- Identify the imposed consequences on the barge impact study of constraints identified in the report.
- Clarify whether Chapter 3 provisions are applicable to weather systems other than hurricanes (i.e., tropical storms).
- Explain the use of a shear strength of 800 psf for the embankment fill rather than the previously identified 400 psf noted in the review of the Design Guidelines document (June 2008 version).
- Explain, for clarity and completeness, why only the empty barge condition was considered.
- Explain why the design undrained shear strength line in Figure 5.5 lies above the c/p line (a line indicating the ratio of cohesion to effective overburden pressure) even though there are many data points that lie below the design shear strength line.
- Add a column in Figure 5.10 to the "Cohesion" section that shows the shear strength at the top of the stratum, which together with strength at the bottom of the stratum that is

included in the table, is more informative than providing the average value for the stratum.
- Add a source for the values provided in Tables 8.2, 8.3, and 8.4 as many of the standard penetration test values assigned to the cohesive strata look suspect based on the reviewer's New Orleans-area experience.

Of the 48 comments on the 75% version presented by the structural engineer, USACE initially concurred with 40 comments, non-concurred with 7 comments, and responded with "For Information Only" to 1 comment. The following are examples of comments that USACE concurred with:

- Explain why waves perpendicular to the floodwall were not simulated.
- Explain why a 90-degree (perpendicular) barge impact on a floodwall was not studied.
- Explain how a change in base elevation near the levee may affect the model results since it was not modeled in the experimental study.
- Include a figure showing the coordinate system for the CFD Control Volume and Boundary Conditions model, which includes the floodwall, still water level, barge, etc.
- Explain how the CFD results from the second control volume are affected by the fact that only the effects of wave and wind were simulated in the experimental study.
- Include a description of the Analytical Model, including the elements such as Piles, Soil, reinforcement steel, boundary conditions used, material properties, etc.

The USACE responded with "Non-concur" for seven of the comments provided by the structural engineer. These seven comments focused on the modeling conducted including the shape of the barge, the mass coefficient used for a broadside collision and bow/stern collision, the use of an empty barge when many fully loaded barges occur in the New Orleans area, the vessel mass, and the drag coefficient. In three instances, the panel member provided a response to the USACE's "Non-concurred" designation, and then closed the comment. In the other four instances, the panel member and USACE discussed the responses through DrChecks and/or on the teleconference before they were closed.

Responses to several of the comments stated that additional information would be included in the report. This was taken into consideration upon reviewing the 100% version. Comments made on the 100% version are provided below.

100% Barge Impact Report Review

The review of the 100% version resulted in 69 total comments from the panel. The comments ranged from small editorial changes to clarifications in terminology and data presented.

The geotechnical expert provided 40 comments on the main 100% version and appendices provided. USACE initially concurred with 7 of the geotechnical comments, and provided a "Check & Resolve" response for the remaining 33 comments. Sixteen comments focused on editorial updates needed in the report for overall enhancement of the report. These suggestions included minor spelling changes, rewording for consistency and clarity, resizing of figures for clarity, and notations to make the document easier to read. Twenty-four of the comments were

recommendations for clarification of the data discussions or suggestions for additional data to enhance the technical report. Examples of those recommendations are provided below:

- Expansion of the abstract or the use of an Executive Summary that provides a "roadmap" of the study and presents its key findings and recommendations is suggested to improve the readability of the document.
- Discussion about the rationale for considering only empty barges should be included in Chapter 7.
- Clarification of the discussion for limiting the pile capacity to a factor of safety of 1.1 is needed.
- Clarification of loads that are considered minimal for the GNOHSDRRS is needed.
- Addition of text to the discussion surrounding the location of the Hero Pump Station Project is recommended for clarity.
- Clarification between the text and Figure 5.8 is needed for the depth the pile tips are driven. The figure uses elevation while the text uses feet as the unit of measurement.
- Quantification of the sensitivity of the spring constant on pile loads and the forces in the concrete is needed.
- Clarification on the extrapolated spring constant data is needed for soils below EL-116.

The Structural Engineer provided 29 comments on the 100% version of the report. USACE initially concurred with 6 of the structural comments, and provided a "Check & Resolve" response for the remaining 23 comments. Twelve comments focused on editorial updates needed in the report for overall enhancement of the report. These suggestions included minor spelling changes, rewording for consistency and clarity, resizing of figures for clarity, and notations to make the document easier to read. Nineteen comments were recommendations for clarification of the data discussions or suggestions for additional data to enhance the technical report. Examples of those recommendations are provided below.

- Clarification of the discussion of the Static Pushover Analysis for floodwalls is needed; conflicting information is provided on whether it was linear or non-linear.
- Justification of the assumption that shear failures were assumed to occur at d/2 is needed, along with an update of the sketch to define "d."
- Addition of a yield line on Figure 5.18 indicating an impact at the center of the monolith is needed.
- Correction of section 5.4.1 is needed; the pile tip is listed at -75 ft, and it should be changed to Pile Tip elevation (-)75 ft.
- Clarification of the basis and rational for selection the Design Load Cases and Barge Impact Values for "Usual", "Unusual", and Extreme" load cases is needed.
- Inclusion of the minimum pressure requirements in Design Load Cases in Section 9.4.2 is recommended.
- Consideration of side-on impact condition in the Design Load Cases, based on the data provided, is recommended.
- Discussion is suggested regarding how each of the following were accounted for in the Finite Element Analysis:
    - Localized plastic deformation of the pile wall,

    - Elastic/Plastic bending of the member,
    - Elastic/Plastic elongation of the member,
    - Barge deformation and/or rotation.
- Clarification of the following points in the Dynamic FEA is needed:
    - The value of the Dynamic Magnification Factor for the barge impact load,
    - The natural period of the structures (flood walls, dolphins),
    - Duration of barge impact loading.

Overall Evaluation
The following sections provide conclusions drawn by each reviewer over the two reviews.

Geotechnical Engineering Overall Comments.
From a geotechnical perspective, project- and site-specific geotechnical studies should be conducted to properly define the site stratigraphy and measure the pertinent soil properties that are required for analyses. The laboratory testing program should include basic indicator tests to classify the soils, as well as to allow correlations to be made with other soil properties. It also should include strength and deformation testing. Although the numerical modeling and analytical results concerning pile loads and impact forces caused by barge impacts were found to be relatively insensitive to the soil properties, accurate characterization of the soil stratigraphy and measurement of the engineering properties of the soils should be used for design and analysis efforts.

Structural Engineering Overall Comments.
From a structural perspective, the results of the Barge Impact Study revealed that the values of "Barge Impact Loadings" used in the June 2008 version of the GNOHSDRRS Design Guidelines were not adequate and needed to be revised. The recommended values of the Barge Impact loads in the report for the "Usual," "Unusual," and "Extreme" design load cases are based on the Probabilistic Barge Impact Analysis. The Barge Impact Study showed that these values may vary by approximately 15% to 20%, which means that there is a certain degree of uncertainty in the recommended barge impact design load cases. In order to be conservative, these recommended design barge impact load values may be increased by 20%. When using the Barge Impact Study, the reviewer believes the user should carefully review Section 9.3 "Assumptions and Limitations" before determining applicability to a particular design situation. In addition, the structural engineer believes that further studies on the applicability of these findings to structures other than those addressed by the study (e.g., dolphins, PRO floodwalls and structures, and HPO floodwalls and structures) should be conducted to determine applicability to other GNOHSDRRS structures in the Greater New Orleans and vicinity. Lastly, the structural engineer believes that further study needs to occur on the impacts of fully-loaded barges and multiple barge impact loading.

4.3 Critical Comments and any other Open Issues that Remain to be Resolved

The IEPR teleconferences conducted throughout these reviews provided an effective voice medium to communicate and discuss peer review comments on the Barge Impact reports with the USACE PDT interactively and in real time. The teleconferences were critical components of the independent peer review process, especially since there was no e-mail or additional telephone contact between the USACE PDT and the IEPR panel members. As a result of the IEPR

teleconferences and resolution of issues included in DrChecks, there are no open comments from the two reviews.

5. CONCLUSIONS

The selection of the panel members using pre-defined technical and conflict of interest criteria, as well as the IEPR process itself, were conducted in strict compliance with USACE peer review guidance documents (described previously), and in the PRQCP.

The IEPR panel members were provided with hard and/or electronic copies of the 75% and 100% versions of the Barge Impact report and supporting documentation and conducted a separate review for each version. Across the two reviews, 143 comments were developed. The USACE PDT concurred with 77 comments; agreed to provide additional information in support of two comments; stated they needed to check and resolve issues raised on 56 comments; and non-concurred with eight comments. An explanation was provided with each comment assigned a "Non-concurred" status. Upon review of the USACE PDT responses, the IEPR panel members determined that some comments needed further discussion as the comments were inadequately addressed. Two IEPR teleconferences were conducted throughout the reviews for the IEPR panel and USACE PDT to discuss those comments that were either identified by the panel as being inadequately addressed or for which the USACE PDT needed further explanation (see Table 1).

Of the 143 comments, the IEPR panel identified 10 (7%) as critical comments, and the USACE classified 43 of the 143 comments (30%) as IEPR value-added remarks. Within the comments, the IEPR panel members recommended various additional details/clarifications be added to improve the design guidance and future use of the Barge Impact report. Below are those items noted by the panel as being most important:

- Aberrant barges can occur during hurricane and other weather-system events that can impact various types of GNOHSDRRS structures in the New Orleans area.
- The study only addressed (i) dolphins, (ii) PRO floodwalls and structures, and (iii) HPO floodwalls and structures; thus, the findings may not be applicable to other structures in the GNOHSDRRS.
- The previously designed and/or constructed GNOHSDRRS floodwalls and fronting structures should be evaluated in light of the results of this study, and if necessary, modifications should be made.
- Although the numerical modeling and analytical results concerning pile loads and impact forces caused by barge impacts were found to be relatively insensitive to the soil properties, accurate characterization of the soil stratigraphy and measurement of the engineering properties of the soils should be used for design and analysis efforts.
- New U.S. Coast Guard regulations concerning barge placement during hurricane and storm events should be implemented carefully so as not to move the risk from the lower, lesser-populated areas of New Orleans to the upper, more highly populated areas of the City.

The remaining comments focused on offering recommendations to clarify the Barge Impact report.

Two IEPR teleconferences were conducted throughout the two reviews for the IEPR panel and USACE PDT to discuss those comments that were either identified by the panel as being inadequately addressed or for which the USACE PDT needed further explanation. Upon completion of the IEPR teleconferences and subsequent evaluations by the USACE PDT, the IEPR panel members considered the comments adequately addressed and closed all of the comments. In general, the IEPR panel members agreed that the physical and numerical modeling results developed for and provided in this document have resulted in barge impact values that are based on actual analytical data, and that are greater and more realistic than what now exists in the GNOHSDRRS Design Guidelines (June 2008). However, the panel members' noted that the barge impact values are subject to the following limitations:

- The study was based only on a single empty aberrant barge and barge impact values for a fully-loaded barge have yet to be developed.
- The results are based on a single one-time impact when the possibility of multiple barge impacts during a slow-moving or a stalled hurricane exists.
- The study addressed and focused only on PRO floodwalls and structures, HPO floodwalls and structures, and dolphin structures.

APPENDIX A

IEPR Panel Member Resumes

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Jay Jani, Ph.D., P.E
Structural Engineer

Experience
25+ years

Expertise
Structural design
Structural integrity assessment

Education
Ph. D., Ocean Engineering (Major: Structural Engineering) Florida Atlantic University, Boca Raton, 1990
M.S., Civil Engineering (Major: Structural Engineering) Carnegie-Mellon University, Pittsburgh, 1984
B.E., Civil Engineering (Major: Structural Engineering) University of Bombay, Bombay, India,1982

Registration
Professional Engineer, Louisiana, 1997
Engineer-In-Training, Pennsylvania, 1983

Special Skills
Extensive software experience:
(i) *ALGOR, COSMOS, MARC, ADINA* - Finite Element Analysis (FEA) Packages
(ii) *RISA-3D* - Interactive 3-D Structural Analysis Software Package
(iii) *MicroSAS, and PIPELAY* - McDermott's in-house Software programs for Structural Design & Analysis of Offshore Structures, and analysis related to Marine Pipe-Laying respectively
(iv) *MOSES* – Naval Architectural/ Ocean Engineering Analysis Package
(v) *AutoPipe* – Pipeline Stress Analysis Package
(vi) *AGA I & II* - Submarine Pipeline On-Bottom Stability Analysis Software Package
(vii) *Caesar II* - Pipeline Stress Analysis Package
(viii) *MathCad*

Professional Affiliations
ASCE, member
ACI, Louisiana Chapter
ASCE-SEI, New Orleans Chapter, Chairman, 2008-2009
Vice Chairman, 2007-2008

Summary of Experience

Dr. Jani is president and senior structural engineer, Engineering Consulting Services, Inc., in Metairie, Louisiana. He has extensive experience in structural design for the civil and marine/offshore engineering industries.

Relevant Projects

- Independent Technical Review (ITR) for USACE's Hurricane Protection Project: Structural Design of T-Walls, 56 feet Sector Gate, Pile Foundation, etc. (9% Submittal), "WBV 16.2 Segnette Pumping Station to New Westwego Pumping Station Flood Wall," N-Y Associates, New Orleans, LA.
- Independent Technical Review for USACE's Hurricane Protection Project: Structural Design of T-Walls, Pile Foundation, etc. (100% Submittal), "Fronting Protection at Cousins, Whitney Barataria and Estelle 1 & 2 Pumping Stations," N-Y Associates, New Orleans.
- Independent Technical Design Review for USACE's Hurricane Protection Project: "Reconnaissance Level Study for three (3) Hurricane Protection Alignments Western Tie-in," Jefferson and St. Charles Parishes, Lake Cataouatche Hurricane Protection Levee, N-Y Associates, New Orleans.
- Independent Technical Design Review for USACE's Project: Structural Design of "Inner Harbor Navigational Canal Replacement Lock, Riverside Gatebay Module," Brown Cunningham and Gannuch, Inc., New Orleans.
- Independent Technical Design Review for USACE's Project: Structural Design of "Harvey Canal Flood Walls," URS Corporation, New Orleans.
- International Matex, "Six-Oil" Project: Structural Design of Pipe Bridge (112 feet long), Pipe Racks, Electrical Platform, Reinforced Concrete Pump-Pit Foundation Slab and Containment Wall, Walkway, Pipe Supports, etc., W. S. Nelson and Co., New Orleans.
- Structural design of reinforced concrete pile-foundation of about 56,000 sq. ft. for a proposed new church to be located at Marrero, LA.
- Structural rehabilitation of a floor slab and the foundation for a commercial building by: (i) designing new reinforced concrete foundation slab and grade beams and, (ii) foundation Under-Pinning using concrete Segmented Piles, New Orleans.
- Structural design for reinforced concrete slab with or without pile foundation for: various carwash structures, vacuum canopy structure, etc., New Orleans.
- Structural design of a reinforced concrete foundation for an 8000 gallon insulated double-wall fuel storage tank, New Orleans.
- Structural design of weather station equipment support structure at various canals in New Orleans, Sutron Corporation, Sterling, VA.
- Residential structural assessment of more than 225 houses, to determine the extent of structural damage caused by hurricane-Katrina to the houses in New Orleans, a FEMA/Shaw Project, New Orleans.
- Structural integrity assessment of various shutters, doors, framings, etc., for various wharf structures in Port of New Orleans, to determine the

Adjunct faculty, Dept. of Civil Engineering at University of New Orleans

extent of structural damage caused by hurricane-Katrina, Port of New Orleans, Hurricane Reconstruction Program, PB Americas, New Orleans.

- Structural design of a proposed new casino building, and a food court building to be constructed in Baton Rouge, Louisiana, using PolySteel Form, Insulated Concrete Building System. Also designed roof system for both the structures using Vulcraft Steel Joists.
- Structural integrity assessment of all phases of offshore platform design for various projects including in-place analysis, transportation analysis, installation engineering (lift analysis, lift rigging design, etc.), pile foundation design, earthquake analysis of offshore platforms, etc., J.Ray, McDermott, Inc., New Orleans.
- Analysis and structural integrity assessment of Shell's Na Kika hull pipe support design based on PDMS model. Consultant to Deepwater Consultant Alliance (DCA), New Orleans.
- Design and analysis of A&R and SCR hooks for several deepwater pipeline installation projects, using J. Ray McDermott's J-Lay System. The pipeline hook design included a 775 Kips capacity A&R hook for one of Shell's subsea pipeline projects. Also performed a finite element analysis for 775 Kips hook, using 'COSMOS' FEA software to study the stress distribution in the hook in a more comprehensive manner.
- Reassessment of PEMEX's Bay of Campeche platforms and subsea pipelines. Responsibilities involved evaluation of structural integrity of potentially unstable marine pipelines subjected to a 100-year storm condition. The analysis included: (i) assessment of on-bottom stability of the pipelines subjected to a 100-year storm condition; (ii) determination of hydrodynamic loads; (iii) determination of the soil friction and passive resistance; (iv) estimation of maximum lateral movement and bending stress in the pipelines caused by a 100 year storm condition. Also performed a 1000-year return period earthquake analysis for the ductility assessment of Pemex's CA-AC-1 platform.
- Worked on all phases of structural design engineering in the field of offshore marine construction including: (i) analyses of offshore oil/gas pipelines; (ii) earthquake analysis of offshore platforms; (iii) installation engineering, including jacket/deck tow-safety analysis, jacket and deck lift analyses, hook evaluations, jacket/deck/pile tie-down design, jacket on-bottom stability analysis, barge structural integrity assessment, etc.
- Worked on all phases of naval architecture and structural design engineering in the field of offshore marine construction including mating of the deck-hull of Shell's "Auger" Tension-Leg-Platform (TLP), analyses off lateral mooring system for TLP-hull, deck transportation analyses, and miscellaneous installation procedures for "Auger" TLP installed in a water depth of 2,860 ft. in the Gulf of Mexico.

David E. Lourie, P.E., D.GE.
Geotechnical Engineer

Experience
30 years

Expertise
South Louisiana soil conditions, local area geology, geotechnical design and construction

Education
M.S., Civil Engineering, Illinois Institute of Technology, Chicago, 1981
B.S., Civil Engineering, Illinois Institute of Technology, Chicago, 1979

Registration
Professional Engineer, Louisiana, Civil Engineering, 1984
Environmental Engineering, 1994
Water Well Drillers, Louisiana, 1987
Diplomate, Geotechnical Engineering, 2010

Professional Affiliations
Louisiana Engineering Society (former Lake Charles Branch President)
National Society of Professional Engineers
American Society of Civil Engineers (former New Orleans Branch President and Chairman of the Geotechnical Activities Group)
Geo-Institute
American Council of Engineering Companies (former New Orleans Chapter President)
ASFE (immediate past President)
Chi Epsilon

Publications
Authored and co-authored numerous technical papers and presentations on coal mine waste material disposal, use of electric cone penetrometers, building large tanks on very weak soils, soil sampling, expansive clays, Brownfield site development, professional liability, professional ethics, and alternate covers and liners for waste disposal facilities.

Summary of Experience
Mr. Lourie is founder and CEO of Lourie Consultants, Metairie, Louisiana, a consulting engineering firm that has been providing geotechnical and geoenvironmental consulting and engineering services to clients in the commercial, governmental, and industrial business sectors since 1992.

He has served as a liaison to the Peer Review Committee of ASFE/The Geoprofessional Business Association and is ASFE's immediate past president. He has been an adjunct professor at Tulane University, a visiting professor at McNeese State University, and a guest lecturer at Louisiana State University and the University of New Orleans.

Relevant Projects
- Worked 11 years for Fugro-McClelland (Southeast), Inc. (formerly McClelland Engineers) in Louisiana and Texas. Between 1983 and 1992, served as president of FMSE, and gained broad experience in the financial and technical operations of the firm's geotechnical, environmental, and construction materials engineering and testing practice in Louisiana.
- Served as the primary engineer on hundreds of studies for many types of projects, dealing with commercial buildings, industrial facilities, offshore and near-shore structures, roads, bridges, railroads, groundwater studies, landfills, site assessments, and pipelines.
- Formulated and conducted forensic investigations and engineering studies to assess failure causes and identify remedial measures for sheet pile walls, earth slopes and levees, foundations, and pavement systems.
- Worked on the field, laboratory, and engineering aspects of many types of projects throughout Texas, in the Gulf of Mexico, and in the Arabian Gulf. Worked on roadways, bridges, major transportation projects (rail and highways), industrial facilities, schools, hospitals, landfills, etc. Frequently planned, supervised, and participated in site investigation programs and developed laboratory testing programs to determine relevant soil properties for design and construction.
- Conducted detailed geotechnical engineering analyses, including those to compute axial and lateral pile capacity, assess the bearing capacity of foundation soils, predict settlements of shallow and deep foundation systems, evaluate the stability of earth slopes, compute lateral earth pressures for permanent and temporary retaining structures, identify constructability issues, develop performance monitoring programs, and interpret the results from various types of field tests.

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