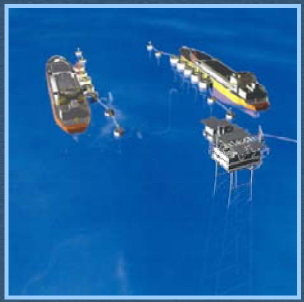

LNG TERMINAL ENGINEERING AND MAINTENANCE STANDARDS (LNGTEMS)

Presented by:

Gayle Johnson

Oakland, Ca
October 19, 2010

Presentation Preview

- Project Background
- Project Description
- Final Product

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Project Background

- Numerous projects proposed in California
- Lempert-Keene-Seastrand Oil Spill Prevention Act gives CSLC jurisdiction
- Project Commencement – 2006
- Schedule spread over 3 years due to funding
- Halcrow – Prime
  - Aker Kvaerner (LNG systems)
  - Energo Engineering (fixed platforms)
  - Granherne Engineering (deep water mooring)
  - Steve Dickenson (geotechnical)

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Project Scope

- 4 Configurations

- Conventional Pier/Wharf

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Project Scope

- 4 Configurations

- Conventional Pier/Wharf
- Deep Water Port (Cabrillo Port)

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Project Scope

- <u>4 Configurations</u>

- Conventional Pier/Wharf
- Deep Water Port
- LNG Vessel Adjacent to Existing Platform (Clearwater Port / Grace)

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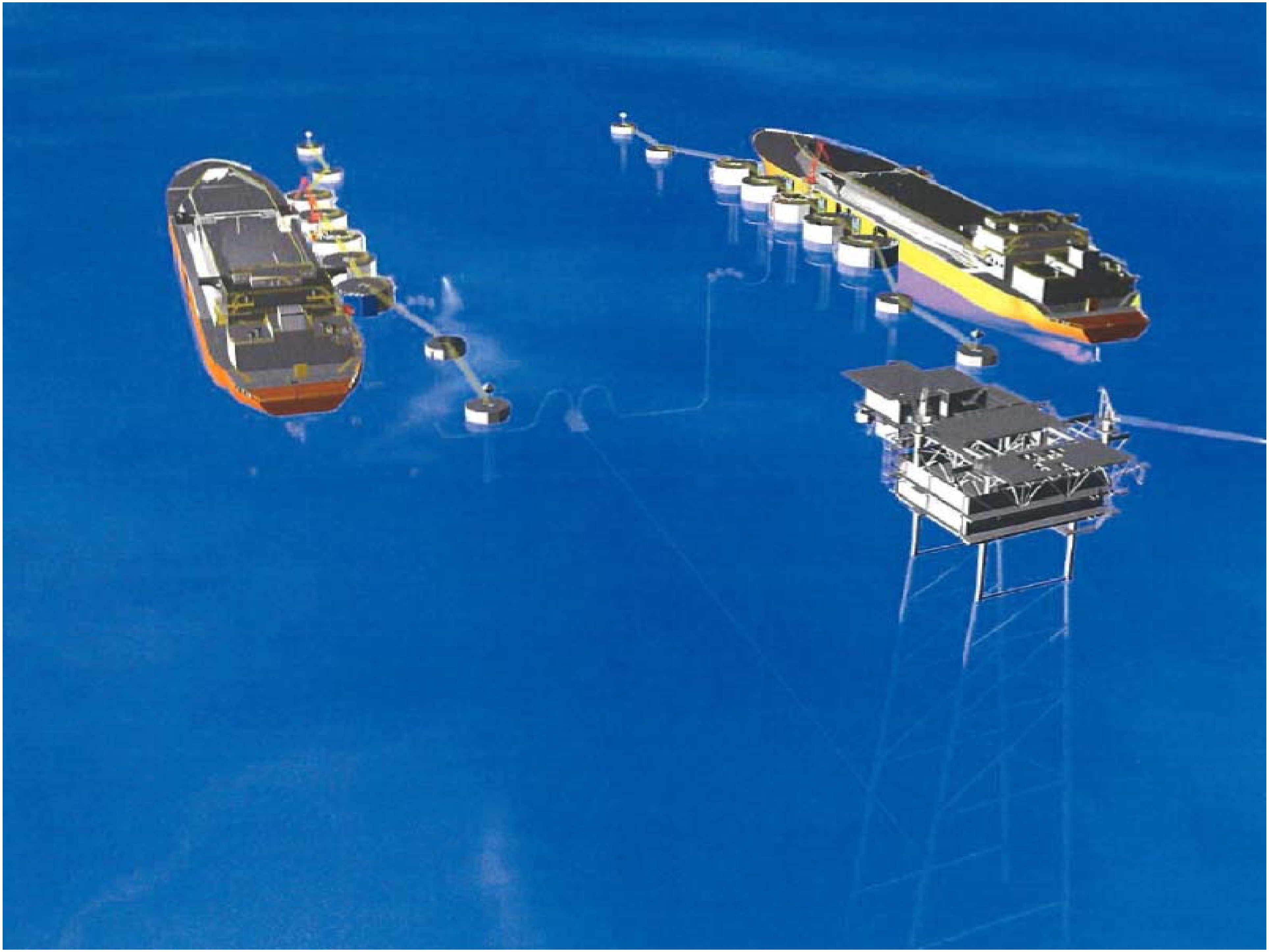

Project Scope

- 4 Configurations

- Conventional Pier/Wharf
- Deep Water Port
- LNG Vessel Adjacent to Existing Platform
- Gravity Based Structure (GBS)

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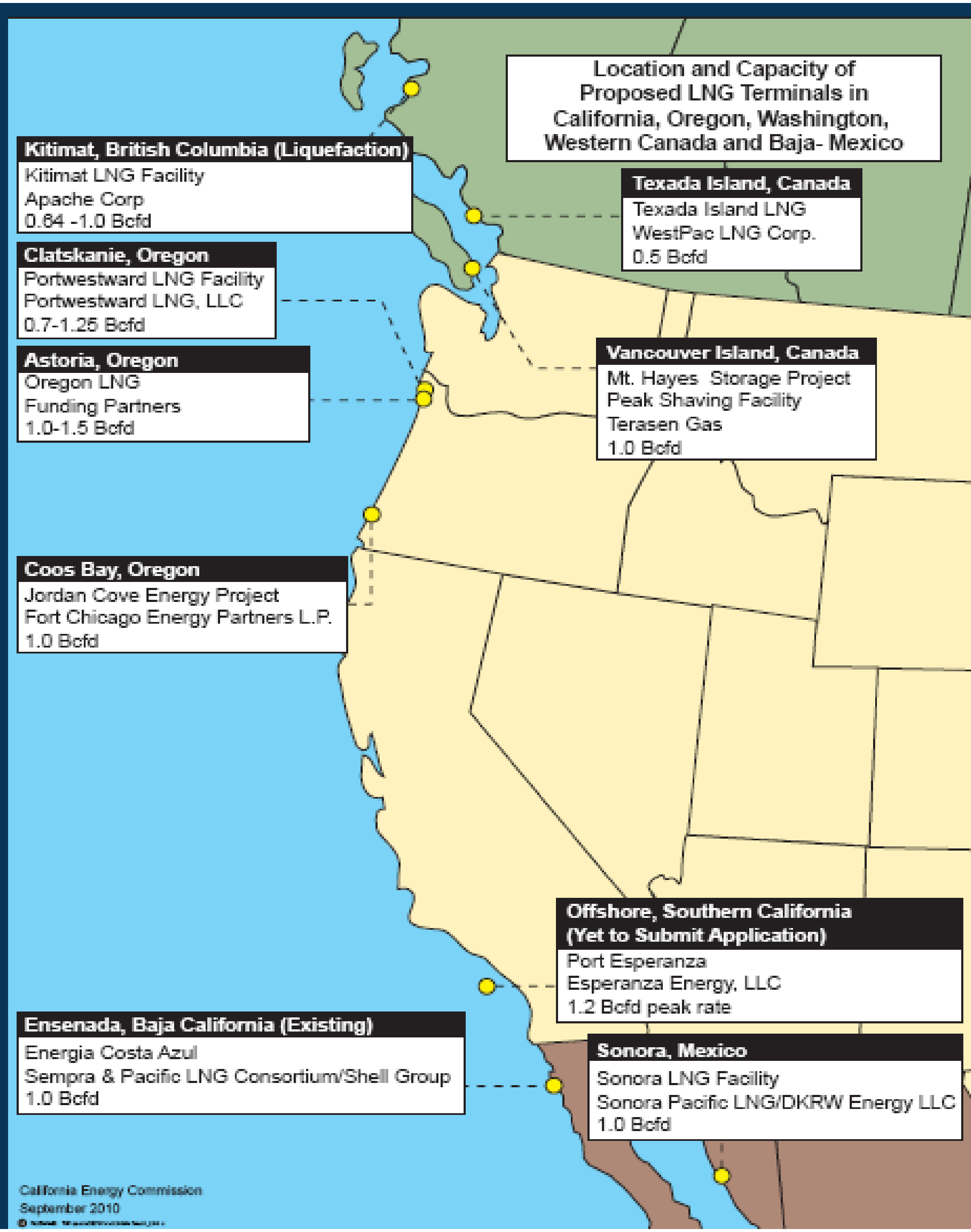
Adriatic LNG – Offshore Italy

California State Lands Commission Prevention First 2010



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Not Covered

- Vessels
  - FSRUs
  - LNG Tank Vessels
  - Tugs
- Siting

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Topics

- Similar to MOTEMS
  - Structural Loading, Analysis, Performance
  - Mooring and Berthing
  - Geotechnical Hazards
  - Component Structural Analysis and Design
  - Fire Prevention, Detection, Suppression
  - Piping and Pipelines
  - Mechanical / Electrical
  - Audits and Inspections
- Focus on LNG Specific Design Issues
- Extra Emphasis on Hazards and Risk Analyses

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Project Status

- Draft Document Completed June 2009
- Industry Workshop Held In Houston
- Project Completed June 2010

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Challenges

- Varying Levels of CSLC Jurisdiction

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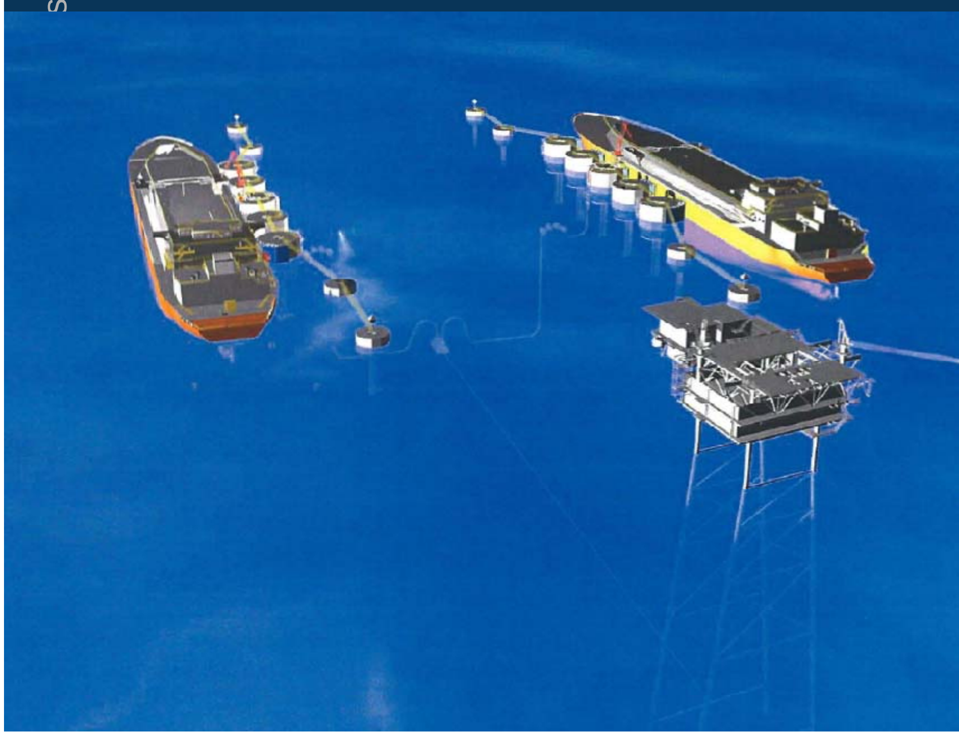

Challenges

- Varying Levels of CSLC Jurisdiction
- Nearshore vs. Offshore Design

Challenges

- Varying Levels of CSLC Jurisdiction
- Nearshore vs. Offshore Design
- Seismic Design Standards

Challenges

- Varying Levels of CSLC Jurisdiction
- Nearshore vs. Offshore Design
- Seismic Design Standards
  - ISO vs. API
  - Some Europeans pushing for 10,000 year RP

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Challenges

- Varying Levels of CSLC Jurisdiction
- Nearshore vs. Offshore Design
- Seismic Design Standards
- New Technologies

Challenges

- Varying Levels of CSLC Jurisdiction
- Nearshore vs. Offshore Design
- Seismic Design Standards
- New Technologies
- Risk Perception

LNG Risk

- Perceived by many to be comparable to nuclear power plants

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LNG Risk

- Perceived by many to be comparable to nuclear power plants
- Attempting to capture “best practice”
- Need to accept that we can’t eliminate risk completely

Contents

- Chapter 1 – Intro
- Chapter 2 – Risk Assessment
  – Methods of Sandia study of spill over water
  – API RP 75
  – API RP 14J
  – Safety critical elements, hazard identification, consquence analysis, risk register

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Contents

- Chapter 3 – Structural Design – Onshore
  - Same as MOTEMS
  - Different return periods for seismic
- Chapter 4 – Structural Design - Platforms
  - API RP 2A for structure
  - 475 / 2475 year RP earthquakes
  - API RP 2FB for Fire and Blast loading
  - Fatigue, minimum deck elevations, steel embrittlement from LNG spill

Contents

- Chapter 5 – Structural Design – GBS
  - ISO Codes
  - Concrete design per Norwegian Standards, British Standards, or DNV.
  - ACI not as commonly used for offshore GBS
- Chapter 6 – Geotechnical
  - Site specific seismic hazards analysis
  - Dynamic soil response, liquefaction, slope stability

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Contents

- Chapter 7 – Mooring and Berthing
  - Onshore uses MOTEMS
  - Floating uses API RP 2SK and OCIMF Single Point Mooring Guides

- Chapter 8 – Geotechnical
  - Facility layout
  - Emergency shutdown and response
  - LNG spill containment
  - Fire and gas detection
  - Fixed and passive fire protection

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Contents

- Chapter 9 – Pipelines
  – Cryogenic risers and subsea pipelines
- Chapter 10 – Mechanical systems
  – focus on LNG specific equipment and systems
- Chapter 11 – Electrical and Instrumentation
  – Includes seismic instrumentation
- Chapter 12 – Inspection
  – Uses API RP 2SIM (Structural integrity management)

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