Engineering Circular
Engineering Reliability Guidance for Existing USACE Civil Works Infrastructure

David M. Schaaf, P.E.
LRD Regional Technical Specialist, Navigation Engineering
Louisville District

New Engineering Reliability Guidance

General Background

- Updating engineering reliability guidance sorely needed
- Currently, there is no structural reliability guidance since previous documents have been rescinded
- Existing reliability guidance for geotechnical discipline
  - Provides a good overview of geotechnical reliability issues
  - However, utilizes Beta-method not applicable for time dependent problems
  - Time dependent analysis, variable distribution, variable correlation issues
- Existing reliability guidance for mechanical/electrical disciplines
  - Also uses Beta methods which make time dependency an issue
  - Currently calls for establishing failure rates for navigation-related mech/elec components from performance of non-navigation uses
  - ORMSS analysis required very careful interpretation and calibration
- No systematic guidance that addresses development of other critical pieces of analysis such as event trees and integration with economic modeling for the purposes of decision-making

New Engineering Reliability Guidance

General Information

Lack of Guidance Causes Problems for Districts and Projects

- Use of Beta methods for time dependent structural problems
- Some major rehab studies with very limited, inadequate reliability analysis

HQUSACE Requested Team from ORMSS to Lead an Effort to Develop New Engineering Reliability Guidance to Cover All Existing Civil Works Infrastructure

Intent is for New EC to Replace All Existing Guidance and Be Used for USACE Studies Requiring Probabilistic Analysis for Investment Decisions

Major Rehab Guidance will Reference this Document as the Source for Completing Reliability Analyses

New Engineering Reliability Guidance

General Information

- Three Year Plan to Develop Infrastructure Reliability Guidance Engineering Circular (EC)
  - Initial funds received in FY04 to establish team, set general schedule, outline
  - Guidance will cover all major engineering disciplines (structural, geotechnical, mechanical, electrical, as well as basic economic aspects)
  - Integration with economics and plan formulation also included
- Technical Team Led By the Louisville District (Lead District on ORMSS Reliability Analysis Efforts)
- New Guidance Needs to be Incorporated in Major Rehab Evaluation Guidance with Respect to Engineering Requirements as well as Other Uses (Systems Studies, Evaluation of Existing Deteriorated Structures)

New Engineering Reliability Guidance

Historical Perspective

Prior Year Efforts on Related Issues Led to Development of Rough Outlines and Formulating Budget and Schedule for New Guidance Document

New Guidance Document Effort was Initiated in FY04 After Majority of FY Funds Loaded (March 2004)

April 2004 "Kick-Off" Meeting Held in DC Area to Include Field Discipline Personnel as well as Corresponding HQ Discipline Personnel

Briefed Group on Need for Updated R&R Guidance, Proposed Outline of Main Volume and Technical Appendices

Outlines for Major Sections by End of FY04 and Start Narratives

Lesson Learned from April 2004 Meeting – Keep Group Small and Focused

- ✓ Keep Development Team Small and Focused
- ✓ Budget Restraints
- ✓ Reasonable Expectations

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April 2004 Meeting Taskers

Outlines for Major Sections by End of FY04 and Start Narratives

Need More Emphasis on Non-Navigation Related Mechanical/Electrical and Coastal/Port Structures

Integrate On-Going Dam Safety Initiatives into the Document

Address Other USACE Initiatives Related to this Effort

- Navigation R&D Program
- General Miter Gate Analysis Model Development for Fatigue and Fracture on Parallel Path
- On-Going Economic Modeling Efforts at IWR

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March 2005 Progress Review Meeting w/ HQ

FY05 Funds Received in February Limiting Much Progress During First ½ of FY

Progress Review Meeting with HQ in March 2005

Refined Outline as Per April 2004 Meeting Used as Guide

Major Portions of Following Main Volume Completed:

- Chapter 1 – Introduction and Background
- Chapter 3 – Engineering Reliability Guidelines
- Chapter 5 – Engineering and Economic Integration

Refocus Document to be More Business Line/Project Oriented

- Previous version from FY04 was separated by discipline

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Major Changes Out of March 2005 Meeting

Personnel at Meeting Approved Idea with Following Taskers from that Meeting

- Create New Technical Appendices on Project/Business Line Basis
- Determine Appropriate POC's to Lead These Appendices
- Revise Main Volume Outline to Pull in General Discussions Regarding Reliability Analysis for Select Disciplines

New Technical Appendices and Technical Leads

- Navigation Appendix (David Schaaf, Louisville)
- Flood Protection Appendix (Robert Patev, New England)
- Hydropower Appendix – (Steve Loney, HDC Portland)
- Coastal and Port Structures – (Dr. Jeff Melby, ERDC-WES)

Technical Appendices to Contain Practical Examples/Case Studies

Refine Main Volume Sections to Includes General Discipline Guidance

Current Schedule Calls for Document Ready for Field Use by 30 Sep 06 Pending Available Funding

New Engineering Reliability Guidance

Current Status of Document

Outline for Main Volume

1. Introduction & Background (purpose, history, on-going initiatives)
2. Engineering Reliability Guidelines (load cases, criteria analysis)
3. Methodologies for Reliability Analysis (available methods, model set-up)
4. Expert Elicitation Methodology (general overview, when to use)
5. Systems Reliability Applications (component redundancy, parallel, series)
6. Engineering & Economic Integration (event trees, base condition)
7. Risk & Reliability for USACE Studies (major rehab, systems studies)
8. Integration with USACE Dam Safety Program (portfolio risk analysis)
9. Risk and Reliability Issues for Navigation Locks & Dams
10. Risk and Reliability Issues for Flood Control Projects
11. Risk and Reliability Issues for Hydropower Projects
12. Risk and Reliability Issues for Coastal/Port Structures
13. Guidelines for Report Writing
14. References

New Engineering Reliability Guidance

Current Status of Document

Outline for Navigation Lock and Dam Appendix

1. Land Lock Wall Stability Reliability Analysis Example (ORMSS)
2. Approach Wall Stability Reliability Analysis Example (ORMSS)
3. Simplified Hydraulic Steel Structure Reliability Example (GLSLS)
4. HF Miter Gate Reliability Analysis Example (Markland Major Rehab)
5. Mass Concrete Deterioration Reliability Example (Chickamauga)
6. Concrete Stilling Basin Scour Example (J.T. Myers Major Rehab)
7. Miter Gate Machinery Reliability Analysis Example (ORMSS)
8. Lock Electrical Systems Reliability Analysis Example (ORMSS)

Appendix Examples Have Complete Process of Model Development Including:

Selection of Modeling Features (Random Variables, Constants, Etc…)
Development of Applicable Limit State
Reliability Model Output and Interpretation
Development of Consequence Event Tree
Economic Analysis
Summary of Results

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Current Status of Document

Outline for Flood Control Appendix

1. Embankments and Levee Examples
    a. Hodges Village Dam Major Rehab Study
    b. Wolf Creek Dam Major Rehab Study
2. Outlet Works for Flood Control Projects
    a. Corrosion/Fatigue of Gates
    b. Performance of Conduits
3. Concrete Structures for Flood Control Projects
    a. Erosion of Spillways
    b. Alkali Aggregate Reaction
4. M/E Equipment for Flood Control Projects
    a. Reliability Block Diagrams (Wolf Creek)
    b. Fault Tree Analysis (Wolf Creek)