

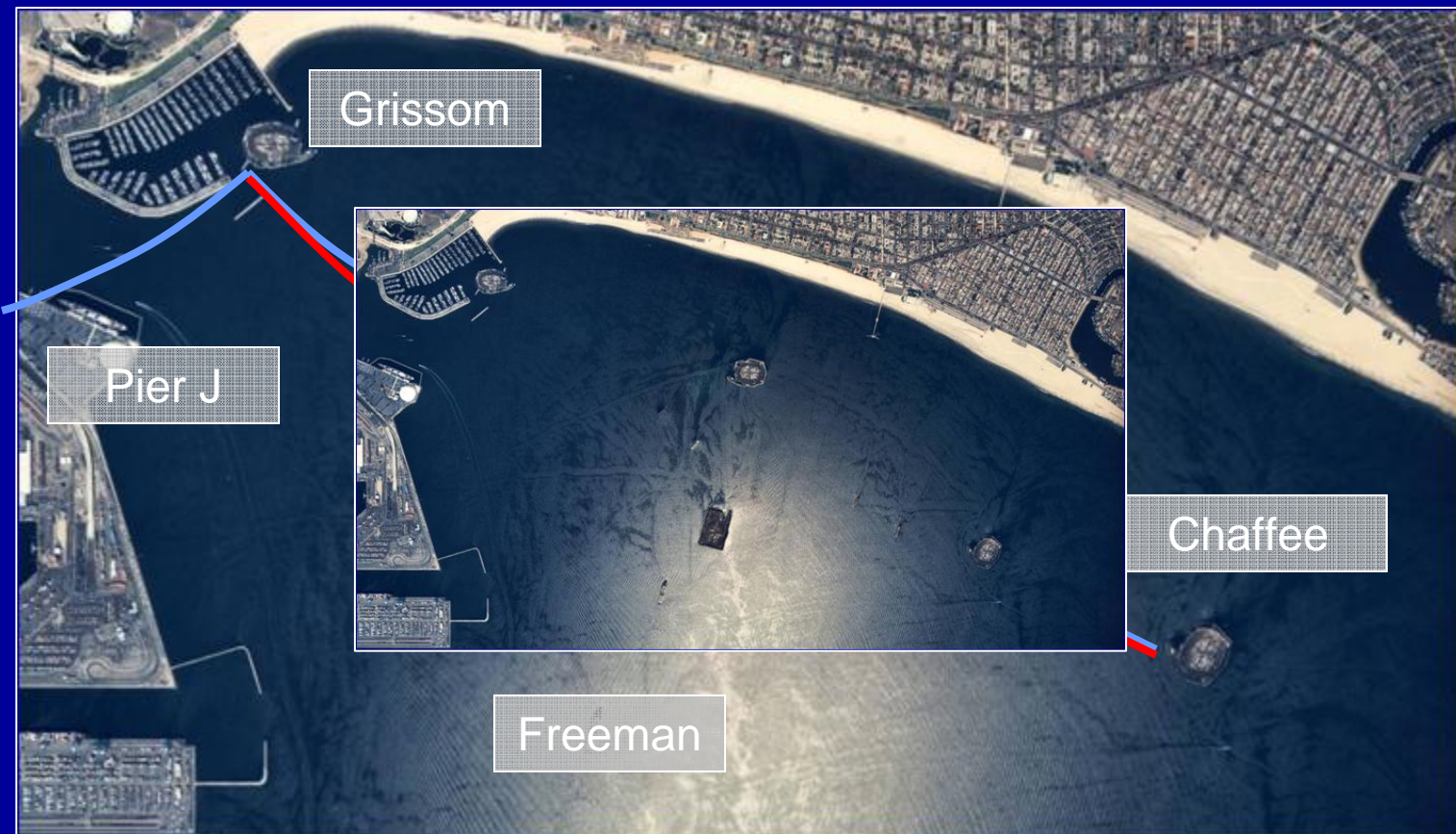
Thums Subsea Pipeline Mechanical Integrity Program



Thums Subsea Pipelines

Original Pipelines installed in 1966

New Pipeline Installations in 1987 and 1993



Thums Subsea Pipelines

- Pipelines Located in an Environmentally Sensitive area
- Potential Impact if Pipeline failure occurs
- Rigorous Integrity Strategy Program must be in place



Mechanical Integrity Program

- **Monitoring Program (Inspection Surveys)**
- **Cathodic Protection**
- **Chemical Inhibition**
- **Pipeline Cleaning Program (Pigging)**



Monitoring Program History

- Magnetic flux surveys conducted annually from 1960's to early 1990's
- Best available technology until 1992
- Problems identifying mill defects and certain anomalies



Monitoring Program History

- **Ultrasonic Surveys conducted starting in 1992**
- **Excavations correlated well with survey data**
- **Excellent Repeatability of Data between Surveys**



Monitoring Program History

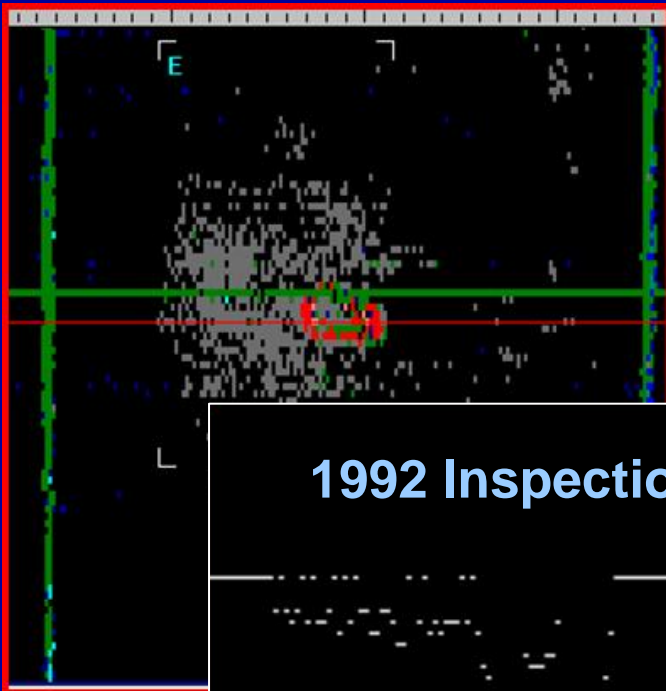
Survey Results Summary

- General localized External Corrosion on Land Portion of pipelines
- Subsea Portions have Low Corrosion rates
- Piping in good shape

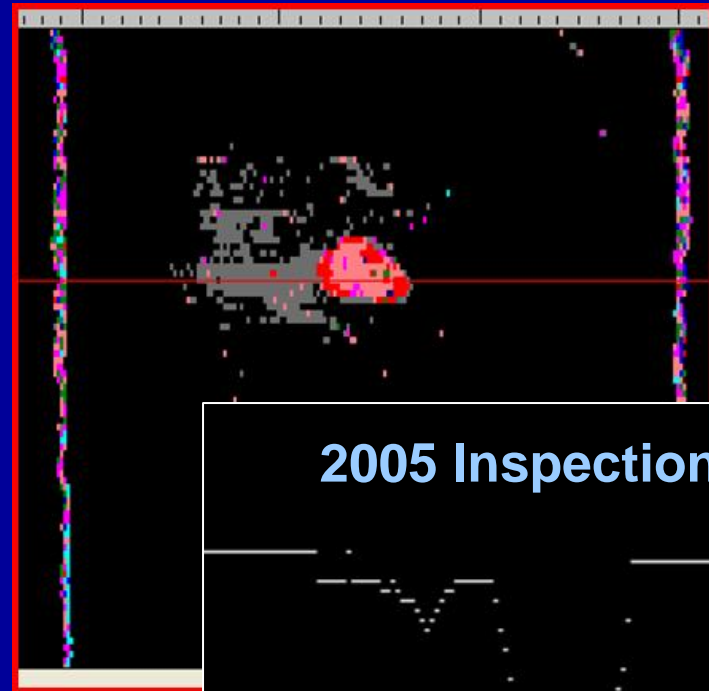


Monitoring Program Improvements

- Long History of Correlating Surveys
- Improvements to UT Technology have increased the Measurement Accuracy of Metal loss Contours



1992 Inspection



2005 Inspection



Monitoring Program Improvements

- **The Improved Resolution**
 - Increased the Accuracy of the data
 - Increased the Number of minor corrosion pits
 - Need to compare the Corrosion rates between surveys
- **Thums utilized a Corrosion Growth Assessment software called RUNCOM™**



Monitoring Program Improvements

RUNCOM™ Objectives

- Compare Data between Surveys
- Identify corrosion features which have grown between surveys
- Identifies areas of New corrosion



Monitoring Program Improvements

Corrosion Growth Data from RUNCOM™ is used to determine:

- Future Growth Behavior
(Key to Integrity Assessment)
- Develop a Schedule of Repairs
- Provide a Basis for Re-inspection Intervals



Mechanical Integrity Program

- **Monitoring Program (Inspection Surveys)**
- **Cathodic Protection**
- **Chemical Inhibition**
- **Pipeline Cleaning Program (Pigging)**



Cathodic Protection Program

Rectifier Monitoring

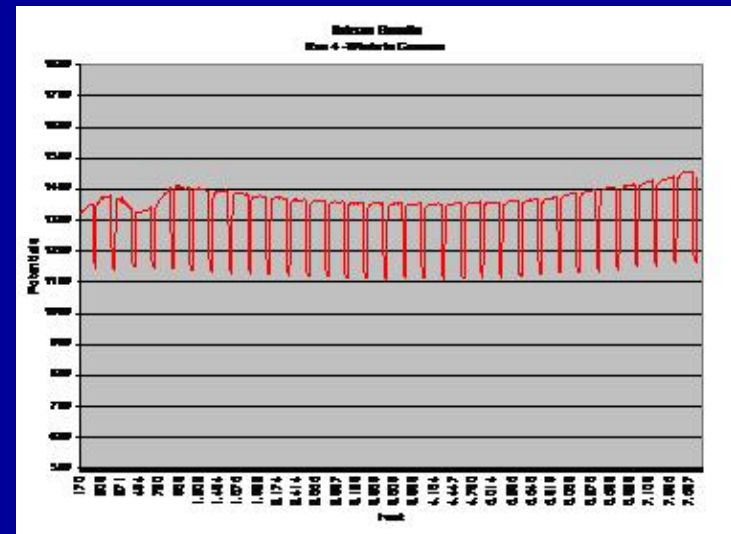
- Cathodic Protection based on an Impressed Current Design
- Monthly Voltage Monitoring
- Data Analysed to determine Adequate Level of Protection



Cathodic Protection Program

Cathodic Protection Surveys

- Annual Over-the-line Close Interval Potential Survey
- Annual Inspection of Isolation Flanges
- Quarterly Pipeline surveys
- Monitor the Potential across the pipelines
- Adjustment made to maintain correct Potential



Chemical Corrosion Inhibition

- Active Pipelines Treated Continuously with Chemical Corrosion Inhibitor
- Batch Treat the Pipelines with Corrosion inhibitor during Maintenance Cleaning (Pigging) Operations
- Corrosion coupons analyzed to ensure adequate Corrosion protection
- Deposits analyzed for evidence of corrosion products



Maintenance Cleaning (Pigging)

- Oil & Gas Pipelines are Pigged on Alternating Weekends.
 - Brush and Wiper Mechanical Pigs
 - Established Pig Maintenance Program
- Solids are Analyzed for Evidence of Corrosion



Subsea Pipeline Program Review

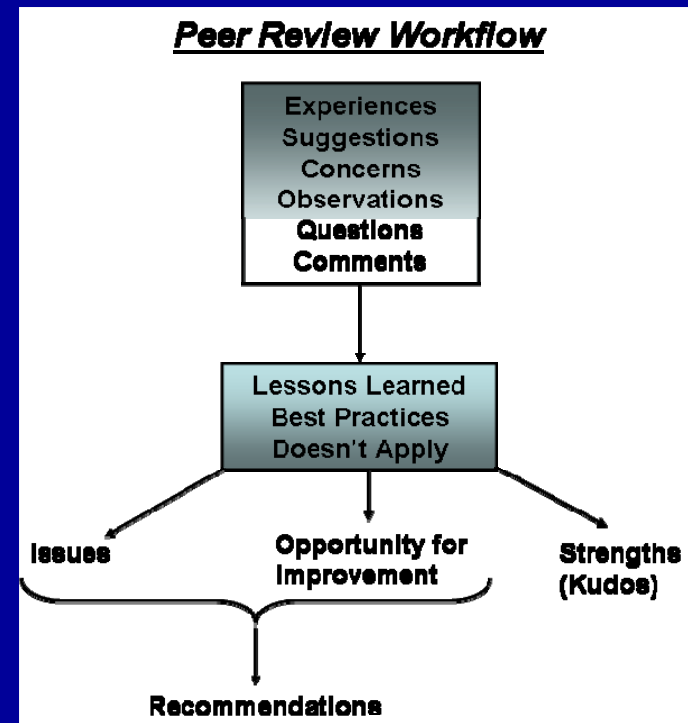
- Peer review conducted in early July 2006
- Well-represented team (16 people): Oxy, LBGO, SLC, Chemical Experts & Industry Consultants
- Objective was to utilize industry expertise to conduct an independent review of Thums Pipeline mechanical integrity program
- Identify improvement opportunities and validate the existing program elements



Subsea Pipeline Program Review

General Results

- Good existing Corrosion program in place
- Well documented Maintenance Pigging Program
- Utilizing state of the art Smart Pig tools and data analysis



Mechanical Integrity Program Summary

- Maintaining Pipeline Integrity is a dynamic Process
- THUMS Oil & Gas Pipelines are well protected
 - Well Maintained Cathodic Protection system
 - High Level of Chemical Protection
 - Regular Cleaning Program
 - Frequent Monitoring of the Pipelines



Questions?



Support slides



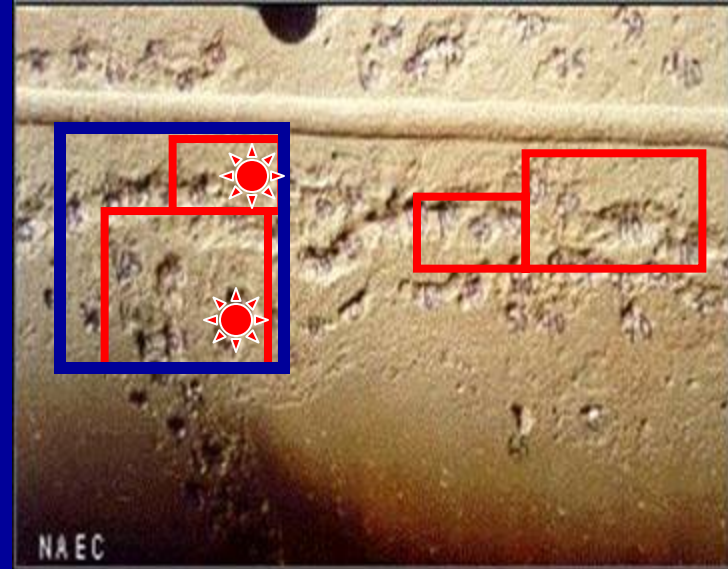
Subsea Pipeline Peer Review Team

Kathye Griffis	THUMS	Thums Pipeline Engineer/ Engineering Team Lead
Jim Van Camp	THUMS	Unit Improvement Team Engineer
Charles Oney	Oxy	Senior Corrosion Engineering Consultant, OOGC WWE
Jim McWhinnie	Oxy	Head of Asset Integrity, Oxy Qatar
Trent Adcock	Oxy	Senior HES Advisor, OOGC
Adel Nasr	WorleyParsons	Materials Application Specialist
Gene Brock	BJ Chemical	Vice President Technical Services
Eric Smith	BJ Chemical	Site Corrosion Specialist
Ken Delunas	BJ Chemical	Consultant Corrosion Engineering
Cliff Moore	Schiff Associates	Senior Engineer, Consulting Corrosion Engineers
Rick Finken	LBGO	City of Long Beach Gas & Oil Petroleum Engineer
Quang Nguyen	LBGO	City of Long Beach Gas & Oil Division Manager LBU
James Hemphill	SLC	Division Engineering Manager
Greg Scott	SLC	Assistant Division Chief
Steve Curran	SLC	Drilling Engineer



Survey Data Analysis Techniques

- Basic Integrity Data
Analysis use Clustered
Data
- Rely on Peak Depth
Comparisons between surveys
- Analysis based on Peak Depth may not
detect active growth areas



Survey Data Analysis Techniques

Key Analysis Issue:

- Maximum corrosion growth does not always occur at the peak depth on the feature.
- In order to reliably determine corrosion growth rates, a method is required that doesn't rely on peak depth comparison between surveys



RUNCOM™

RUNCOM™ uses Raw Signal Matching

- Accurate matching of corrosion sites (joint-joint)
- Survey to Survey inaccuracies associated with tool performance & sizing algorithm
- Compares the metal loss profiles between surveys
- Difference is the rate of Corrosion Growth

