CEMVN-ED-E 27 March 2011

MEMORANDUM FOR: Commander, Mississippi Valley Division

SUBJECT: Independent External Peer Review of the Phase IV Report – Spiral Welded Pipe Piles For Coastal Structures.

1. Reference the Final Independent External Peer Review (IEPR) Report, March 26, 2010 and NAD subject memo dated March 26, 2010, transferring the disposition of the IEPR to the New Orleans District (MVN) through the Mississippi Valley Technical Office, CEMVD-RB.

2. The IEPR of Phase IV – Spiral Welded Pipe Piles For Coastal Structures Report (March 2010), was conducted from July 2009 through January 2010. The independent team consisted of two (2) Panel Members from two (2) major engineering disciplines; geotechnical and structural. The IEPR effort included an Orientation Briefing, IEPR Conference, and Teleconference.

3. A total of 145 comments were submitted by the IEPR Team. The USACE PDT evaluated each comment and provided a response that included specific revisions that will be made to the SWP Report, as appropriate. This allowed the reviewers to see how the final report will be revised to incorporate their comments.

4. The following comments from the IEPR Report by the reviewers are furnished to highlight what they consider the most important items to be addressed. . Comments from the report are reproduced here in *italics* followed by the USACE response.

   a. *Clarify the historic use of SWP piles by USACE and provide additional information to support the application of the study's findings.*

      There will be a separate section in the final Phase IV – Spiral Welded Pipe Piles For Coastal Structures Report addressing the historic use of SWP by USACE.

   b. *Clarify pile performance in regards to D/t ratio and its importance to weld performance.*

      The following will be incorporated into the final report *Phase IV Report - Spiral Weld Pipe For Coastal Structures*, as clarification of pile performance with respect to pipe diameter to wall thickness ratio.

      SWP piles are thin wall cylindrical shells (TWCS), and experimental data show that the reserve post buckling strength of such shells is negligible in comparison to that of other structural members. We performed Four Point Flexural Tests (FPFT) at North Carolina State University (NCSU) on five SWP (with D/t = 36, 36, 48, 48 and 55) and three straight seam pipe (SSP) (with D/t = 40, 48 and 48) piles. The SWP with a D/T of 55 performed very weel during the stress tests. However to extrapalate to a higher D/t based on one pipe test is not prudent. As a result We have limited SWP to a maximum D/t of 55. It is extremely important to avoid local buckling inorder to maintain weld integrity along the SWP. Therefore we have

chosen a conservative approach to the use of SWP and will perform future testing of SWP with D/t ratios >55.

Most of the SWP piles used in HSDRRS Risk Reduction area will be fully supported beam-columns that are subjected to combined axial and bending stresses near the pile head. Often the axial loads will contribute 50% to the total combined stresses, and the designers will need a fuller understanding of how local shell buckling controls the behavior of an SWP pile if the D/t ratio exceeds 55.

c. *Clarify existing concerns regarding the weld beads and their possible influence on axial pile capacity.*

This subject will be addressed in an Appendix to the *Phase IV Report - Spiral Weld Pipe For Coastal Structures*.

d. *Provide the locations of the Valero Refinery and the Berth 2 Upgrade projects to aid the reader in understanding the overall area where these tests were conducted.*

Both of these projects are in Paulsboro NJ along the Delaware River. Many piles were battered. Approximately one hundred 30-inch diameter piles, each 157 feet long, were batter piles driven at the Berth 2 Upgrade project by Weeks Marine. Contractors did not have any problems with the SWP piles in any of these cases. During the Valero Project less than 1% SWP piles of the piles had to be pulled. Not due to failure but because they had encountered obstructions. In all cases the tips of the SWP piles had some damage but the welds were in perfect condition with no cracking.

e. *Summarize in one section, rather than throughout the document, the load test programs used and dynamic pile monitoring using a PDA and the CAPWAP process.*

Section 6.5.1 of the *Spiral Weld Pipe Piles For Coastal Structures Report* will be edited to list the test programs used for the study and provide a description of each program.

f. *Specify the locations where PDA and CAPWAP analyses were not preformed.*

Suburban and Elmwood Canal Pump Stations, Metairie, LA, Jefferson Parish

g. *Clarify the interpretation of the overburden influences on the embedded portion of the pile below El-26.*

Pertaining to the design of the project, it is not the intent of this committee to Evaluate the pile load tests for design purposes. The committee is only interested in the effects of the weld bead pertaining to the skin friction component along the pile (i.e. comparison between SSP and SWP). Therefore since the removal of overburden within the casing is the same for both pile types (SSP and SWP) no further analysis is required and the conclusions are not affected.

Appropriate language will be added to the report.

h. *Clarify discussion of the vibratory hammer on porewater pressure to not unduly target vibratory hammers.*

This statement will be removed from the report and references to vibratory hammers will be made only in context to their use in the study test sites.

i. *Update the conclusion section to reflect discussions on rate of strength of gain in the first 10 days.*

Section 10 of the *Spiral Weld Pipe Piles For Coastal Structures Report* will updated with a discussion of strength gain in the first 10 days after driving.

j. *Modify the driving resistance description to describe driving penetration.*

Section 10.2.2 of the *Spiral Weld Pipe Piles For Coastal Structures Report* addresses this discussion.

k. *Review and confirm that a restrike test should be conducted a minimum of 14 days following completion of the static load test.*

Section 10.2.5 of the *Spiral Weld Pipe Piles For Coastal Structures Report* specifies re-strike 14 days following static load testing (initial driving of the pile).

l. *Clarify that the current pile driving and load test discussion focuses on piles that are plugged or have end plates installed rather than open-ended pipe piles that are coring.*

We did not use plugs or end-plates for this testing. All piles were open-ended.

m. *Clarify that piles will penetrate multiple strata that will contribute to the skin friction component of pile capacity, rather than just one stratum.*

Section 6, §6.2 will be edited to explain multiple strata and how they contribute to the overall friction component of the pile holding capacity.

n. *Summarize the load test programs to provide a roadmap for the reader.*

Section 10.2.5 of the *Spiral Weld Pipe Piles For Coastal Structures Report* will be edited to summarize the load test programs.

o. *Describe operational and interpretive methods in respect to PDA and axial pile load tests in one location in the report then reference throughout the document.*

The referenced information will be incorporated as part of Appendix C beginning on page 185 of the SWP Final Report.

p. *Clarification is needed regarding the discussions of soils in Section 6.8.3 as conflicting data is presented.*

This section will be re-written as small sections and sentences for more clarity to the reader.

q. *Discussion regarding shear strength of the clays should be updated to note that strength varies by*

Section 6.9.3 of the report will be edited and a discussion of the clays shear strengths will be incorporated.

r. *Explanation is needed on the ground surface elevation value or range in values at the test sites along with a greater explanation of the fill to EL -15.*

The following will be added to the final *Phase IV, Spiral Welded Pipe Piles For Coastal Structures* report.

"The upper layer is classified as a fill material. These materials represent those not found naturally within the depositional environment at the specific site. Although the history of why and how the fill materials were deposited is unknown, these materials are not part of the natural sequence of the expected environments. Uncharacteristic moisture and strength values help to identify these fill areas and there is commonly a sharp contrast in sediment character and engineering properties between the fill and underlying natural deposits. The fill material consists of somewhat heterogeneous regions of silt with clay and sand layers, clay with sand and silt layers, and silty sand with clay layers. Because silt appears to be the dominant material in the samples, with most clay and sand samples containing silt layers or lenses, this material was grouped into single low plasticity silt (ML) from an average ground surface elevation of -2.5 feet to elevation –15."

s. *Discussion regarding the relative density of SM stratum based on standard penetration test (SPT) and/or CPT data for the granular strata should be included to be consistent with information provided for cohesive strata.*

The data for percent passing 200 sieve is not available. However the relative density will be addressed in the final *Phase IV, Spiral Welded Pipe Piles For Coastal Structures* report.

t. *Discussions around the swap layer at EL -98 should be reviewed and updated along with the consistency description of the Pleistocene clay layer (should be medium to stiff not medium).*

Descriptions of the swamp and Pleistocene layers will be updated in the final *Phase IV, Spiral Welded Pipe Piles For Coastal Structures* report, along with a discussion of this topic to provide more detail in this section.

u. *Clarify in the report the IPQA determination of weld defects.*

The manufacturing IPQA uses UT NDT in line. This does not actually detect the defect, but simply points out anomalies. The defects are detected when the pipe is offline and a UT NDT is performed by hand, This will determine if there is a defect or not. If a weld defect is discovered the weld will be repaired or the pipe will be marked defective. Repairs shall be accomplished in accordance with AWS D1.1.

v. *Include the actual values of "Load," "P and Bending Moment," and "M at various stages" of the tests including when the failure occurred.*

The suggested tables will be added to the 100% report as part of the NC State four point load test that are provided in Appendix D. We believe this level of detail belongs in the appendix.

w. *Include the missing data noted throughout the report.*

1) Second paragraph, last sentence will be added for clarity with respect to the results of the study and it's applications.
2) Supplier and Material Assessment information will be furnished and incorporated into the final report.
3) Page 100, first line in the SWP Final Report there is missing text. This issue will be corrected.
4) The After Action Review (AAR) for the Olmstead Damn Project will be provided and incorporated as Appendix B of the final report.

x. *Include the findings of the FEA study with regards to the effect of the lack of root pass penetration (LOP) on the stress concentration, associated crack initiation and propagation in the spiral weld joints.*

A paragraph describing the findings of the FEA study will be added, and Figures 8.12, 8.13 and 8.14 will be enlarged to more clearly display the results.

5. **Conclusion.** The IEPR of the Spiral Welded Pipe Study was conducted as required, and in accordance with, all applicable laws and USACE regulations. The reviewers of this study were instrumental in providing another structural pile option for CEMVN that will allow for substantial savings over traditional pipe piles and H-Piles. At all stages of the review the peer reviewers demonstrated their command of the topics and their desire to contribute meaningfully to improvements to Corps specifications for structural piles in South Louisiana that will result in greater stability and longevity of structures. They are all to be commended and thanked for their service. The final document *Spiral Welded Pipe Piles For Coastal Structures* was published in February 2010 and has been utilized by USACE New Orleans and A-E Firms.

This memo closes out the action on the Independent External Peer Review Process.

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Chief, Engineering Division

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