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Third Party Assessment
Final Presentation Meeting (100%)

Presented by:

SIMPSON GUMPERTZ & HEGER (SGH), Risktec

26 April, 2022

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Statement

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RED HILL - ASSESSMENT

FINAL ASSESSMENT PRESENTATION – 100%

(b)(6), PE, SE, F.ASCE — Senior Principal

(b)(6), PhD, PE — Staff Consultant

(b)(6) (Risktec) — Principal Engineer II

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26 April 2022

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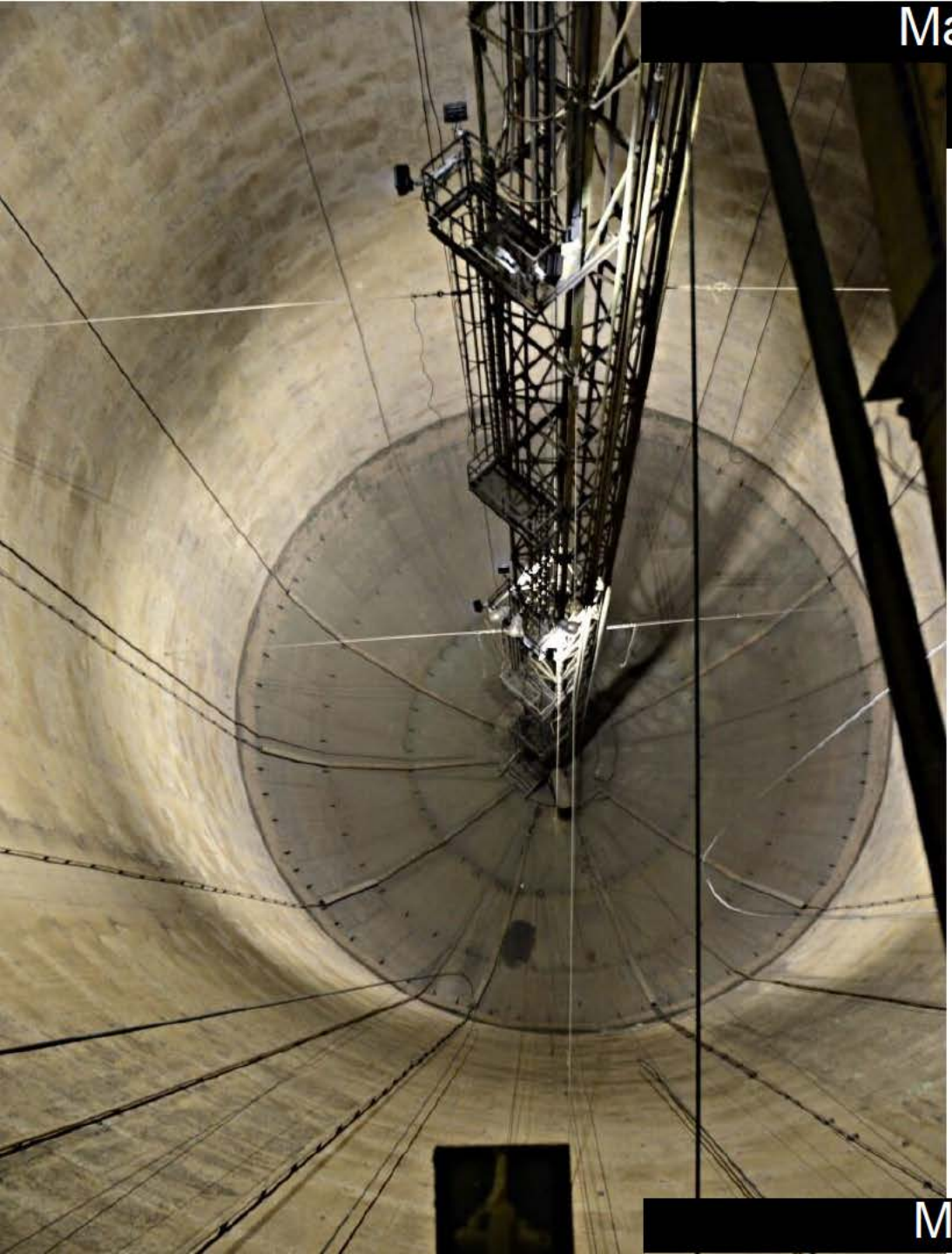

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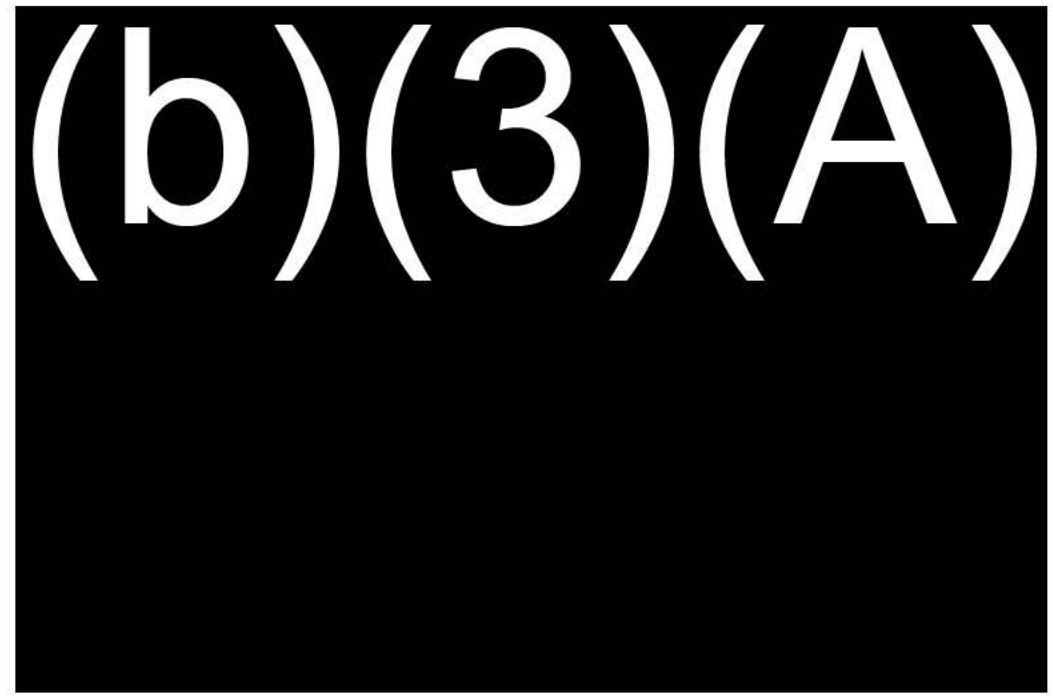
Meeting Agenda

- Introduction
  - Objectives and Approach
  - Project Team and Metrics
  - Summary
- Assessment Findings and Recommendations
  - Process Hazard Analysis (PHA)
    - Hazard and Operability Study (HAZOP)
    - Operational Readiness Assessment
  - Facility Walkdown Observations
  - Structural and Mechanical Integrity Assessment
  - Repair and Retrofit Recommendations
- Discussion

Objectives and Approach of Independent Assessment

- Objectives
  - Assess the design, integrity and operations of the fuel system at JBPHH, including the Red Hill underground storage tanks, in order to:
    - Safely defuel the Red Hill underground storage tanks
    - Safely operate the balance of JBPHH
- Approach
  - Perform walkthroughs of the facility
  - Review previous studies and inspection reports
  - Perform analytical studies to evaluate the facility
  - Develop repair scheme concepts and recommendations for changes to operations



PROJECT STATUS - SCHEDULE

Task / Deliverable	Milestones		Duration (days)	Weeks from Project Kickoff
	Start	End		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Performance Period	*17-Jan-22*	*30-Apr-22*	103	
Kickoff	17-Jan-22			
Closeout		30-Apr-22		
Assessment				
Data Review	17-Jan-22	11-Apr-22	84	
Process Safety Mgt & Risk Mgt	31-Jan-22	25-Mar-22	53	
Identification of Operational Deficiencies	31-Jan-22	25-Mar-22	53	
Structural and Mechanical Integrity Evaluation	31-Jan-22	11-Apr-22	70	
Retrofit Concepts	14-Feb-22	18-Apr-22	63	
Cost Estimates	7-Apr-22	29-Apr-22	22	
Special Studies				
Response to Stakeholders	24-Jan-22	23-Apr-22	89	
Reporting				
Plan of Action and Milestones (POAM)	17-Jan-22	24-Jan-22	7	
Safety Plan	17-Jan-22	24-Jan-22	7	
Interim Assessment Identified Deficiencies (50%)	21-Feb-22	15-Mar-22	22	
Pre-Final Assessment Report (75%)	22-Mar-22	11-Apr-22	20	
Assessment Report (100%)	15-Apr-22	29-Apr-22	14	
Out brief	8-Apr-22	15-Apr-22	7	
Weekly Reports				

SOME PROJECT DETAILS

Site Visits

- More than 70 walkdowns and inspections

Data Review

- Received and reviewed more than 3,600 documents under 120 transmittals

Deliverables Issued

- Plan of Actions and Milestones (POAM) to perform the independent assessment
- Supplemental POAM to perform independent assessment to safely defuel the facility
- Safety Plan
- Weekly Reports and Presentations
- Initial Stakeholder Meeting and Presentation (30%)
- Interim Deficiencies and Recommendations Report and Presentation (50%)
- Pre-final Assessment Report (75%)
- Project Status & Follow-up to 50% Presentation
- Final Assessment Report and Presentation (100%)

PROJECT TEAM

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SGH | Consultants to SGH | Risktec

(b)(6)

SUMMARY OF ASSESSMENT

- We deem it safe to defuel the facility (and to operate the balance of the JBPHH facility) with the recommendations that we are providing
- Our recommendations include:
  - Any modifications that affect the loading or structural response of tanks, structures or piping systems should be engineered in a coordinated manner
  - Independent third-party verification of design changes, repairs and modifications currently being planned and implemented should be employed
  - A more robust facility specific integrity management program and anomaly tracking system should be implemented
  - A risk-based process safety management system should be adopted

Red Hill Assessment
Process Hazard Analysis

April 26, 2022

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Project Status

Assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and defueling. Develop corrective actions including repairs and operational changes to address deficiencies.

Major Task	Status
Deliverable 1 – Hazard and Operability Study (HAZOP) Operational Risk Assessment	HAZOP Complete for Hotel Pier to Red Hill Fuel Transfers and Defueling on February 11
	HAZOP Complete for Remaining Fuel Transfers and Special Operations on February 25
	HAZOP Report with 120 Recommendations (13 Recommendations for Defueling) Issued March 2022
Deliverable 2 – Operational Readiness Review	OSHA Process Safety Management Field Checklist - Complete
	EPA Spill Prevention Countermeasures and Controls Field Checklist - Complete
	Field Validations and Interviews - Complete
	Operational Readiness Report with Opportunities for Improvement To Be Issued April 2022
Proposed Implementation Plan	Plan includes operational issues and HAZOP issues

Deliverable 1 Recap- HAZOP Results

Approximately 120 draft recommendations have been made in the following categories (includes facility operations and defueling):
Reducing the Likelihood of Loss of Containment from Piping, Pumps and Tanks
Engineering Design – Addressing: Line Sag/Vacuum, Dresser Couplings, and Other Issues
Improved Instrumentation Reliability
Automation to Reduce Potential Human Error
More Robust Administrative Controls (Procedures)
Increasing Detection of Loss of Containment
Sensors for Fuel Release
Cameras for Observing More Areas
Reducing Impact of Loss of Containment
Aqueous Film Forming Foam (AFFF) System

Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks

PHA Rec #	Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks
	Procedural Controls:
1	To increase the likelihood of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system.
25	Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery.
9	Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling.
107	Consider additional operators and technical support for defueling operations (Engineer, Process Safety Support, Trainers).
38	Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves.

*Full list of recommendations can be found in the final HAZOP Report

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Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks (continued)

PHA Rec #	Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks
	Equalization Lines:
27	If possible, add an equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line.
	Additional Pressure Indication Transmitters:
6	Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation.
	Underlying Causes of Line Sag:
31	Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted.

*Full list of recommendations can be found in the final HAZOP Report

Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks (continued)

PHA Rec #	Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks
	Reliability of Oil Tight Door:
28	Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand.
	Piping and Hose Integrity:
14	Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL.
	Response Organization and Preparedness:
99	The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing and resources for each organization needs to be clearly defined, drilled and aligned prior to defueling operations.

*Full list of recommendations can be found in the final HAZOP Report

Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks (continued)

PHA Rec #	Recommended Actions Prior to Safely Defueling Red Hill Storage Tanks
	Dresser Couplings:
8	Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design.
32	Evaluate the need for Dresser Couplings in the (b)(3)(A) main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing (b)(3)(A). If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on (b)(3)(A) JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service.

*Full list of recommendations can be found in the final HAZOP Report

Deliverable 2 - Operational Readiness Review

Operational Readiness Review Process

Facility Tour and Walk Through

Operational Review

- Document Reviews
- Field Validation and Interviews
- SPCC Field Checklist
- Process Safety Management Field Checklist

Identify Deficiencies and Develop Recommendations for Mitigation

Element #	Element Name	Reference[1]	Question
2	Process Safety Information (PSI)		e) ventilation system design?
2	Process Safety Information (PSI)		f) design codes and standards employed?
2	Process Safety Information (PSI)		g) material and energy balances for processes built after 5/26/92 for PSM, 6/21/99 for RMP?
2	Process Safety Information (PSI)		h) safety systems (e.g. interlocks, detection or suppression systems)?
2	Process Safety Information (PSI)	119(d)(3)(ii) 68.65(d)(2) **R, O, I**	2.5 Based on review of a representative sample of PSI, has the employer documented that equipment complies with recognized and generally accepted good engineering practice, codes and standards?
2	Process Safety Information (PSI)	119(d)(3)(iii) 68.65(d)(3) **R, O**	2.6 Based on review of a representative sample of PSI, has the employer determined and documented that where equipment is designed, and constructed in accordance with codes, standards, and practices that are no longer in general use, the equipment is designed, maintained, inspected tested, and operated in a safe manner?
2	Process Safety Information (PSI)	GMP R	GMP1 Are there written procedures in place to:
2	Process Safety Information (PSI)		a) Manage PSI as below; and
2	Process Safety Information (PSI)		b) Maintain PSI on file for the life of the process?

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OSHA PSM Field Checklist

- Employee Participation
- Process Information
- Process Hazard Analysis
- Operations Orders
- Training
- Contractors
- Pre Startup Safety Review
- Mechanical Integrity
- Safe Work Practices
- Management of Change
- Incident Investigation
- Emergency Response
- Compliance Audits
- Trade Secrets

Checklist Recommendations – Summarized

Rec #	Recommendation
Fully Implement Life Critical Standards covering high risk activities that will apply to all employees and contractors	
8	Energy Isolation (Lockout Tag Out)[1]
18	Hot Work [1]
9	Line Break[1]
10	Confined Space
18	Work Authorization
	1 Prior to defueling

Safe Work Practices

Consider the Operations Department (Fuels) to be the owner of the Life Critical Standards. The owner:

- Will issue the permits for work conducted within their area,
- Will be trained to issue hot work permits, and
- Shall be responsible for monitoring hot work being conducted in their area of operation.

Checklist Recommendations – Summarized (continued)

Rec #	Recommendation
Develop Operations Orders and Process Information	
1	Ensure that Process Information is updated or created as needed and maintained in a document control system.
5	Establish Operations Orders addressing all phases of the operations. Normal operations and emergency operations should be addressed; emergency operations should address loss of electricity, building ventilation, fire or explosion.[1, 2]
6	Ensure the new template addresses PPE required and hazards of the fuels.[1]
7	Ensure Operations Orders are periodically reviewed and updated and maintained in a document control system.[1, 2]
11	Implement an access control process.[1]
	1 - Prior to defueling *2 – PHA/HAZOP Recommendation*

Process Information

Operations Orders

Checklist Recommendations – Summarized (continued)

Rec #	Recommendation
Change Management, Pre-Startup Safety Reviews and Mechanical Integrity	
14	Develop a formal written procedure implementing a Management of Change (MOC) process. The process should be paper-based initially with the goal to move to an electronic system once the program is fully implemented and understood.[1,2]
13	Develop a written plan for conducting Pre-startup Safety Reviews. The plan should include roles and responsibilities, conditions that must be met prior to startup, communication requirements to affected people, and update of records.[1]
15	Require operator training before any process change is made.[1]
16	Develop and implement detailed Mechanical Integrity procedures for all equipment subject to test and inspection requirements.
17	Develop structured written procedures for training personnel involved in maintaining the ongoing Mechanical Integrity of process equipment.
	1 - Prior to defueling *2 – PHA/HAZOP Recommendation*

Management of Change

Pre-Startup Safety Review

Mechanical Integrity

Checklist Recommendations – Summarized (continued)

Rec #	Recommendation
Training and Process Hazards Analysis	
12	Ensure Operators are trained to reliably perform their roles including training on Operations Orders and formal verification of competency.
2	Consider repeating/revalidating the Process Hazard Analysis (PHA) every 5 years to assess the hazards introduced by implementing changes to the process. The next PHA would be due in 2027.
3	Develop a policy and schedule for PHA completion.
4	Evaluate JBPHH risk matrix to include expanded consequences for Environmental and Public Impact

Training

Process Hazard Analysis

Checklist Recommendations – Summarized (continued)

Rec #	Recommendation
Incident Investigation	
19	Consider updating OPNAVINST 5102 to reflect modern incident investigation tools and techniques that are fit for purpose for the level of incident. (such as Source, Tap Root, Apollo, 5 Whys and Fishbone for simple investigations, and others). [1]
19	Ensure training is provided in current incident investigation techniques.[1]
19	Lessons learned should be communicated at all levels for serious incidents.[1]
20	Consider revising OPNAVINST to reflect investigation requirements for environmental and public impacts.
21	Develop an action tracking system to track status of all corrective actions.
	1 Prior to defueling

Incident Investigation

Checklist Recommendations – Summarized (continued)

Rec #	Recommendation
Emergency Response	
22	Ensure personnel are trained and there is a system in place to carry out and document head count following a local muster or evacuation.[1]
23	Distinguish between local emergencies with muster points and evacuation emergencies.[1]
23	It is recommended that alarms are tested weekly to ensure alarm operability and to raise awareness of employee understanding of alarm types.[1]
23	All employees entering the facility should be trained on the types of alarms and muster/evacuation routes.[1]
24	Ensure an emergency response critique is carried out, documented, and that actions are followed up after each actual emergency response or drill.[1]
	1 Prior to defueling

Emergency Response

EPA SPCC Field Checklist

- Completed checklist
- Verified by field inspection
- Verified by personnel interviews

- Integrated Contingency Plan, Facility Response Plan and SPCC Plan are thorough and comprehensive.

- No concerns were identified

- One recommendation is made from the Facility Siting checklist (included in HAZOP):
  - The roles, staffing and resources for each [response] organization needs to be clearly defined, drilled and aligned prior to defueling operations.

What do we need for Defueling (in addition to HAZOP recommendations)?

- **Operations Orders** and **Training** on the Orders (this was part of the HAZOP defueling recommendations)
- **Management of Change** -paper version
- **Prestart-up Safety Review Program (PSSR)-** paper version
- **Safe Work** Permits for
  - Hot Work permitting
  - Lock out-Tag out permitting
  - Line and Equipment Opening permitting
- **Emergency Response** Organization Roles and Training
- Access Control

Supporting Tools

- Action tracking program
- Root cause investigation tool and templates
- Management of Change and PSSR templates
- Document control process
- Access Control
- Training
  - Hazard awareness
  - Incident Investigation and tools
  - MOC training

How do we Implement both the HAZOP and Operational Readiness Assessment?

Step 1 - Defueling

- Engage stakeholders from NAVSUP, NAVFAC, DLA, etc., to review Defueling Recommendations
- Determine those recommendations (HAZOP and Operational Readiness) to be actioned prior to safely Defueling
- Develop and communicate Defueling Plan of Action and Milestones (POAM) by May 31st, 2022*
- Implement selected recommendations as soon as practicable
- Target completion of defueling of Red Hill Tanks by May 2023*

- Determine if there are other recommendations that could be implemented simultaneously with defueling, while not taking resources from the defueling effort?

* Reference: DOD Fact Sheet following Secretary Austin's direction.

Step 2 - Post Defueling: Implement Remaining HAZOP and Operational Readiness Recommendations

- Engage stakeholders from NAVSUP, NAVFAC, DLA, etc., to review all other recommendations
- Determine those recommendations to be actioned
- Determine those recommendations that require engineering and contracting
- Develop “fit-for-purpose” management system
- Begin implementation of recommendations
- Track progress of implementation

Management System: Implement Process Safety Management elements to supplement the Navy's Safety Management System (M-5100.23)

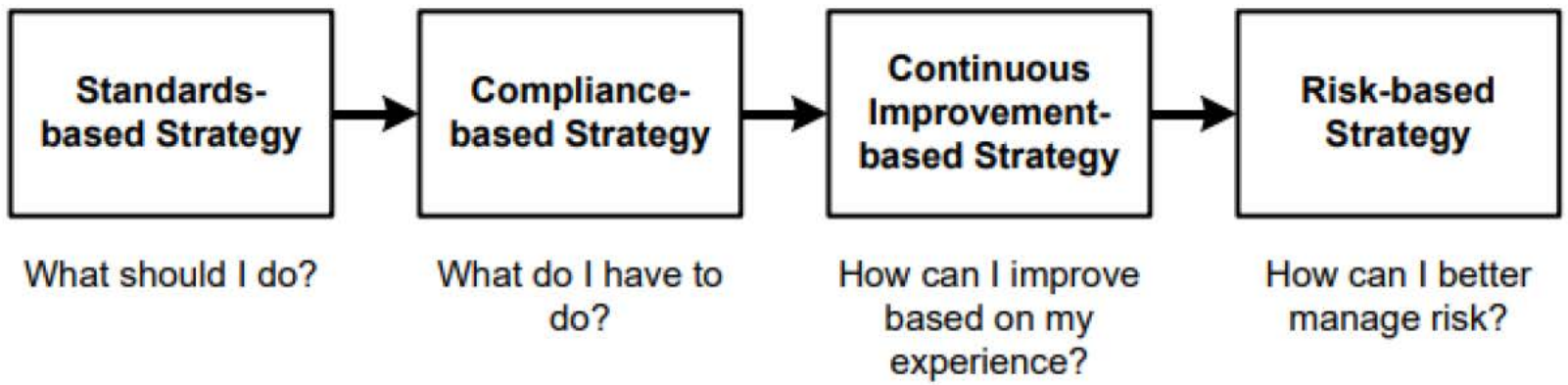
Note: Operating Procedures, Training, Management of Change, Pre-Startup Safety Review and Safe Work Permitting recommended prior to Defueling

PSM Elements	
1. Employee Participation	8. Mechanical Integrity
2. Process Safety Information	9. Hot Work Permits (Safe Work Permitting)
3. Process Hazards Analysis	10. Management of Change
4. Operating Procedures	11. Incident Investigation
5. Training	12. Emergency Planning and Response
6. Contractors	13. Compliance Audits
7. Pre-Start-up Safety Review	14. Trade Secrets – not applicable

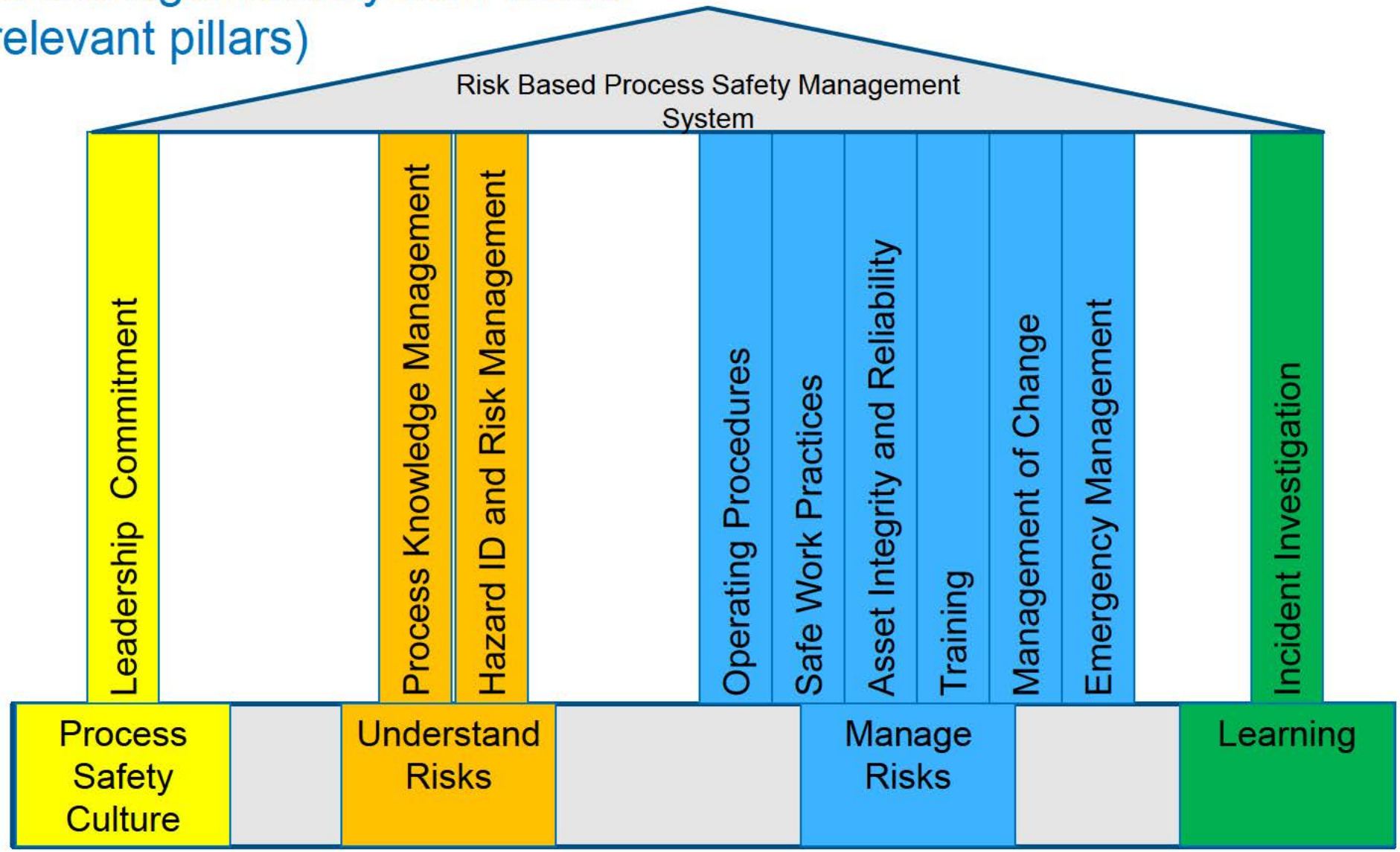
One Option to Consider: Risk-Based Management?

Industry Best Practice

Risk-based management is **the process of identifying risk, assessing risk, and taking steps to reduce risk to an acceptable level**. The risk management approach determines the processes, techniques, tools, and team roles and responsibilities for a specific project.



Risk-Based Management System Model (showing relevant pillars)



Risk-Based Management System

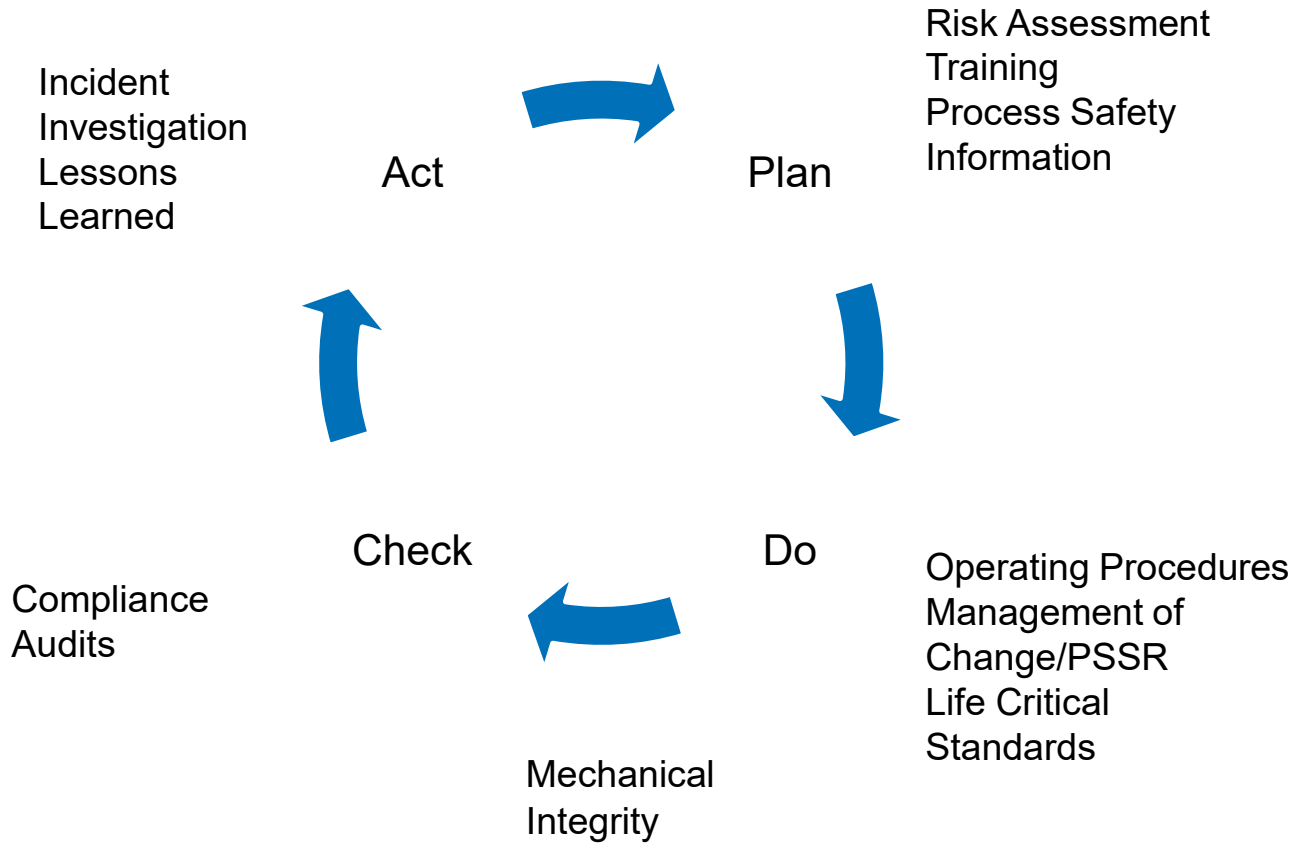
Develop Management System for Ongoing Continuous Improvement

Best Practices

- Emergency Response
- Employee Engagement

Opportunities for Improvement

- Management of Change/PSSR
- Operating Procedures and Training
- Mechanical Integrity
- Incident Investigation
- Process Safety Information
- Life Critical Standards



Proposed Implementation Plan

Timing	Recommendation
Immediate	Review third-party assessment
	Hold stakeholder meeting to review defueling recommendations and assign accountability for those to be actioned
	Develop POAM for Red Hill defueling considering recommendations selected from Table 2 in Section 4.1.1. and Table 5 in Section 4.2.

Proposed Implementation Plan (continued)

Timing	Recommendation
0-12 months	Implement POAM to defuel Red Hill tanks (including administrative and engineering changes from the HAZOP)
	Revise facility risk matrix
	Train all employees on risk awareness
	Develop/revise operating orders for defueling activities
	Develop/update “life-critical” safety standards (selected for defueling operations) and other selected programs: • hot work and safe work permitting • opening process piping and equipment • plant access and security • pre-start-up safety reviews • lock-out/tag-out (energy isolation) • personal protective equipment • management of change • emergency response • incident investigation
	Implement selected life-critical safety standards and other selected programs prior to defueling
	Train all affected employees on life-critical safety standards, defueling operating orders and other selected programs

Proposed Implementation Plan (continued)

Timing	Recommendation	
1-2 years	Safely defuel Red Hill tanks	
	Provide oversight, process safety support, training, coaching and mentoring for defueling activities as required	
	Hold stakeholder meeting to review all other recommendations and assign accountability for those to be actioned	
2-4 years	Implement selected recommendations for operational improvements to Pearl Harbor DFSP (including administrative and engineering changes from the HAZOP)	
	Develop/update EHS standards, for example:	
	• process safety information • corrective action tracking	• confined space entry • process hazard analyses
	Implement EHS standards, new and existing	
	Train all affected employees on EHS standards	

Proposed Implementation Plan (continued)

Timing	Recommendation
Every 5 years	Conduct Process Hazard Analysis to review cumulative effect of all changes on process integrity
On-going and periodically as required	Audit process safety management system to identify continuous improvements
	Leverage operational success at PRL DFSP enterprise-wide

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FACILITY WALKDOWN OBSERVATIONS RECAP

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Fuel System

- Red Hill underground fuel storage tanks
- Red Hill to storage and distribution points, including all tunnels, piers and docks
- Aboveground storage tanks

Our JBPHH Fuel Footprint

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SITE VISIT OBSERVATIONS

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Support of F24 Line

- Supports missing, damaged, and deficient
- Inadequate lateral restraint at PS 77, 74, 73, 46 & 44, and others.
- Retrofit required

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Lug and Rod Dimensions - May 6th Event

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SITE VISIT OBSERVATIONS

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Poorly Configured Pipe Supports

- Retrofit required

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Significantly Corroded Pipe Supports and Braces

- Supports 47 and 48 near Tanks 9/10
- Evaluated adequacy of heavy valve support and developed retrofit design

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Lower Access Tunnel - F-24 Pipeline

- Wrap damage, crevice corrosion, and pipe support deterioration

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Blast/Fire Resistant Window

- Operator viewing window and supporting framing within Pumphouse is not blast-resistant
- Control room door not blast or fire-resistant
- The control room is operationally critical and houses key personnel

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SITE VISIT OBSERVATIONS

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Pumphouse - Diesel Tank for Emergency Generator

- No apparent anchorage between tank and foundation; retrofit required

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Tank 47, Upper Tank Farm

- Measured pit depth at surface corrosion location on new tank double bottom annular ring

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SITE VISIT OBSERVATIONS

Tanks 1 & 2, Hickam

- Potential concern during earthquakes due to overconstrained piping
- First pipe support constrains uplift of the attached piping as tank uplifts; guide provided, which allows for longitudinal (but not vertical) movement movement

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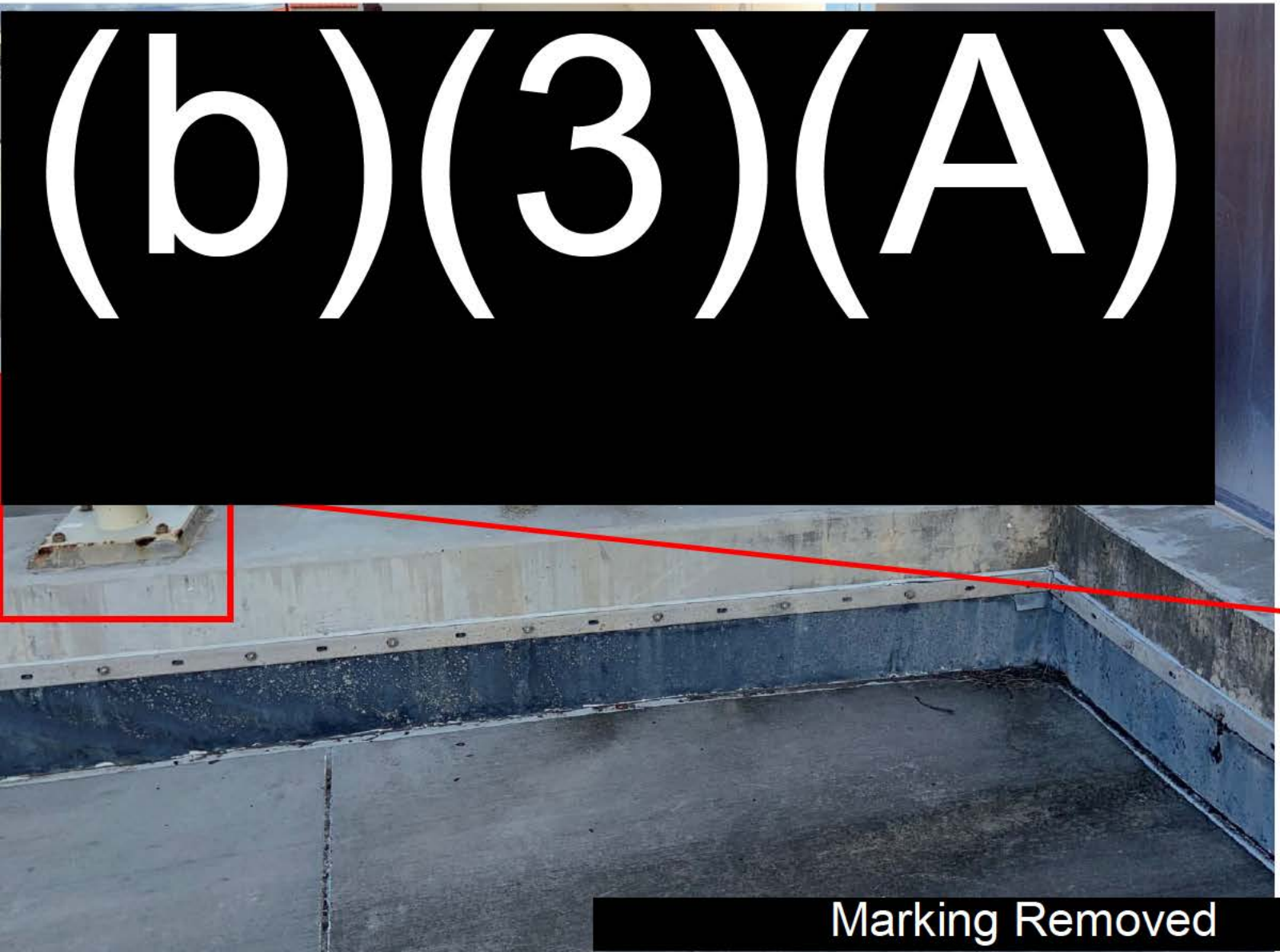

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Kilo Pier

- Missing fuel pipe support anchor bolts
  - Increases unsupported length, increases demand on remaining anchor bolts
  - Probable stress corrosion cracking

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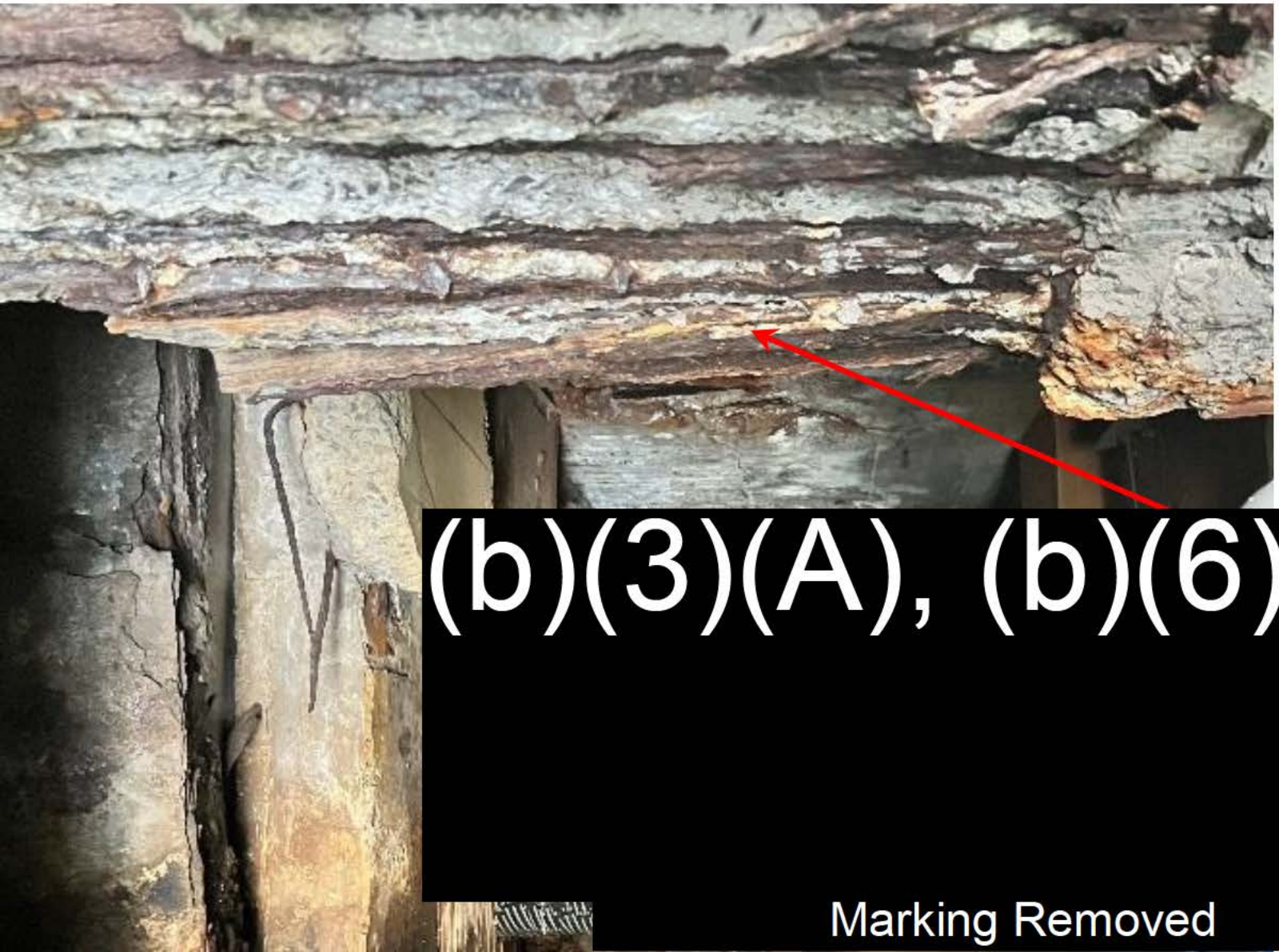

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Mike Dock – Deck

- End of Mike Dock (b)(3)(A)
- Exposed and corroding reinforcing bars on the underside of the deck reduces the deck capacity to withstand heavy loads

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Mike Dock – Pipe Supports

- Missing roller supports, uneven roller supports, damaged support beam, failed coating, exposed reinforcing on pipe support beam

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SITE VISIT OBSERVATIONS

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Bravo Dock – Riser Pipe

- Corrosion and pitting observed on riser pipe and low-point-drain pipe, extending from fuel pipe

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STRUCTURAL AND MECHANICAL INTEGRITY ASSESSMENT

- Piping: JP-5, F-24, and F-76 lines
- Pipe supports
- Underground storage tanks and nozzles
- Aboveground storage tanks
- Fitness-for-service assessment

Standards used to develop the methodology and assessment basis

- UFC 3-460-01 – Design: Petroleum Fuel Facilities
- UFC 3-460-03 – Petroleum Fuel Systems Maintenance
- ASME B31.4 – Pipeline Transportation Systems for Liquids and Slurries
- AISC 360 – Specification for Structural Steel Buildings
- API 579-1 / ASME FFS-1 – Fitness-For-Service
- API 650 – Welded Tanks for Oil Storage
- ASCE 7 – Minimum Design Loads for Buildings and Other Structures
- ACI 318 – Building Code Requirements for Structural Concrete and Commentary
- ASCE – Guidelines for Seismic Design of Petrochemical and Other Industrial Facilities
- PIP STC01015 – Structural Design Criteria

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Load Cases

- Self-weight
- Weight of pipe and tank contents
- Operating pressure
- Vacuum condition
- Surge loads
- Earthquake loads

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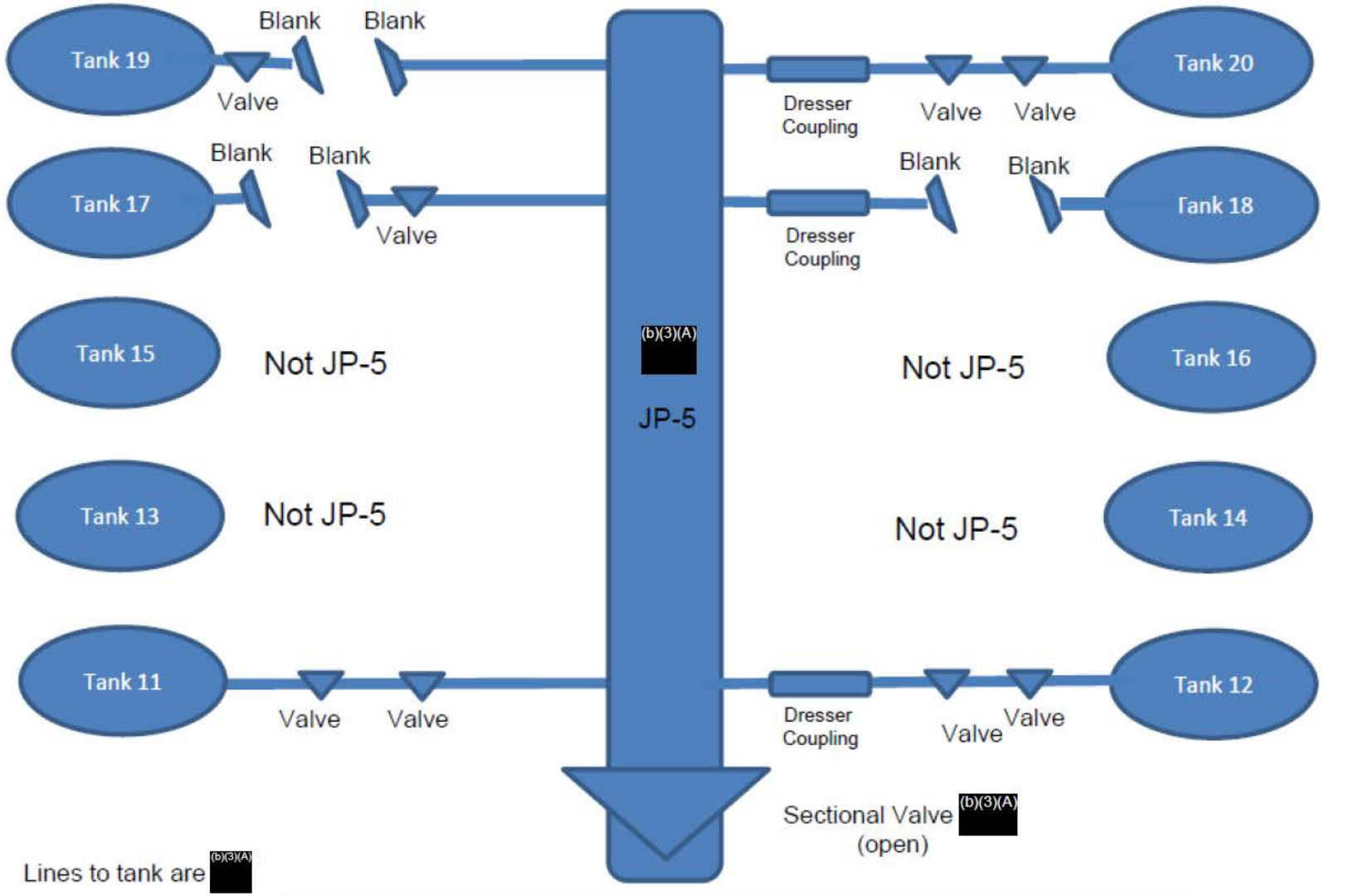
MAY 6 EVENT SIMULATION



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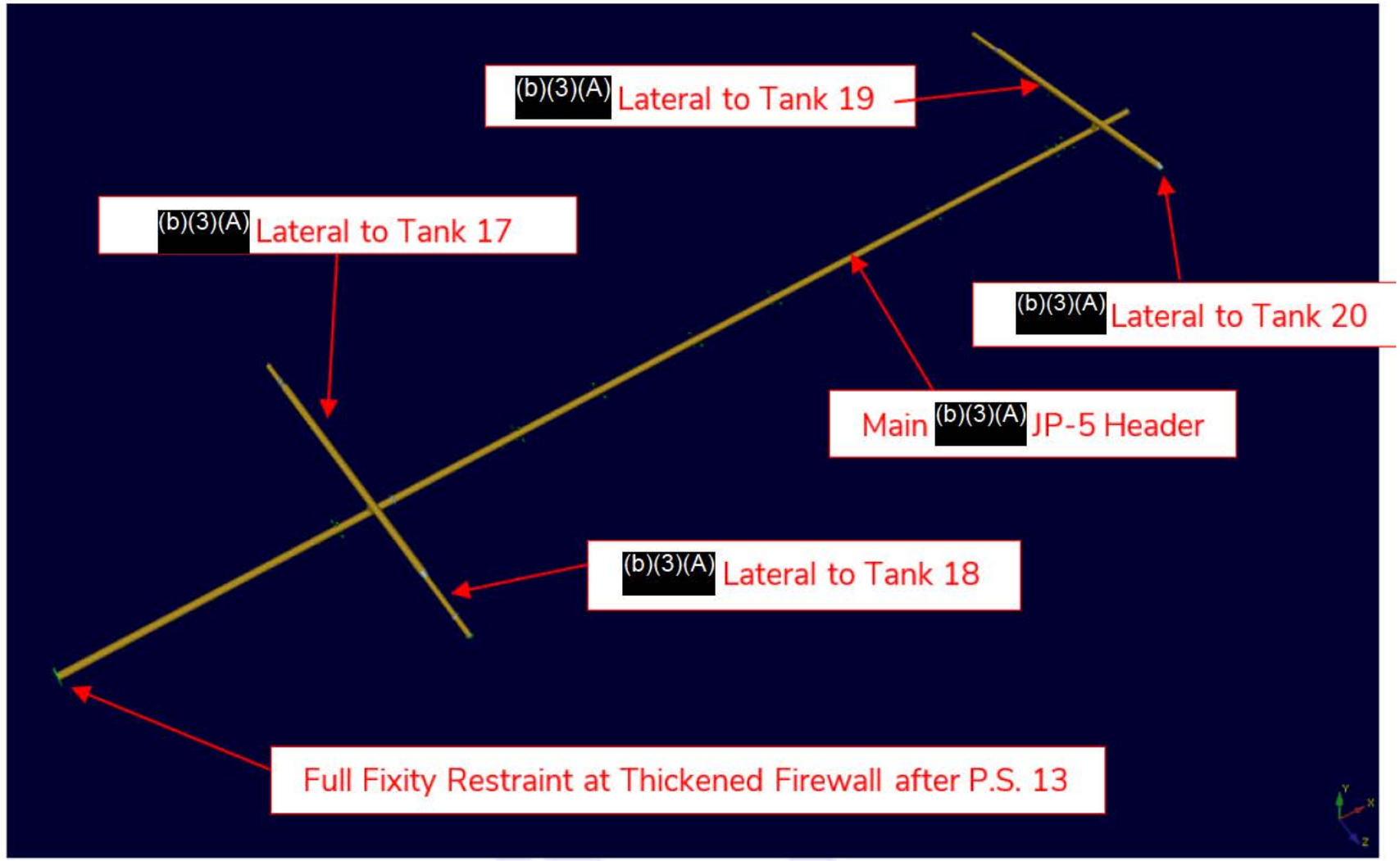
JP-5 Piping



SGH

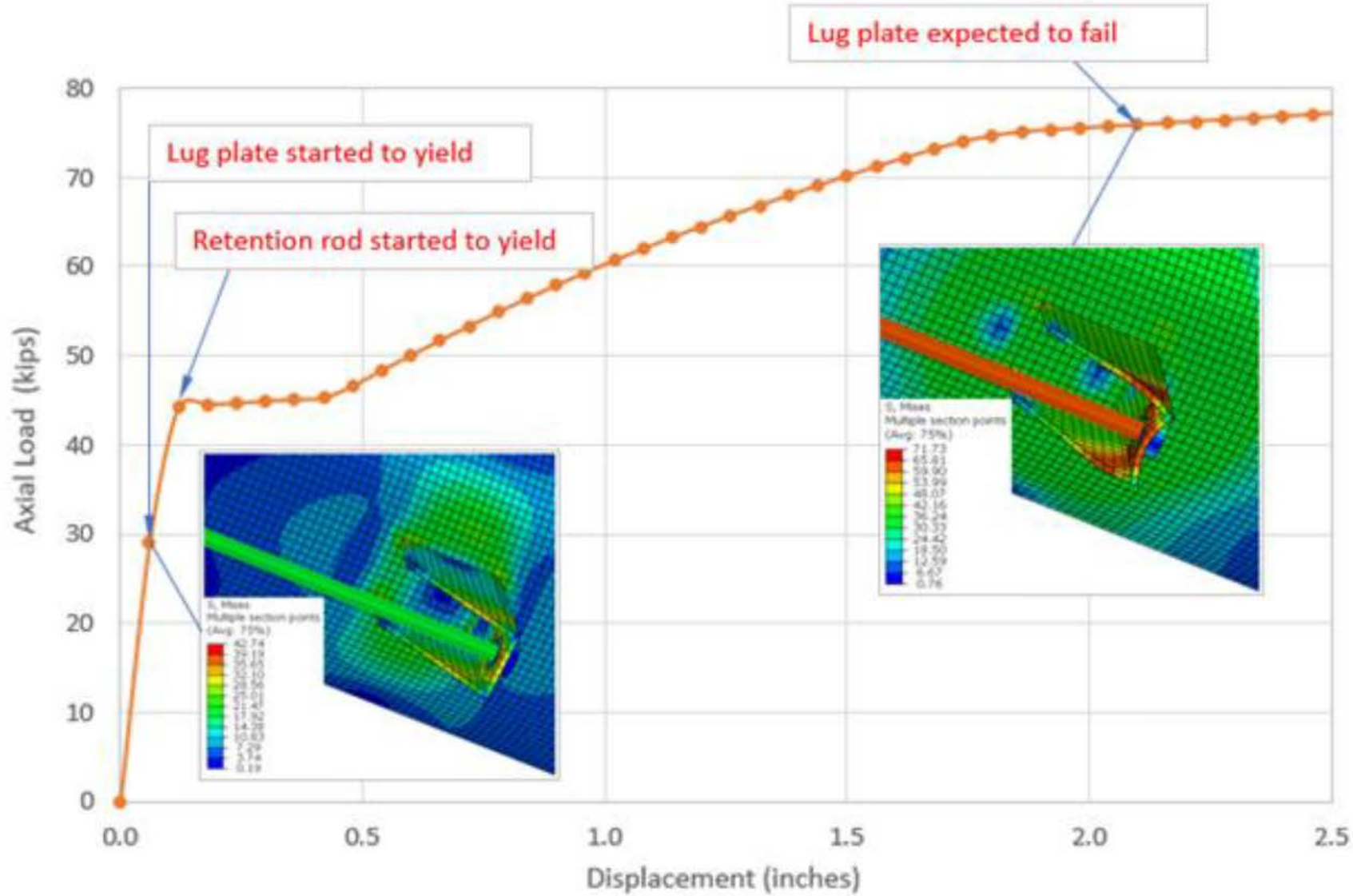
Simulation of Bent Lugs - May 6th Event

(b)(3)(A)

SGH

Tank 20 Dresser Coupling FE Analysis

(b)(3)(A)



SGH

Emergent JP-5 Pipeline Repairs (design by others)

(b)(3)(A)

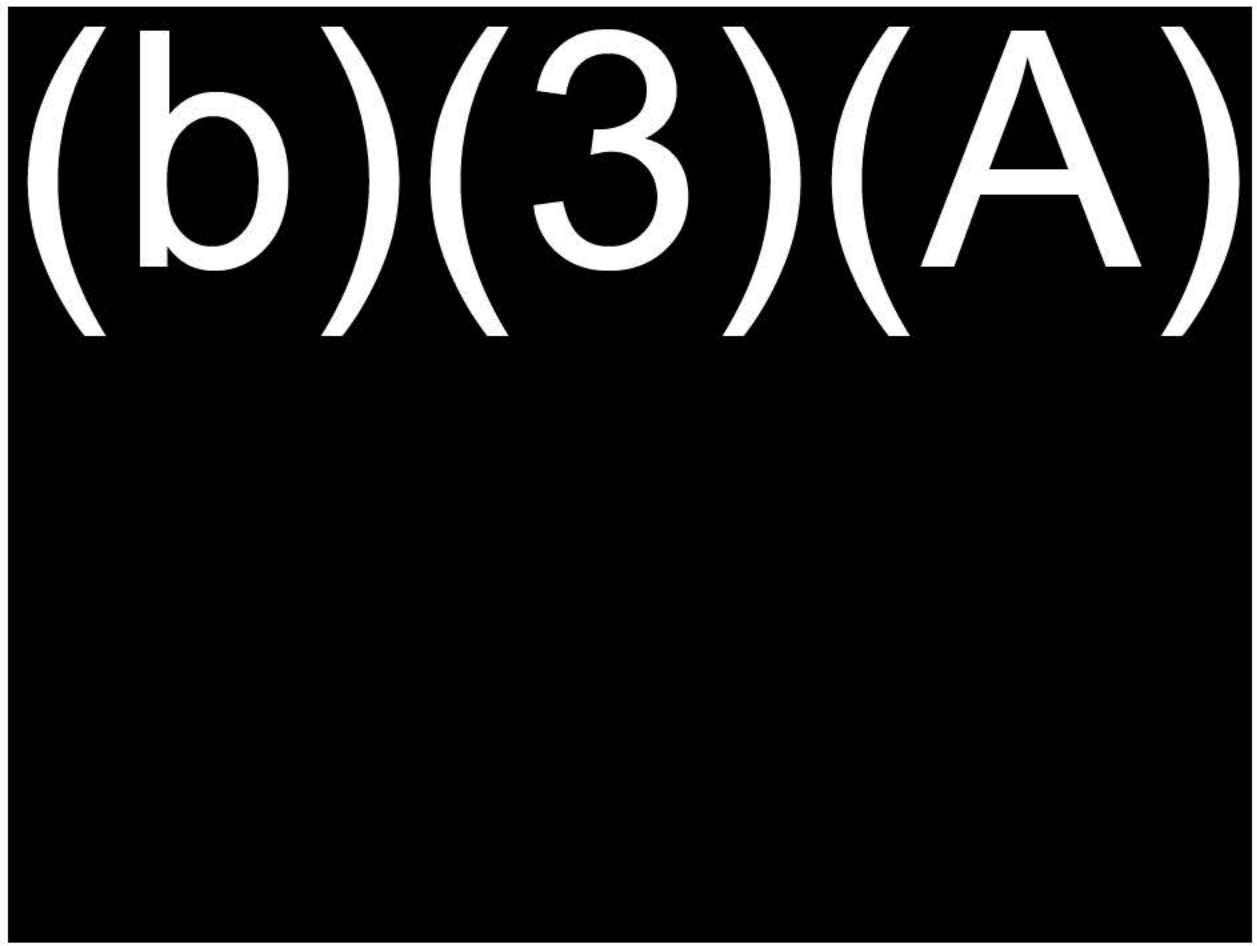
SGH

Ongoing Work (design by others)

(b)(3)(A)

SGH

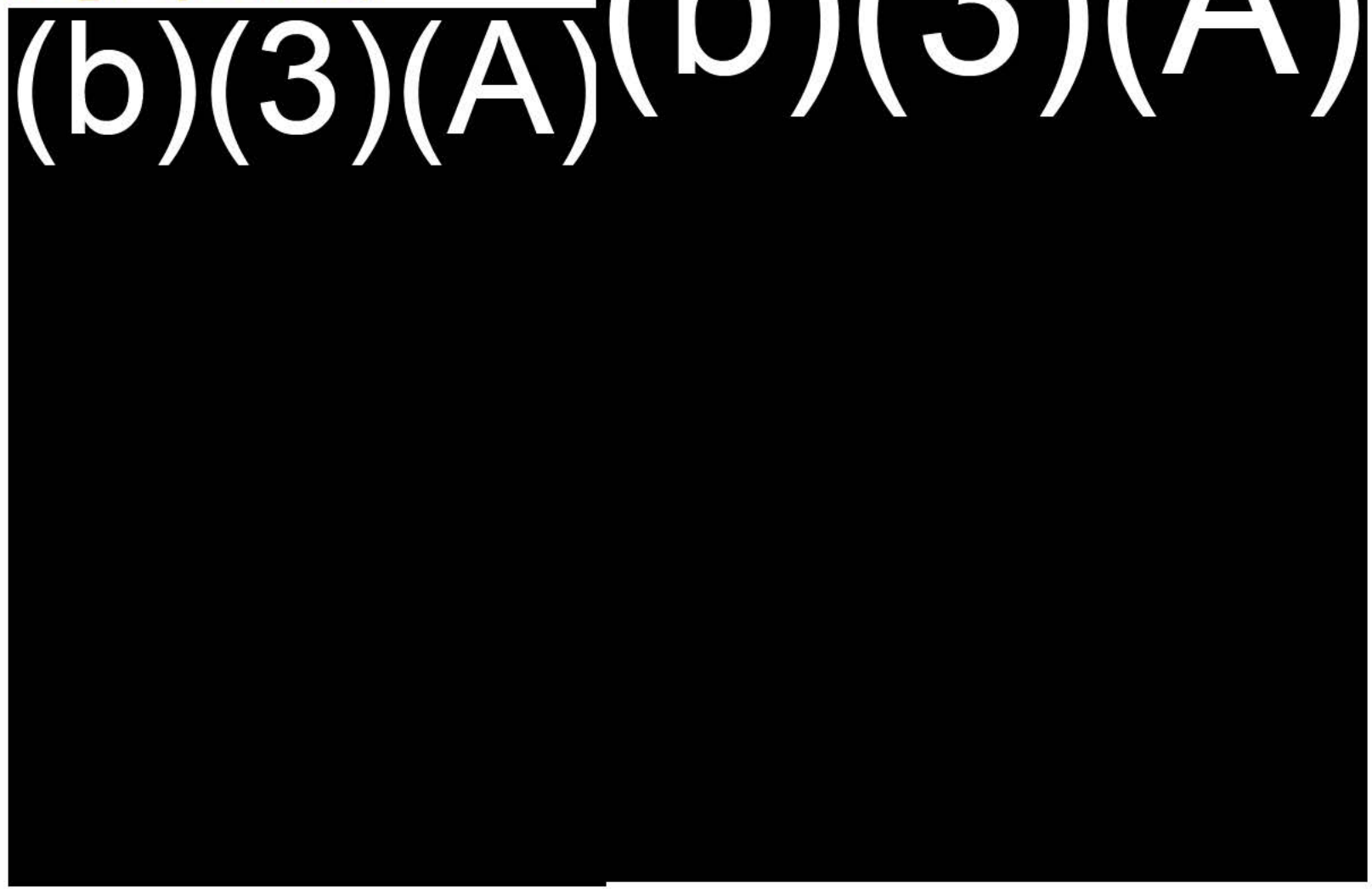
Ongoing Work



Ongoing Work (design by others)

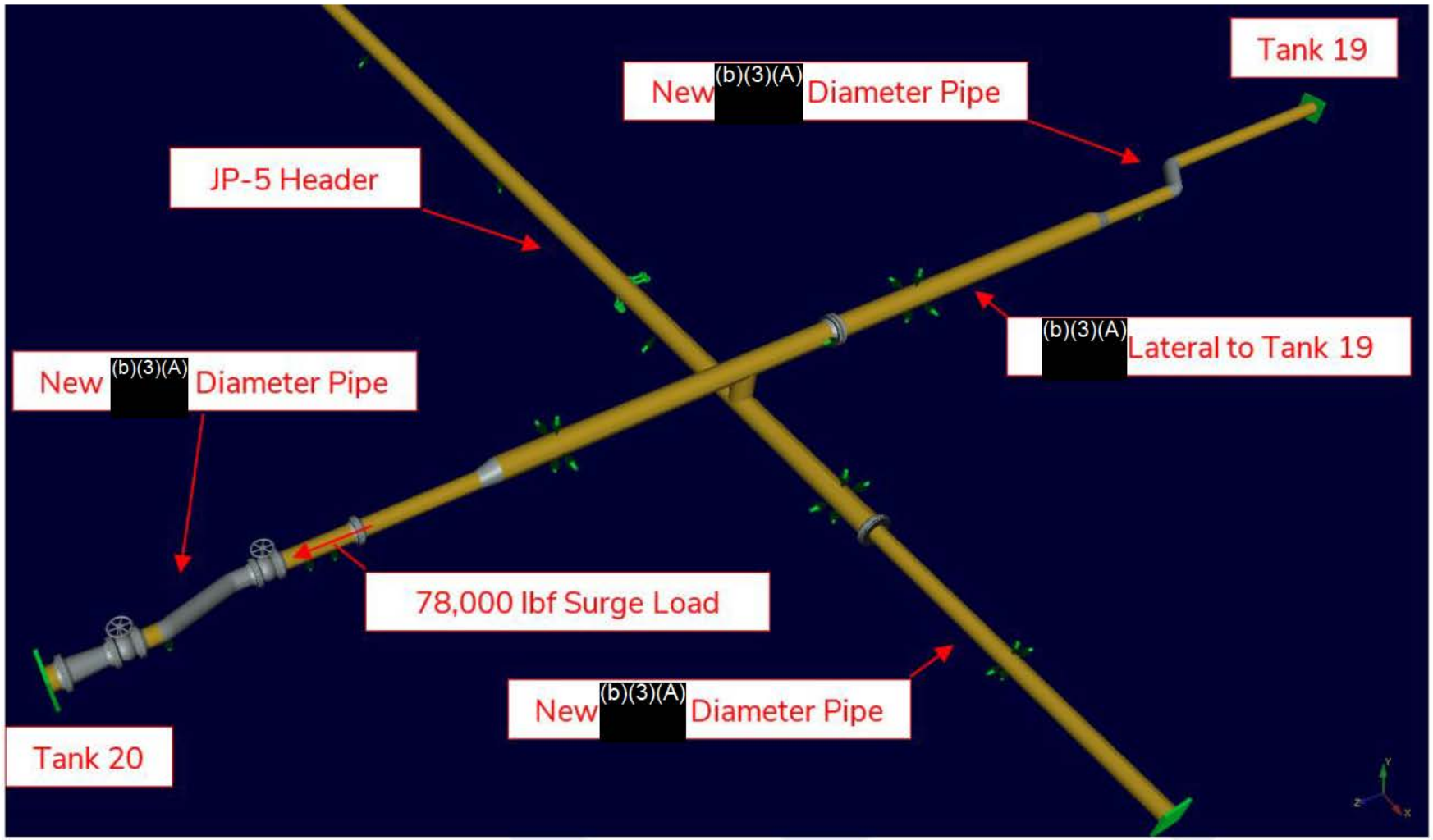
(b)(3)(A)

(b)(3)(A)



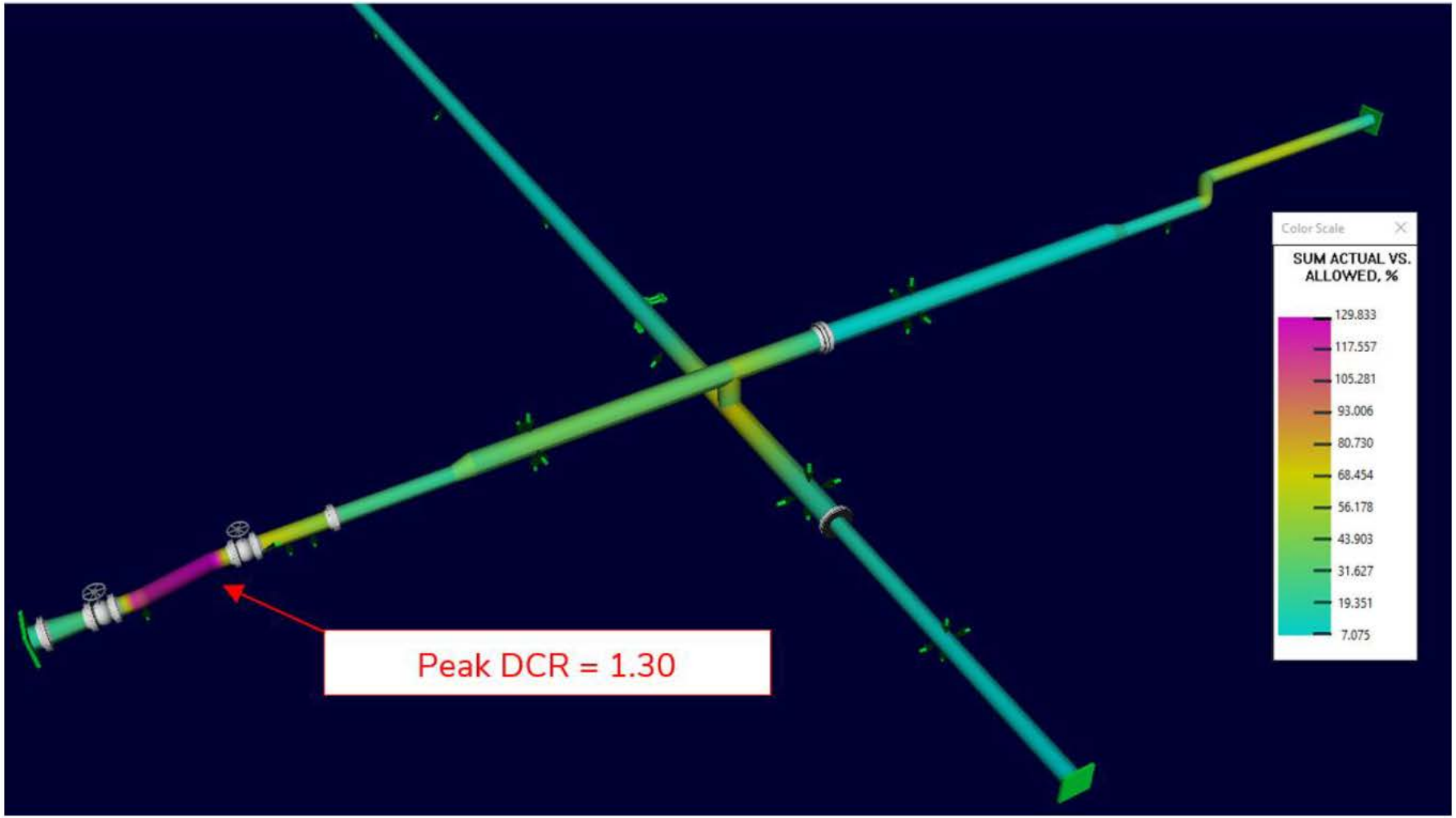
SGH

FE Model with Connected Piping



SGH

Surge Load Applied to Tank 20 Ball Valve



Based on our evaluation, piping with bends at the tank entrances is susceptible to potential overstress due to surge loads.

We recommend further investigation to determine the extent of the issue and potential mitigation for all tanks.

Marking Removed

SGH

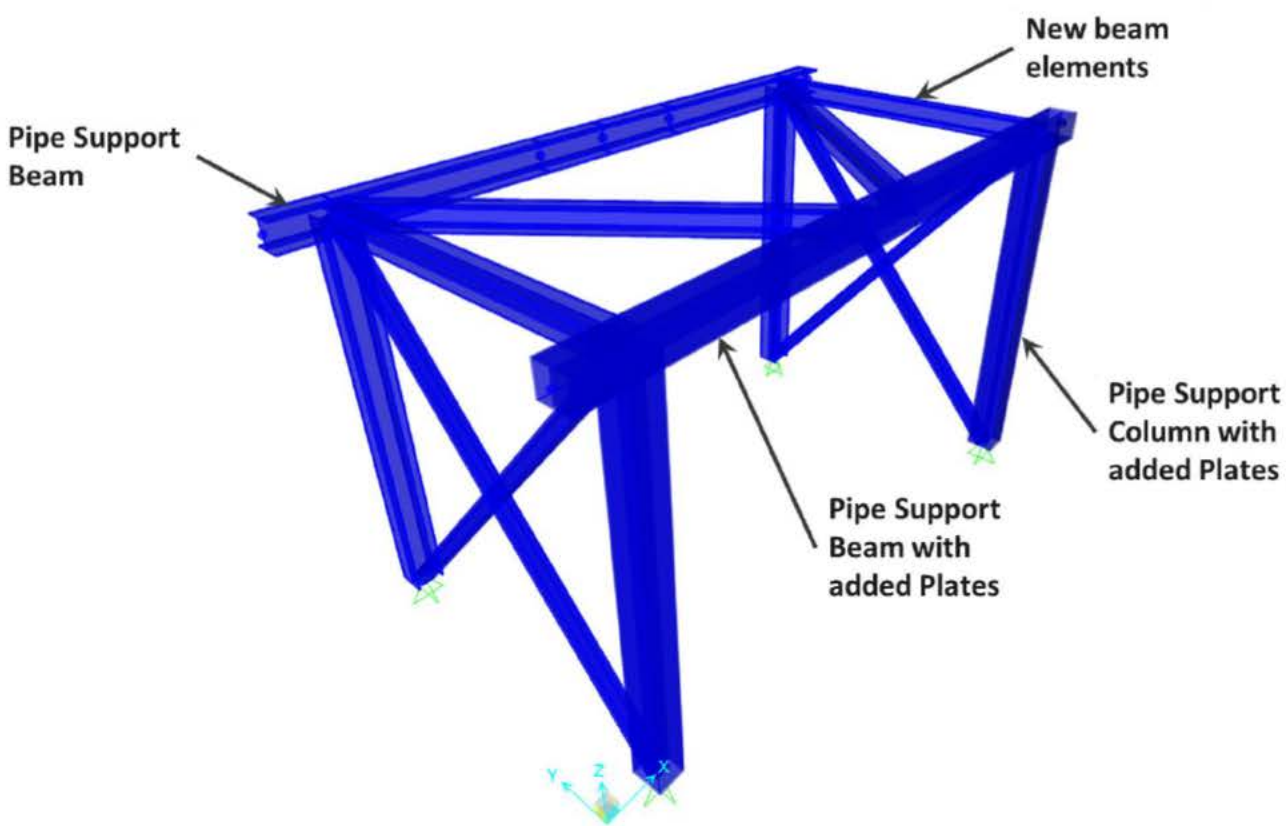
Conceptual Axial Restraint (typical) and Frame Modifications at Tank 20

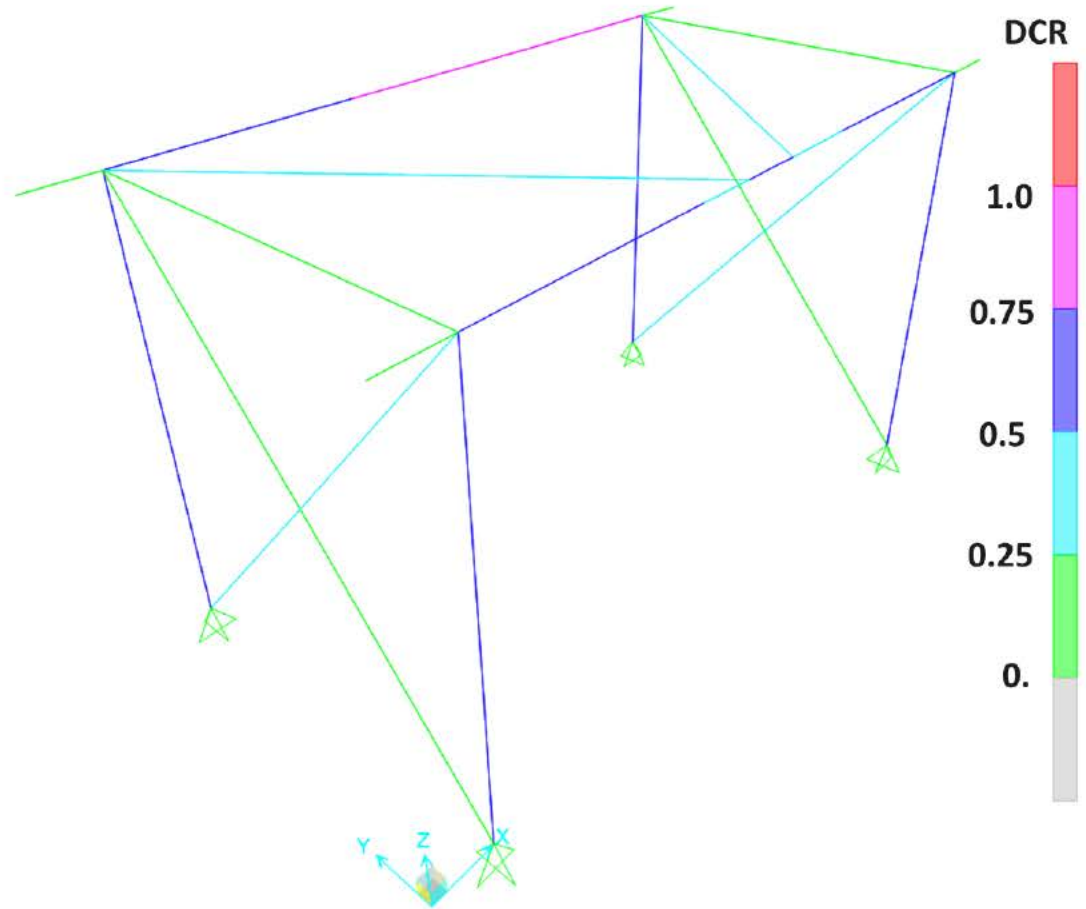
(b)(3)(A)

Marking Removed

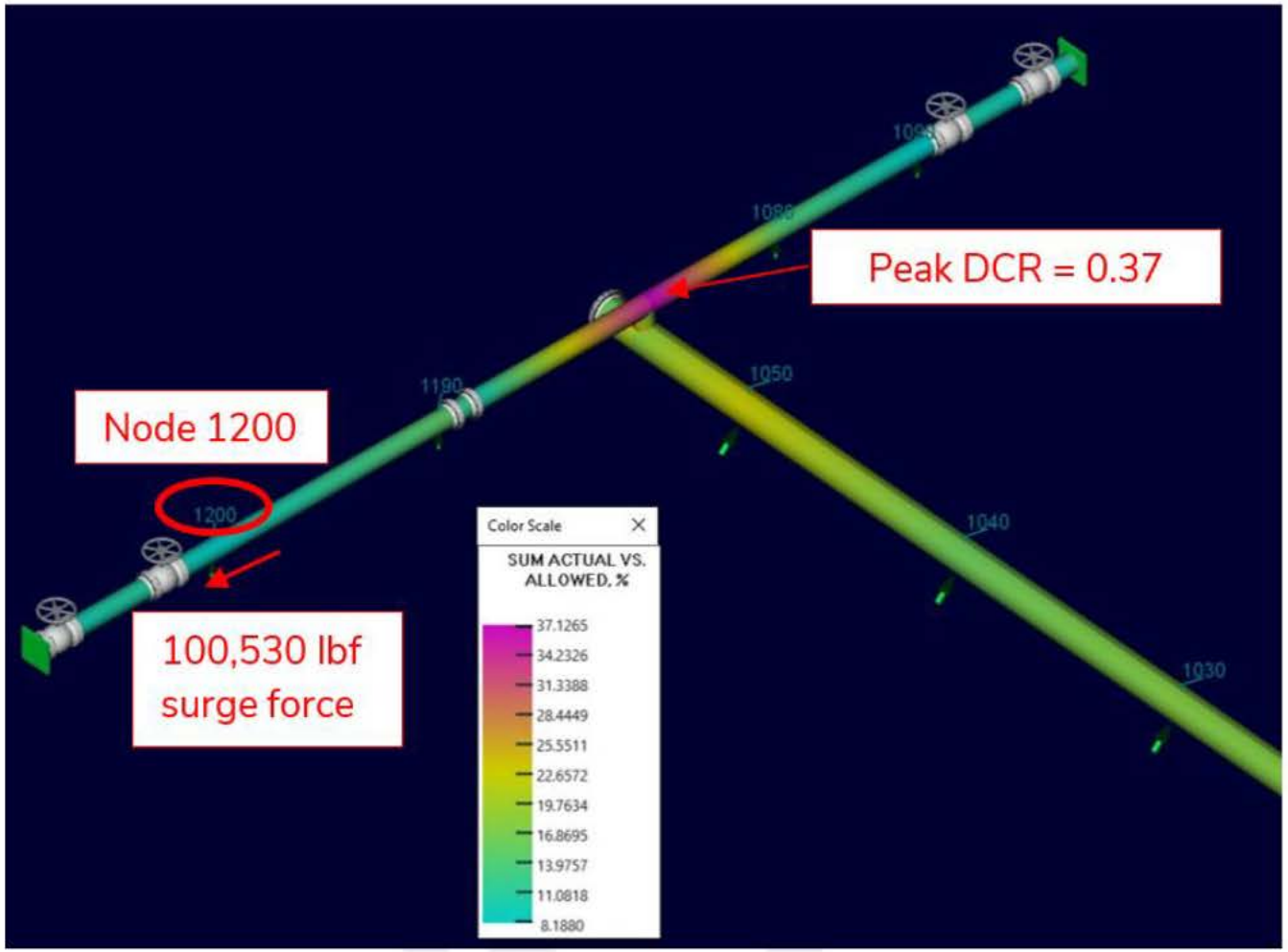
SGH

Conceptual Axial Restraint (typical) and Frame Modifications at Tank 20

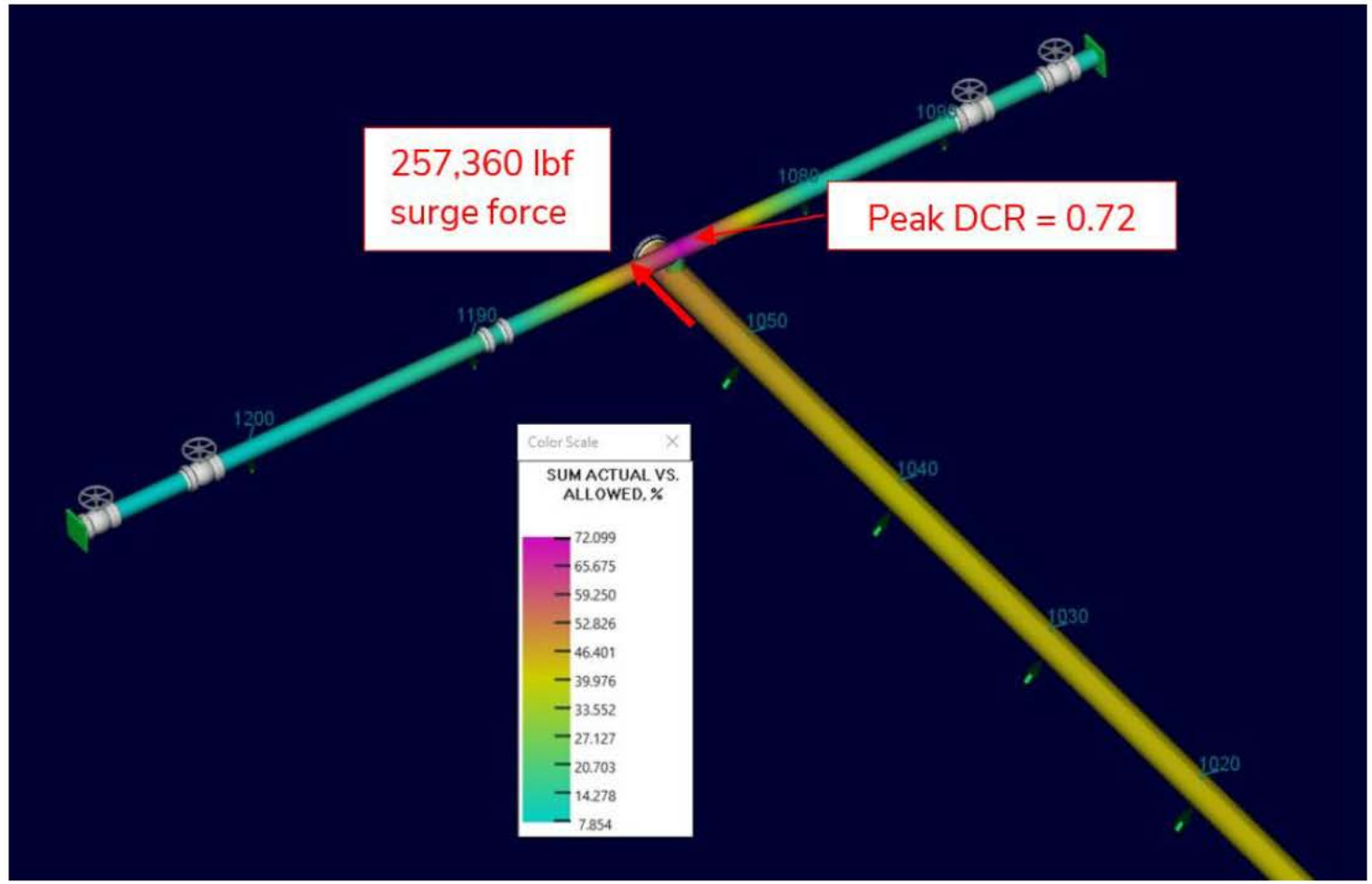




F-76 Line Surge Load Applied to Tank 15 Ball Valve



F-76 Line Surge Load Applied to Main Header Blind Flange



SGH

F-24 Surge Load Applied to Main Header Blind Flange

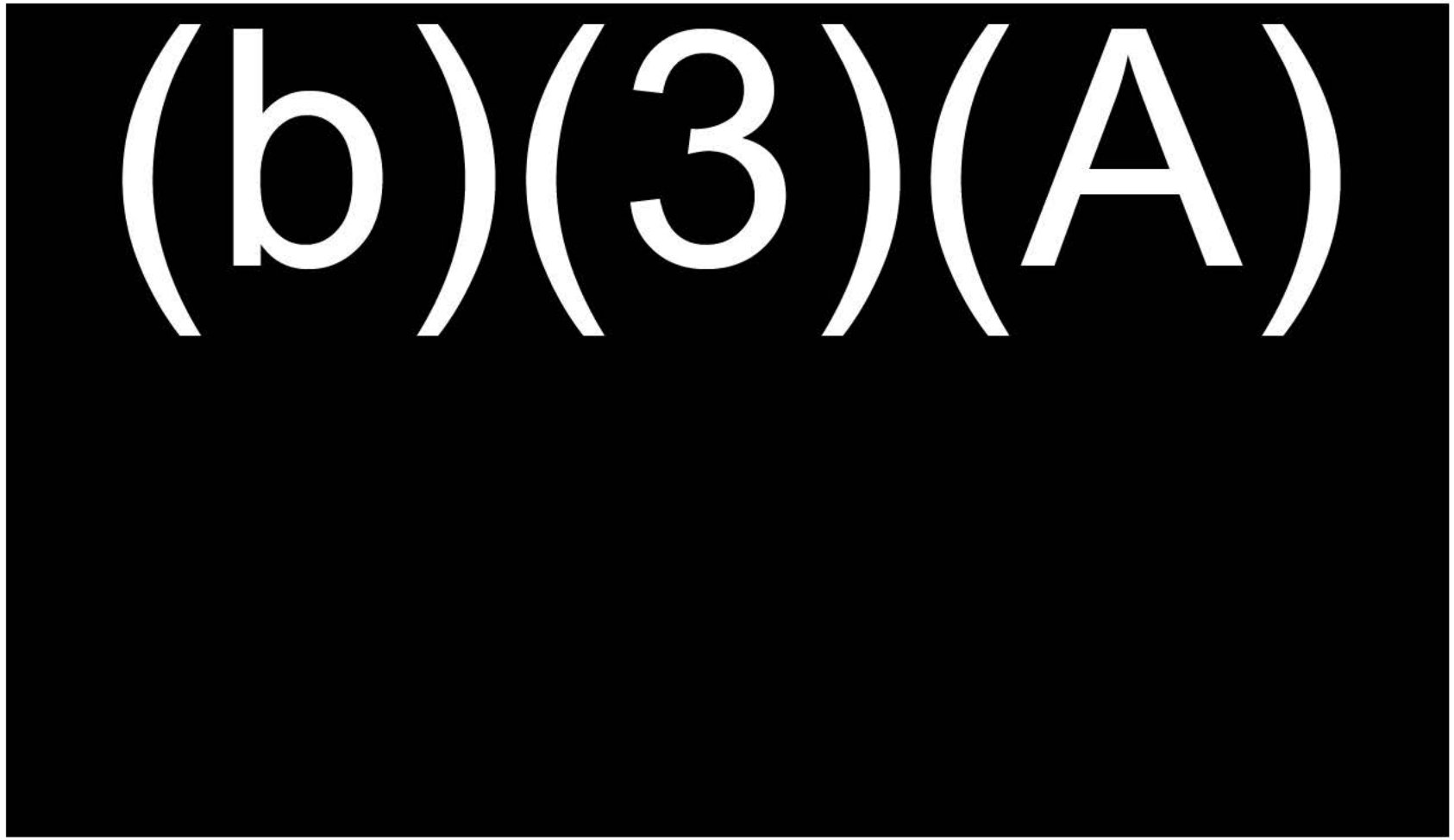
As-observed Configuration

With Axial Restraint

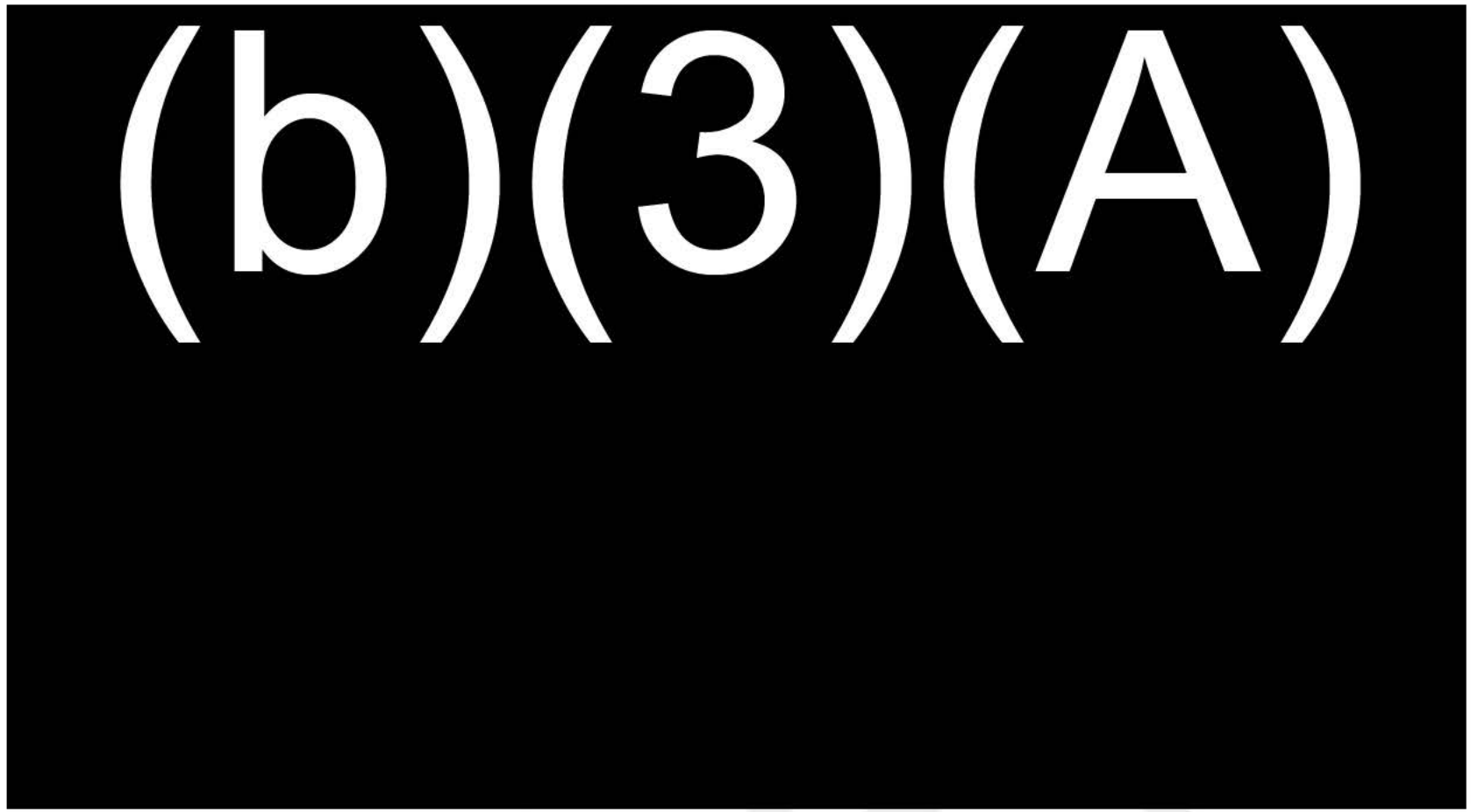
(b)(3)(A)

SGH

Tanks 13 and 14 Area Modifications (design by others)

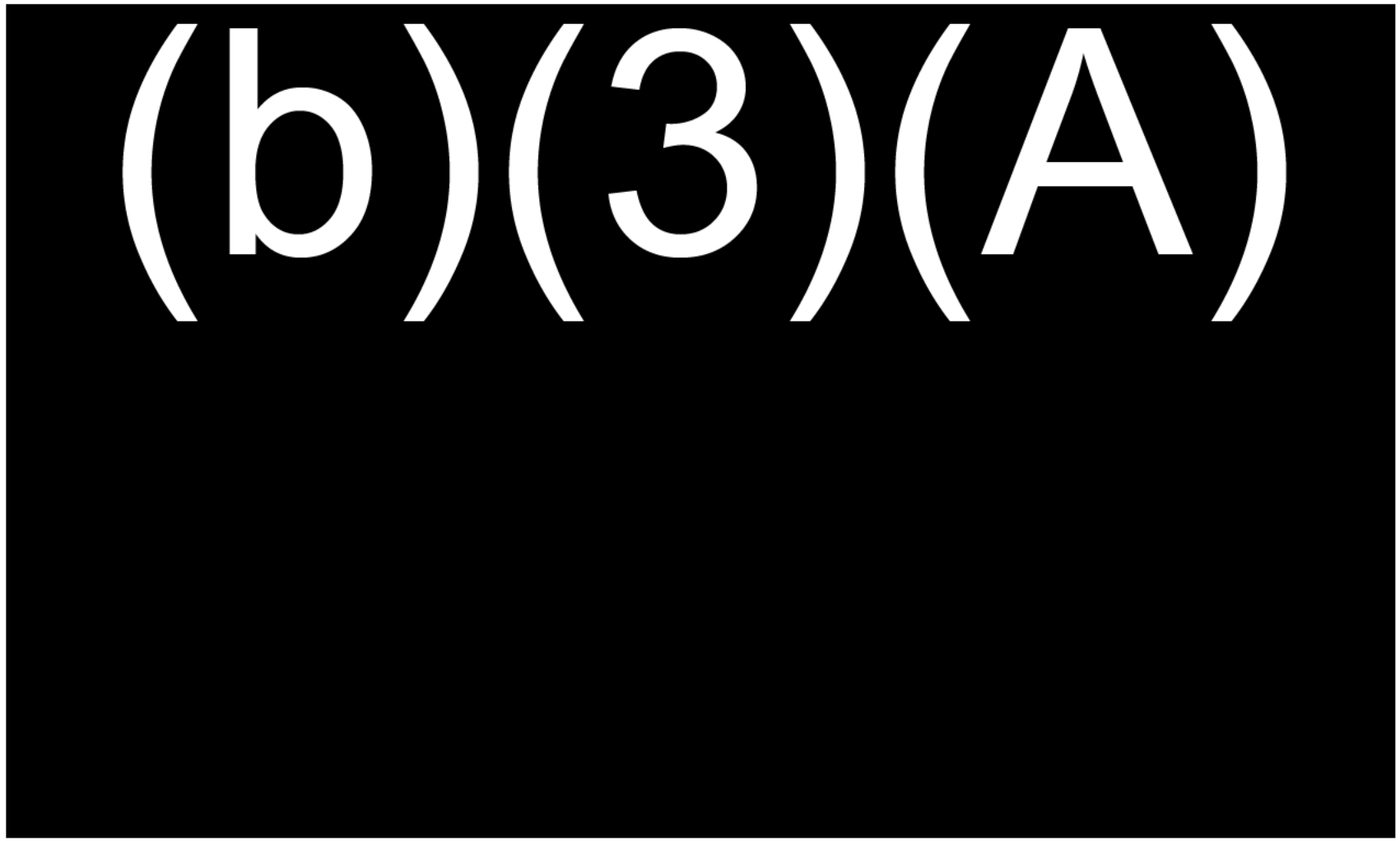


FE Model with Planned Modifications



SGH

F-24/JP-5 Surge Load Applied to Tank 14 Side Temporary Piping



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SURGE EVENT ANALYSIS – DEFUELING MODELS

SGH

DCR Summary

Model	Surge Load Location	DCR (Before Retrofit)	DCR (After Retrofit)
JP-5 Defueling Models at Tanks 19-20	Tank 19 Spectacle Blind	1.05	0.26
	End of JP-5 Header Blind Flange	0.27	
	Tank 20 Ball Valve	1.30	0.39
F-76 Defueling Models at Tanks 15-16	Tank 15 Ball Valve	0.37	
	End of F-76 Header Blind Flange	0.72	
	Tank 16 Ball Valve	0.36	
JP-5/F-24 Defueling Models at Tanks 15-16	Tank 15 Ball Valve	0.35	
	End of F-24 Header Blind Flange	3.39	0.46
	Tank 16 Ball Valve	0.35	
Tank 13-14 Defueling Models	F-76 Blind Flange - Tank 14 Side	0.24	
	F-24/JP-5 Blind Flange - Tank 14 Side	1.56	0.25
	F-76 Ball Valve - Tank 13 Side	0.24	
	F-24/JP-5 Ball Valve - Tank 13 Side	1.45	0.26

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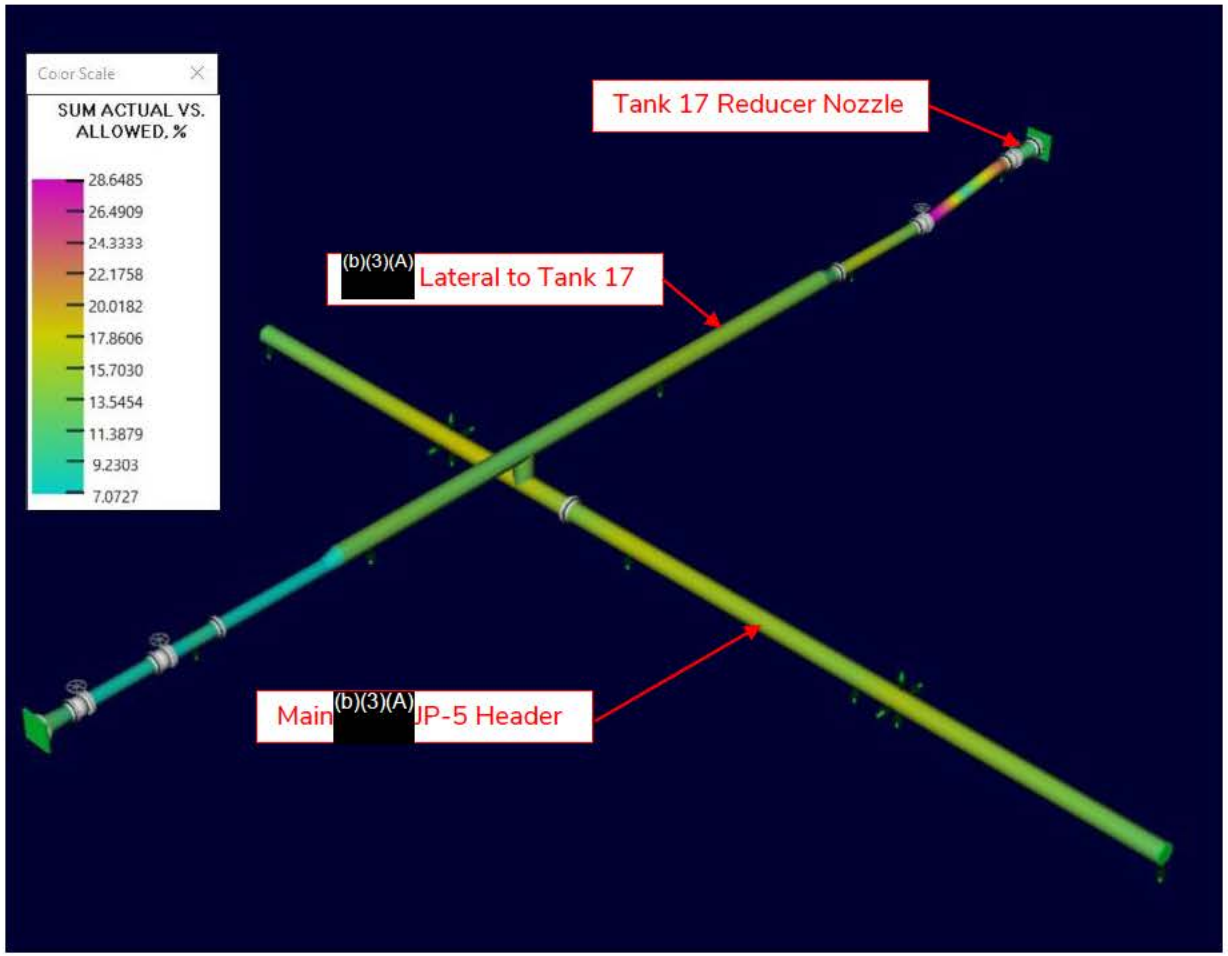
Tank 17 Nozzle Analysis

(b)(3)(A)



Unsupported Valves in Harbor Tunnel

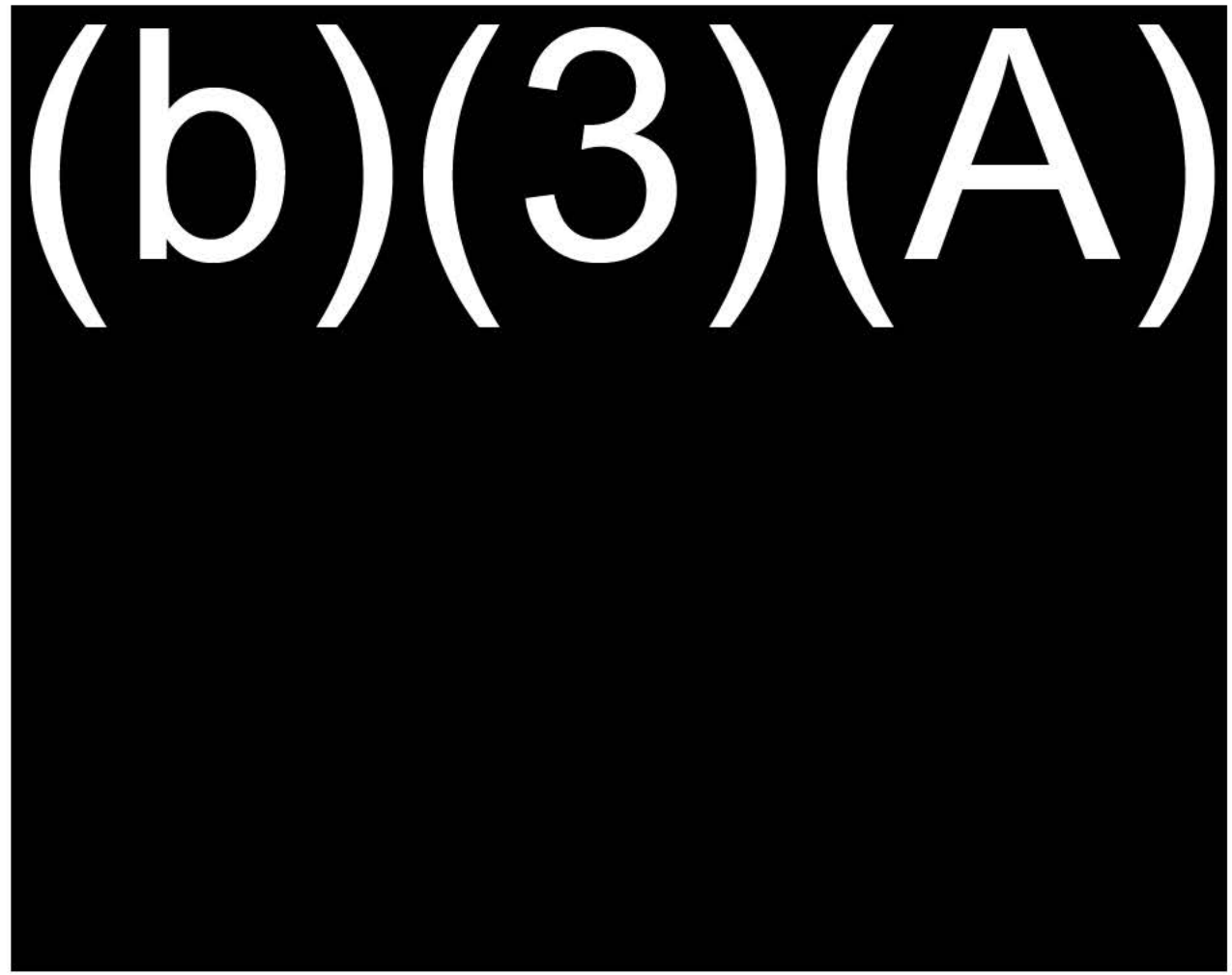
(b)(3)(A)

SGH

Local Allowable Stress Checks

- Pipe supports (for JP-5/F-24 lines) resting on (b)(3)(A) F-76 pipe
- Observed at pipe supports 138 through 143 and pipe support 195
- Checked local stresses in the F-76 pipe

Pipe Support No.	DCR
Supports 138 through 143	0.16
Support 195	0.30



SGH

Local Buckling Under Vacuum Condition

- Reference: Offshore Standard DNV-OS-F101
- Cases checked:
  - Vacuum only
  - Combined loading

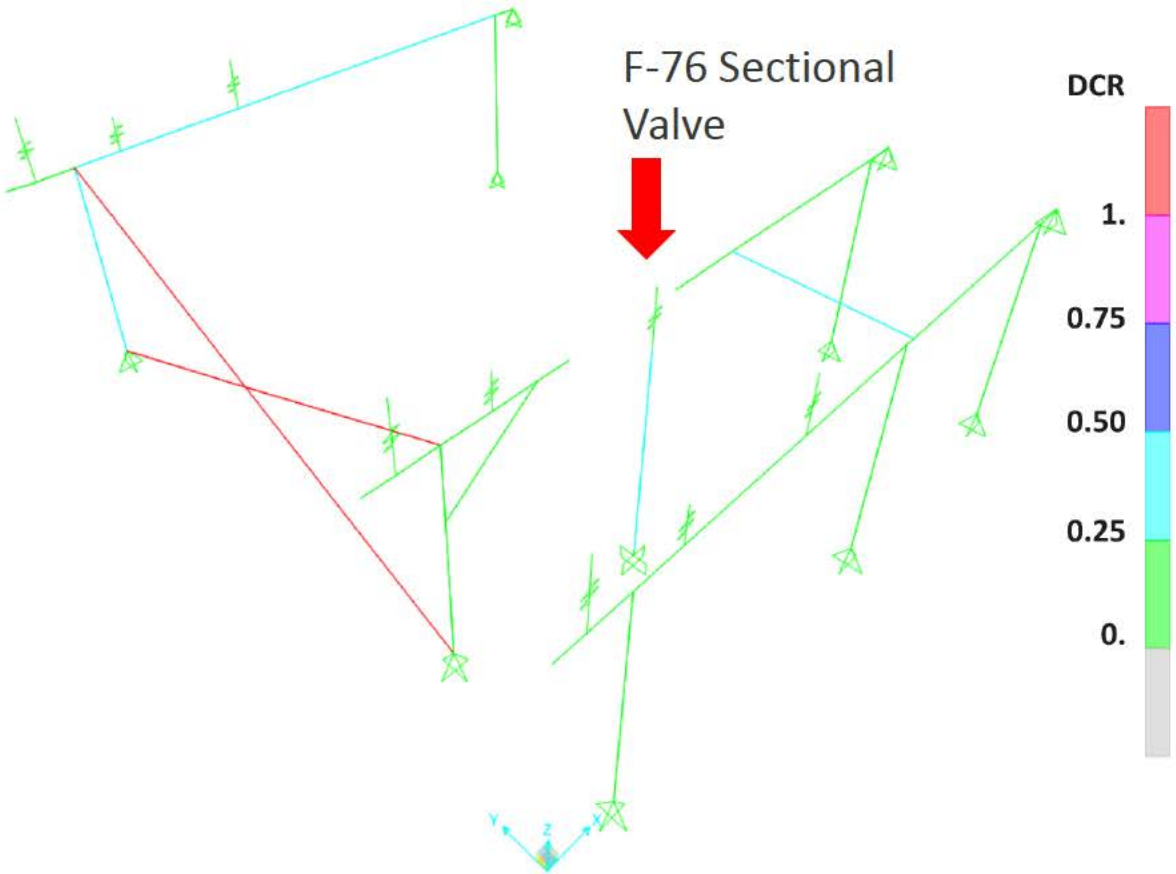
Local Buckling Case	DCR
Vacuum Only	0.45
Combined Loading	0.48

- Dresser coupling vacuum test
  - 20 inches of mercury
  - 66% of 1 atm. vacuum

SGH

Finite Element (FE) Analysis Results – Lower Access Tunnel

- Pipe Supports 46 to 48 – if corroded members are replaced



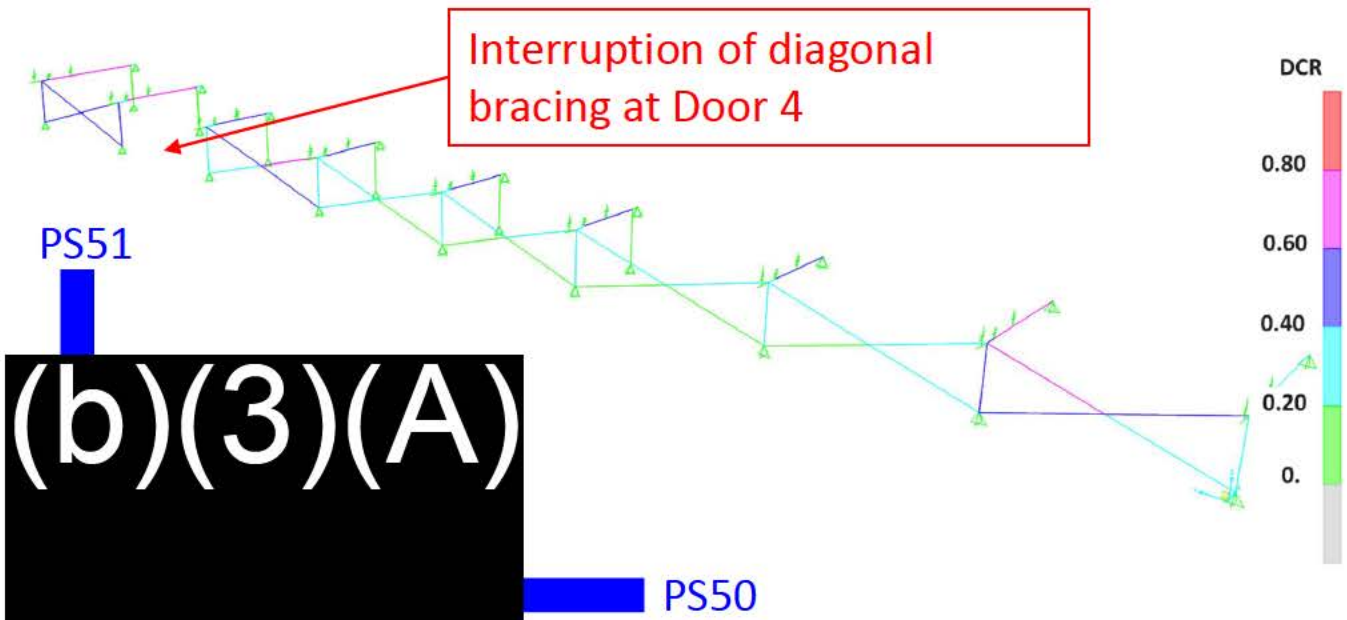
F-76 Sectional Valve

(b)(3)(A)

SGH

Finite Element (FE) Analysis Results – Lower Access Tunnel

- Pipe Supports 49 to 57



(b)(3)(A)

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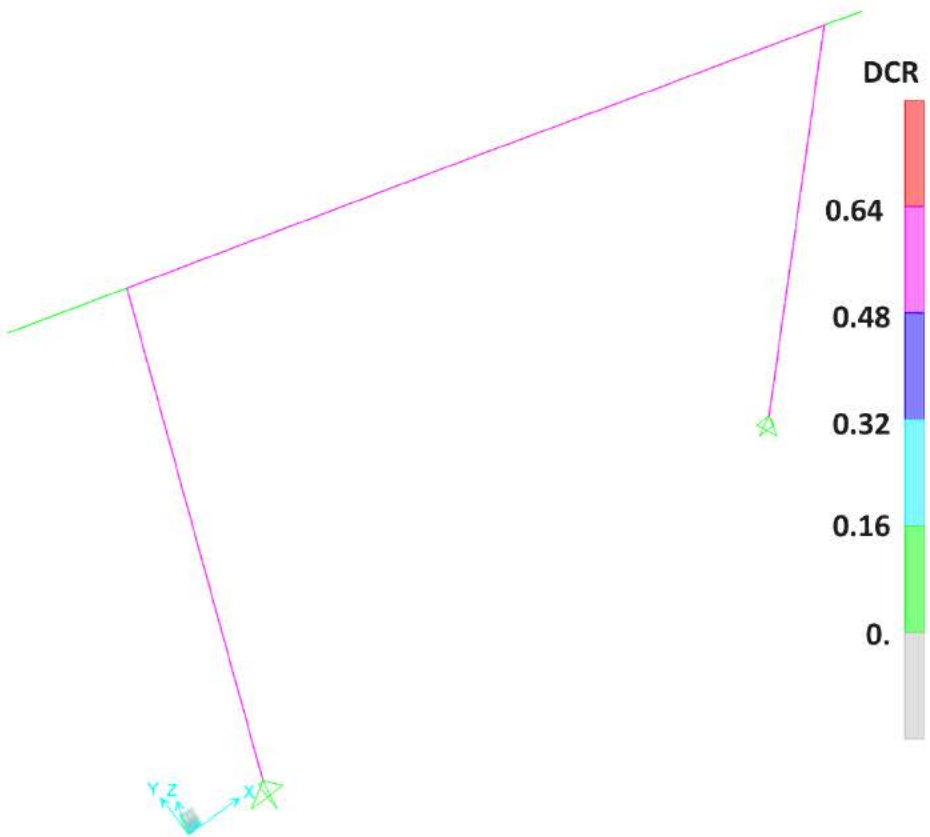
Finite Element (FE) Analysis Results – Gallery at Tanks

- Pipe Support Tank Gallery 20



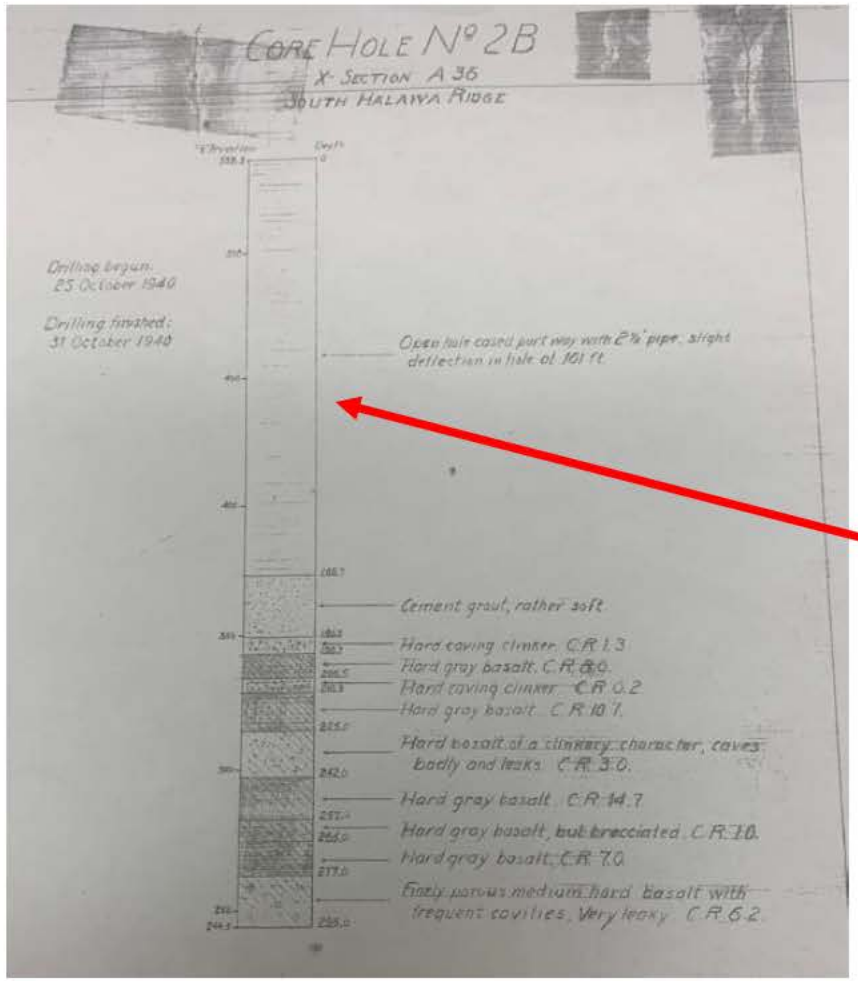
(b)(3)(A)

RESULTS OF PIPE SUPPORT ANALYSIS

Summary of DCRs

Model	Maximum DCR (After Retrofit)	Comment
Harbor Tunnel Pipe Supports	0.60	Adequate for operational and seismic loads
Supports 30 to 38	0.55	Adequate for operational and seismic loads
Supports 46 to 48	4.37 (0.53)	Needs retrofit for seismic loads and around the existing valve. Additional column and bracing added
Supports 49 to 57	0.65	Adequate for operational and seismic loads
Supports 78 to 92	4.47 (0.28)	Adequate for operational loads, two additional braces required for seismic loads.
Pipe Support 97	0.24	
Pipe Support 100	0.73	
Pipe Supports in Tank Gallery 10	0.39	
Pipe Supports in Tank Gallery 15	0.34	

Rock/Soil Properties around Underground Storage Tanks



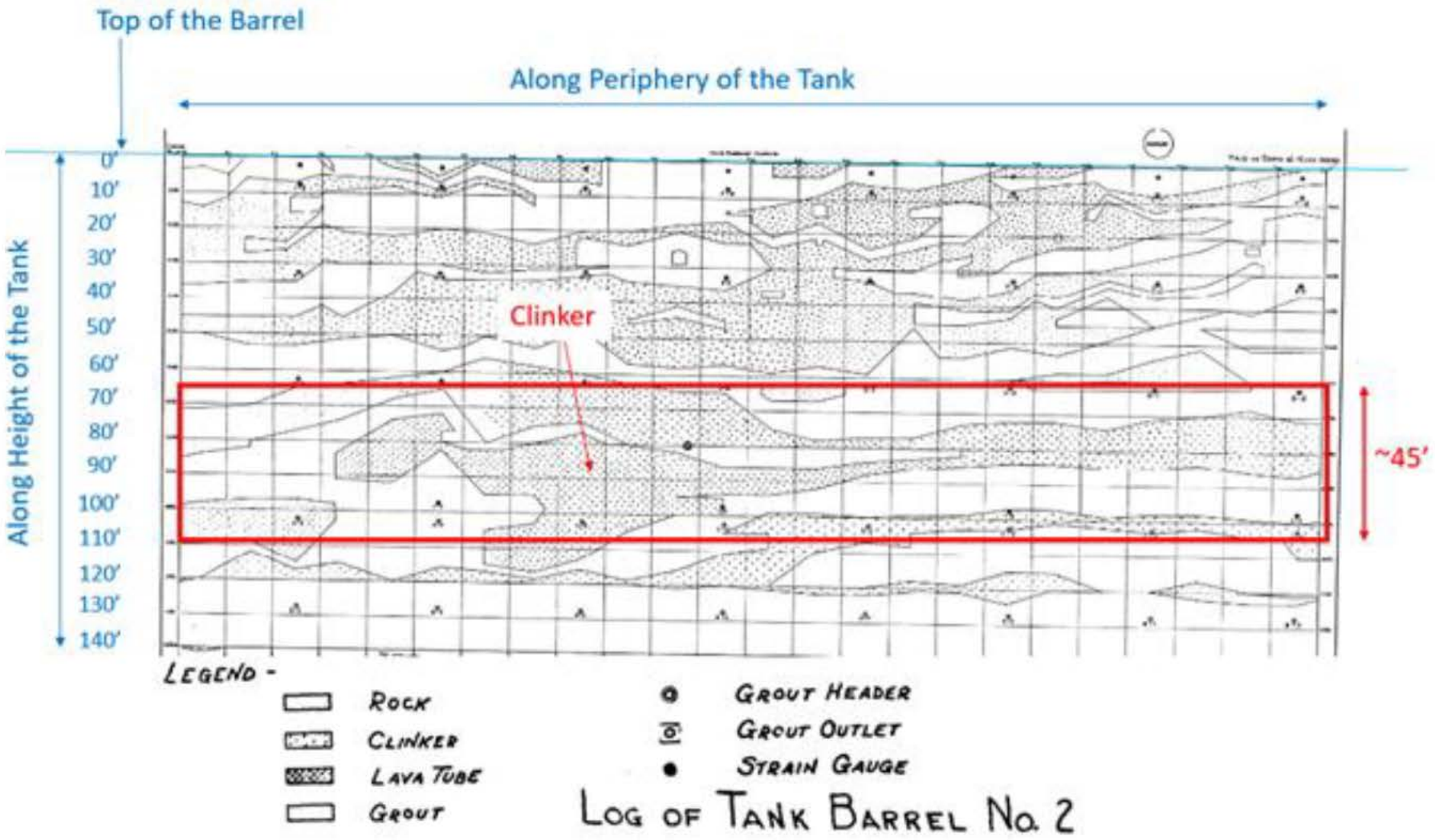
Bore Hole 2B

- Reviewed bore hole data, log of formations data, and other relevant documents to estimate the soil stiffness properties applied as the boundary conditions in the tank FE models

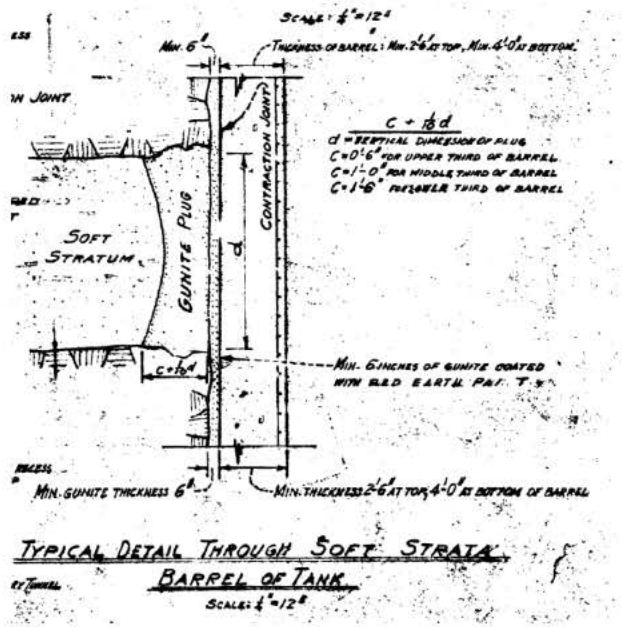
(b)(3)(A)

Plan view showing bore hole locations relative to the tanks

Clinker Formation and Gunite Plug

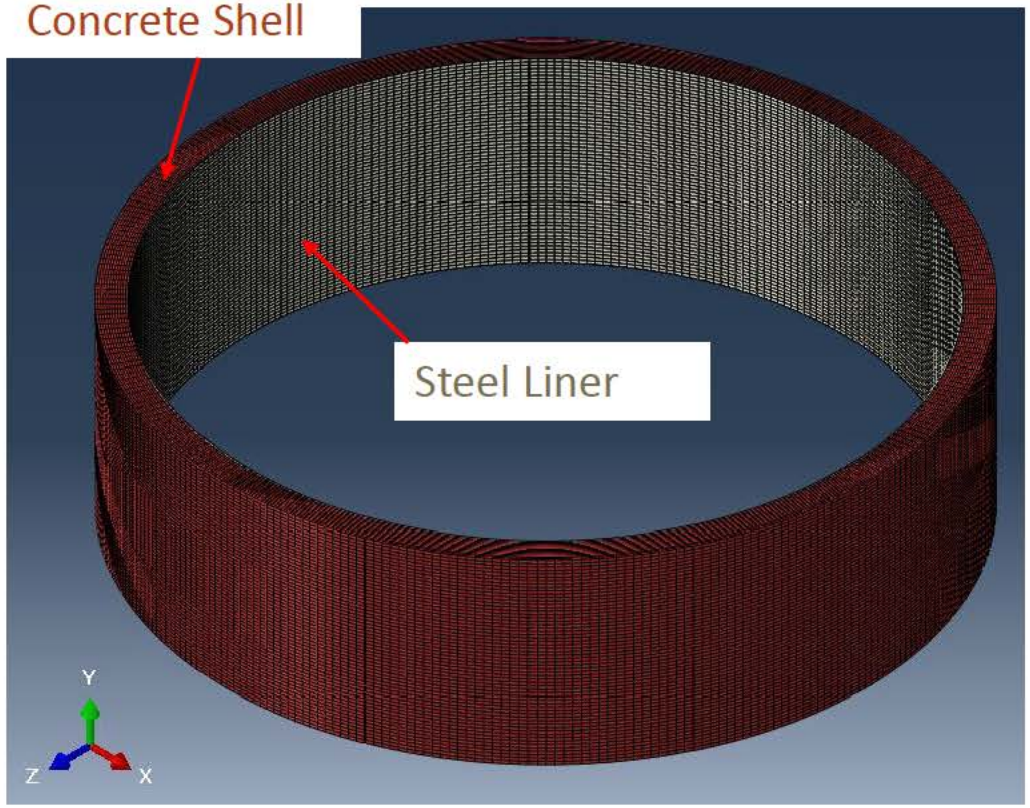


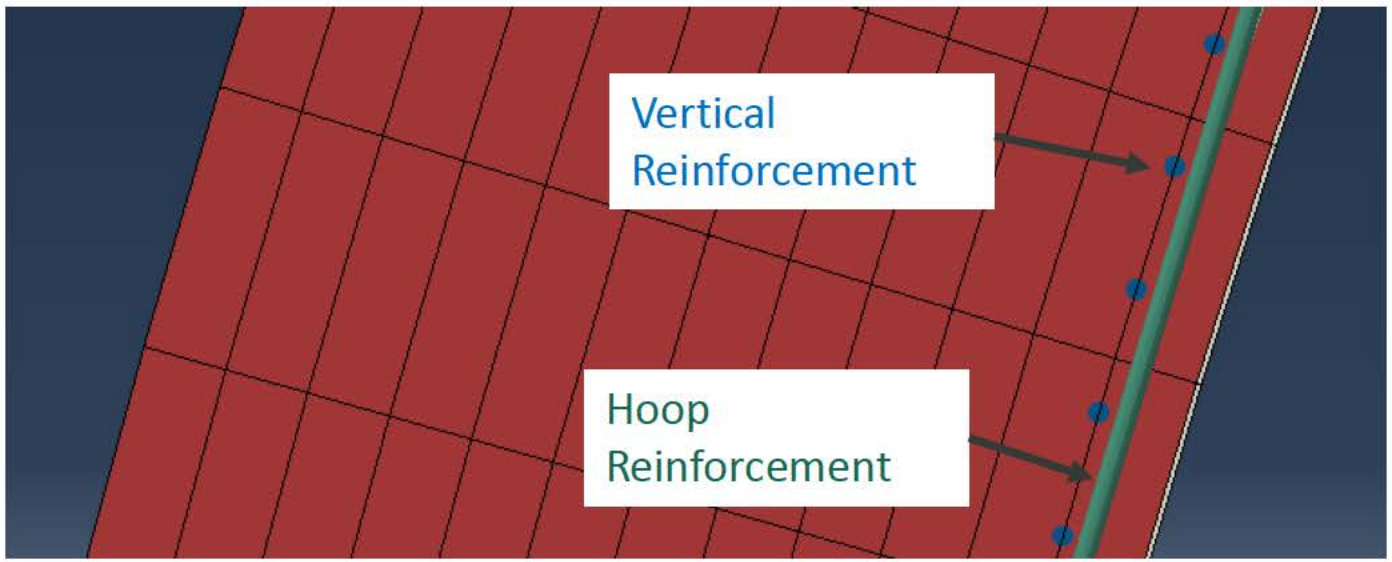
LOG OF TANK BARREL No. 2



TYPICAL DETAIL THROUGH SOFT STRATA
BARREL OF TANK

Local FE Model





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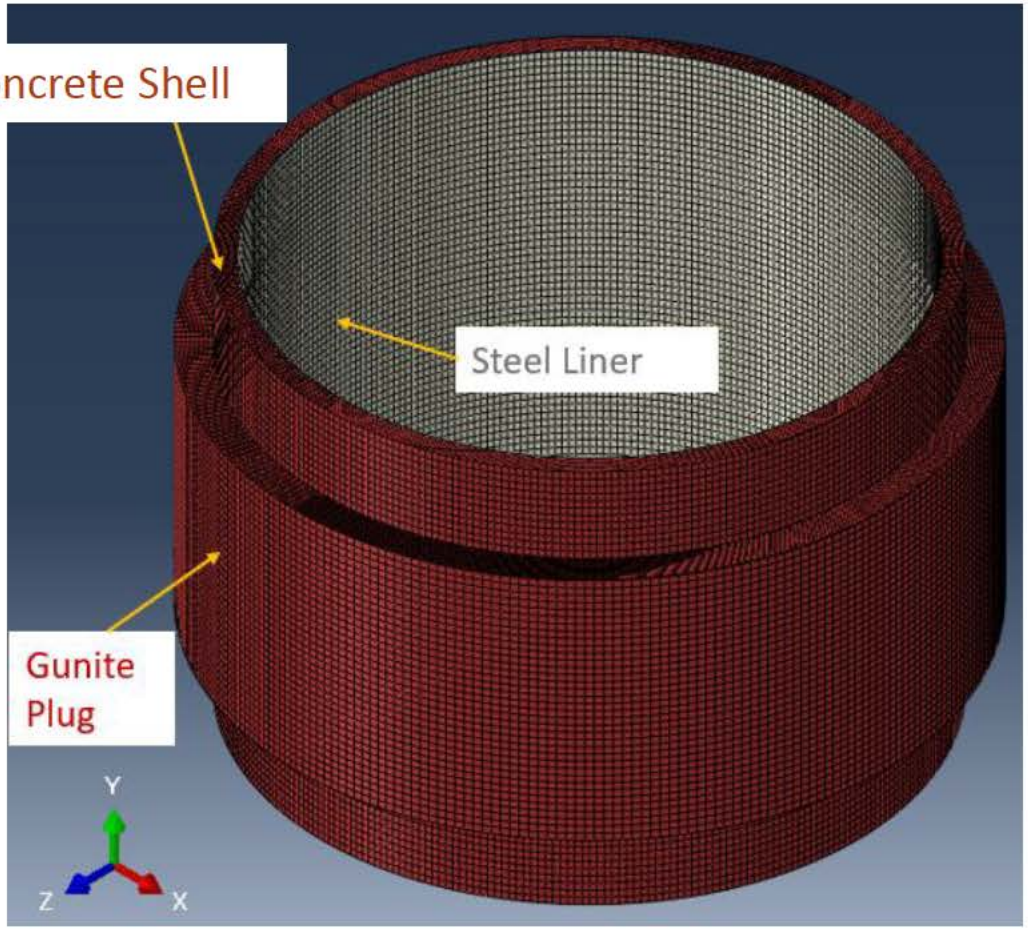
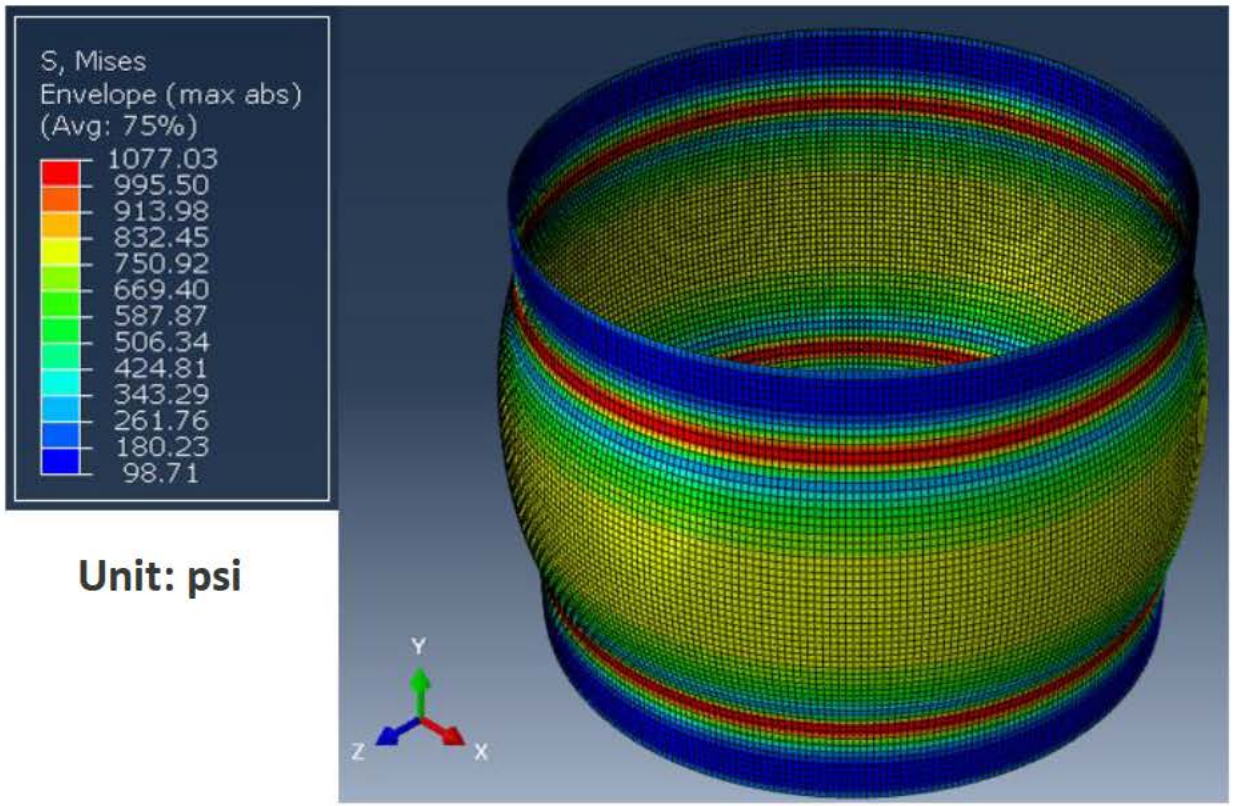
Hydrostatic Response





Unit: psi

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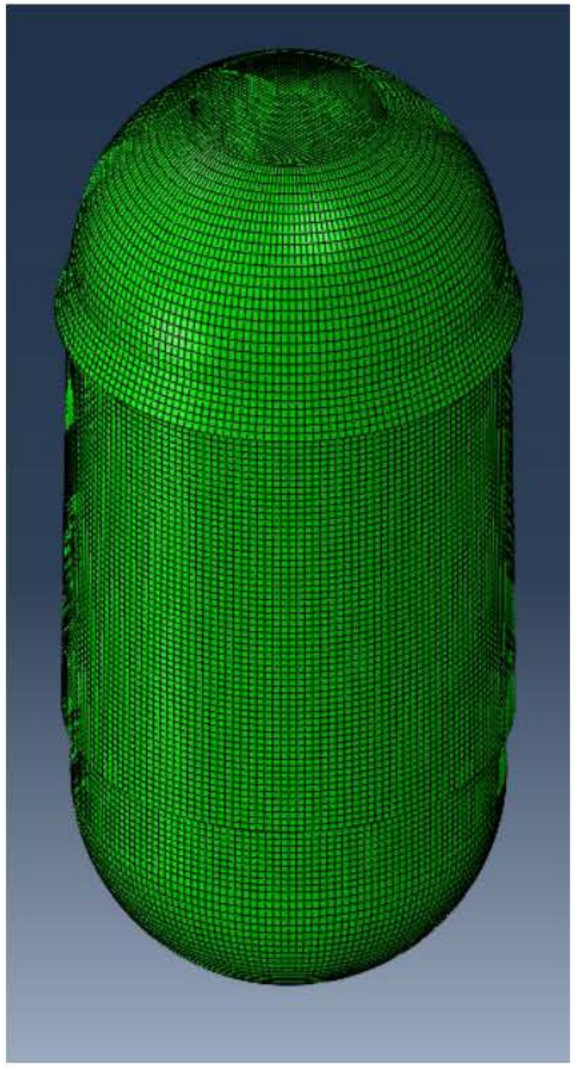
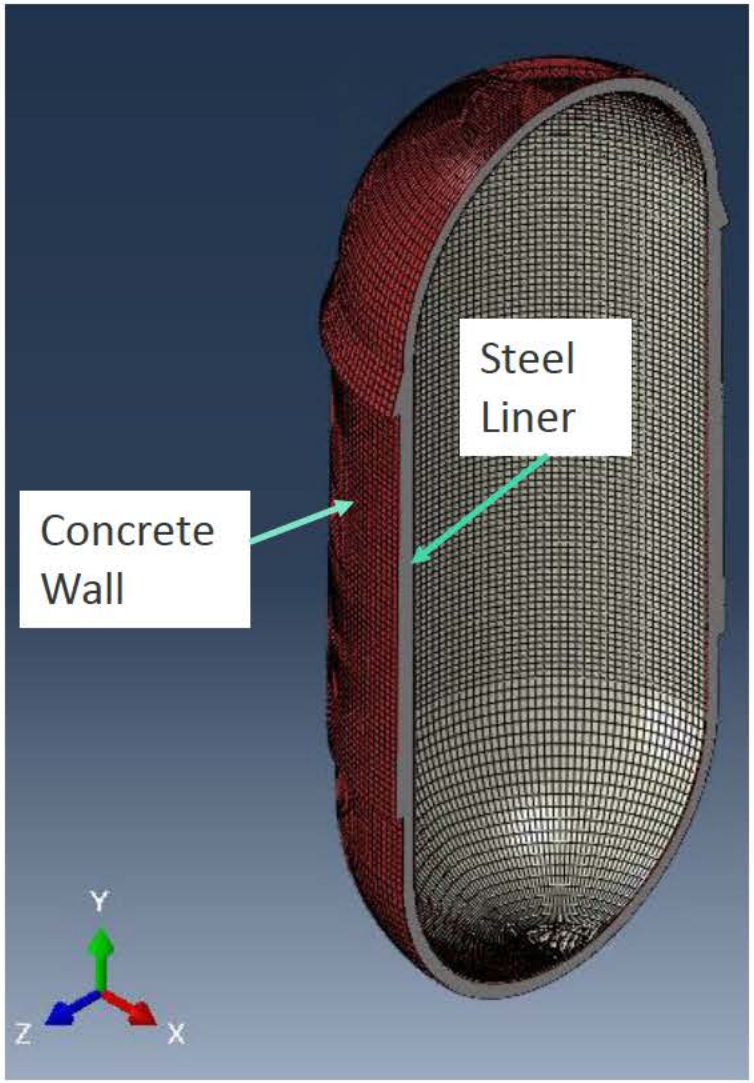
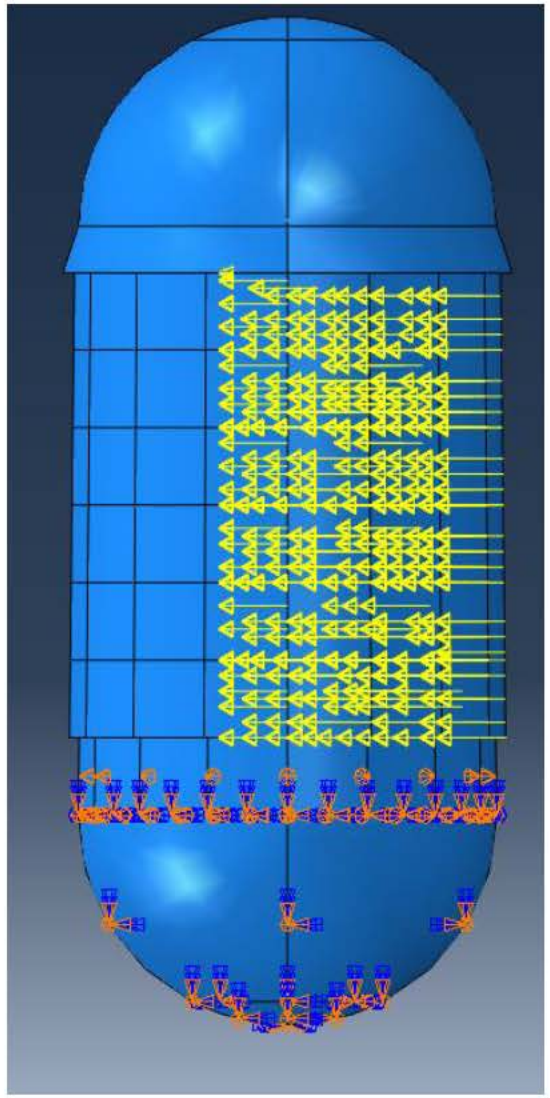
UNDERGROUND STORAGE TANK – GLOBAL FE MODEL







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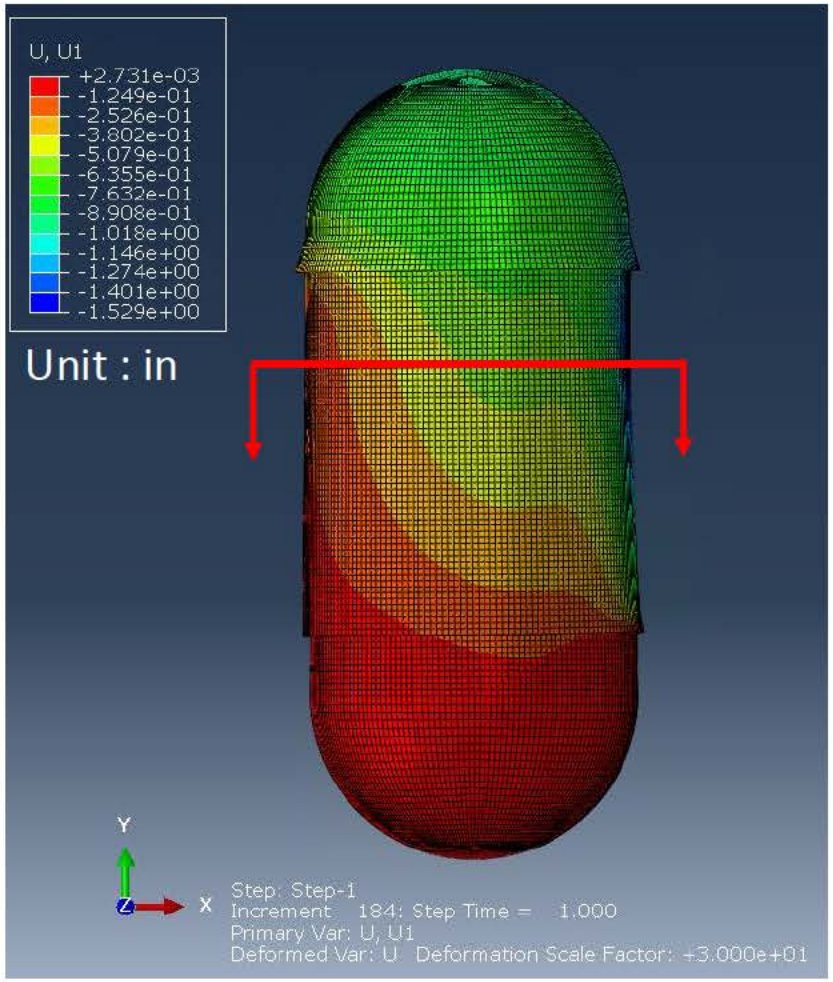
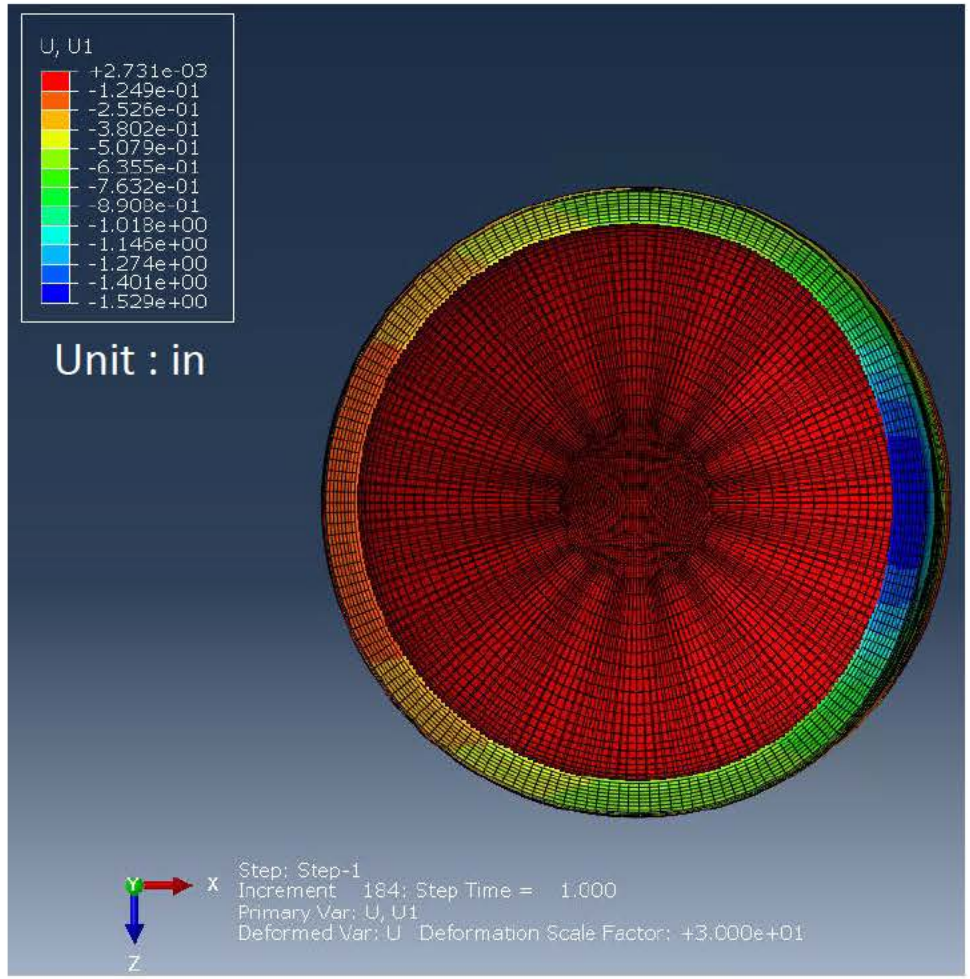
Horizontal Deflections





- Maximum displacement for the global response (rigid body rotation) is less than 0.5 in
- Local bending of tank wall results in approximately 1.5 in deflection

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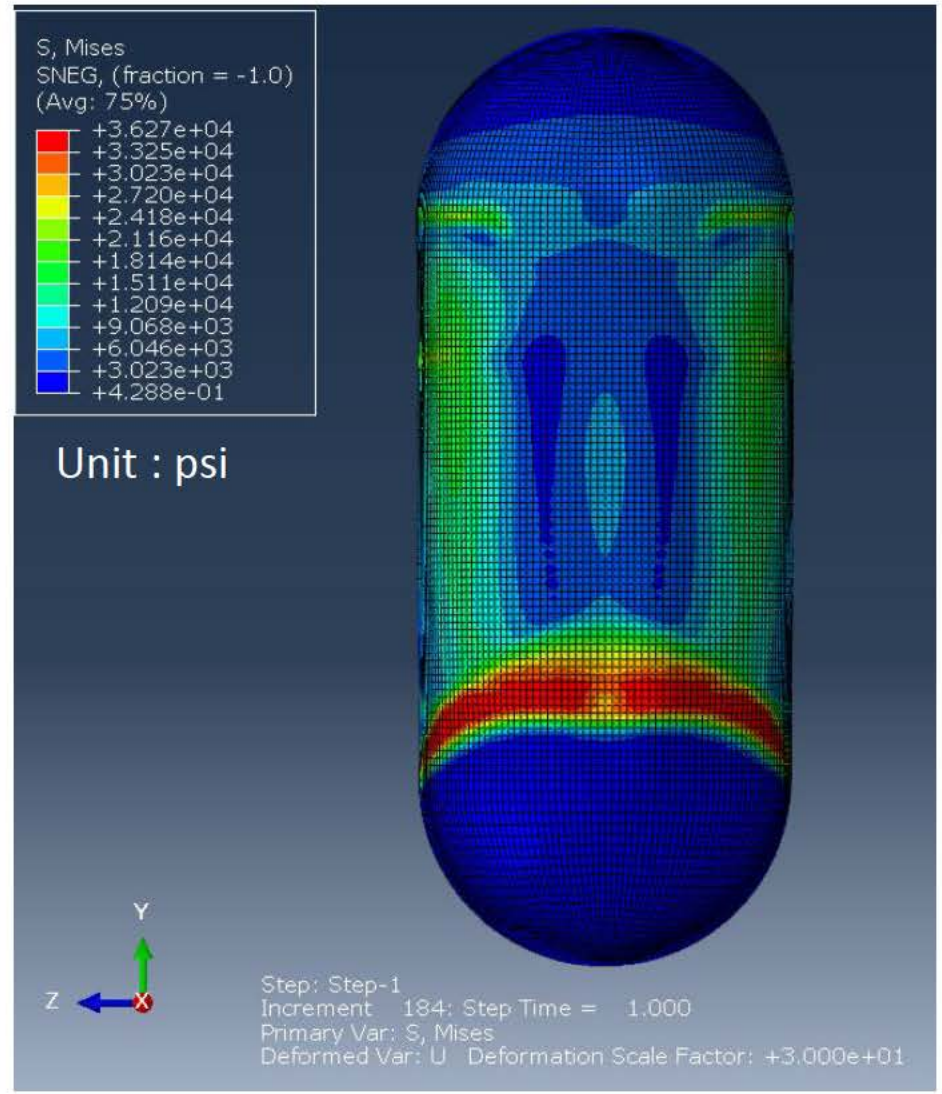
Steel Liner Stresses

- Liner plate might be overstressed at the interface of the clinker layer and the solid rock around the tank
- The plastic strains are relatively small (~0.004)
- Rupture of the liner highly unlikely due to a design level earthquake event



SGH

Summary of API 650 Appendix E Evaluation Results

Location	Upper Tank Farm						FORFAC	
Tank ID	46	47	48	53	54	55	B1	B2
Diameter	164'-0"	164'-0"	164'-0"	164'-0"	164'-0"	160'-0"	60'-0"	60'-0"
Height	38'-5"	40'-0"	40'-0"	39'-11"	40'-0"	42'-0"	21'-9"	21'-9"
Anchored(A)/ Unanchored (U)	U	U	U	U	U	U	U	U
New Double Bottom	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Is Tank Adequate based on API 650 Evaluation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

- For Tank 55 at Upper Tank Farm, evaluation results indicate that the tank is adequate to resist a design seismic event and will likely not uplift. However, we still recommend that overconstrained piping be mitigated for Tank 55 to avoid potential tank damage and loss of product in the event of tank uplift during an earthquake event.
- We similarly recommend that overconstrained stairways be mitigated at all tanks, as applicable.

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Summary of API 650 Appendix E Evaluation Results

Location	Near Lube Oil Facility	Entrance of Adit 3		Hickam Field			
Tank ID	301	311	AFFF	11-1	11-2	11-3	11-4
Diameter	42'-0"	21'-0"	33'-0"	93'-0"	93'-0"	63'-0"	63'-0"
Height	24'-0"	16'-0"	25'-0"	48'-0"	48'-0"	54'-0"	54'-0"
Anchored(A)/ Unanchored (U)	A	A	U	U	U	A	A
New Double Bottom	No	No	No	No	No	No	No
Is Tank Adequate based on API 650 Evaluation?	Yes	Yes	Yes	No	No	Yes	Yes

- For Tanks 11-1 and 11-2 at Hickam Field, evaluation results indicate that although the tanks are stable, there is potential tank uplift risk during a design seismic event assuming Seismic Use Group III. As a result, we recommend that overconstrained piping be mitigated for Tanks 11-1 and 11-2 to avoid potential tank damage and loss of product in the event of tank uplift during an earthquake event.
- We similarly recommend that overconstrained stairways be mitigated at all tanks, as applicable.

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Assessment Summary

- We conducted Fitness For Service (FFS) assessment of fuel pipes in the Harbor Tunnel and above ground according to API 579
- Our calculations are based on measurements taken by SGH staff during site inspections
- We adopted a conservative approach to the calculations, similar to previous FFS assessments by others
- Our assumptions included:
  - Maximum operating pressure of 300 psi
  - Widespread corrosion pitting at areas of section loss
  - Yield strength of 30 ksi, based on previous test data

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Location	Fuel	Pipe Outer Diameter (in.)	Nominal Pipe Thickness (in.)	External Pit Depth (in.)	Pit Depth (% of Nominal)	Level I Assessment (Pass/Fail)	Level II Assessment (Pass/Fail)
(b)(3)(A)			0.375	0.14	37.30%	Pass	
			0.375	0.15	40.00%	Pass	
			0.28	0.1	35.70%	Pass	
			0.203	0.085	41.90%	Pass	
			0.203	0.085	41.90%	Pass	
			0.203	0.065	32.00%	Pass	
			0.375	0.08	21.30%	Pass	
			0.237	0.22	92.80%	Fail	Fail
			0.237	0.044	18.60%	Pass	
			0.375	0.13	34.70%	Fail	Pass
			0.25	0.038	15.20%	Pass	
			0.375	0.119	31.70%	Fail	Pass

Level I & II Assessments

- All measured corrosion pits passed the Level 1 assessment, apart from:
  - The pit in the riser of Bravo Pier, which had penetrated through 93% of the wall thickness
  - The two pits in the HT (b)(3)(A) diameter F-76 line also failed by a small margin
- We then reassessed using a Level II approach. The Harbor Tunnel pipe passed this assessment.

(b)(3)(A) Marking Removed

(b)(3)(A)

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STRUCTURAL AND PIPING SYSTEM IMPROVEMENT AND RETROFIT RECOMMENDATIONS FOR DEFUELING AND CONTINUING OPERATIONS

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Design Improvement Recommendations for Defueling

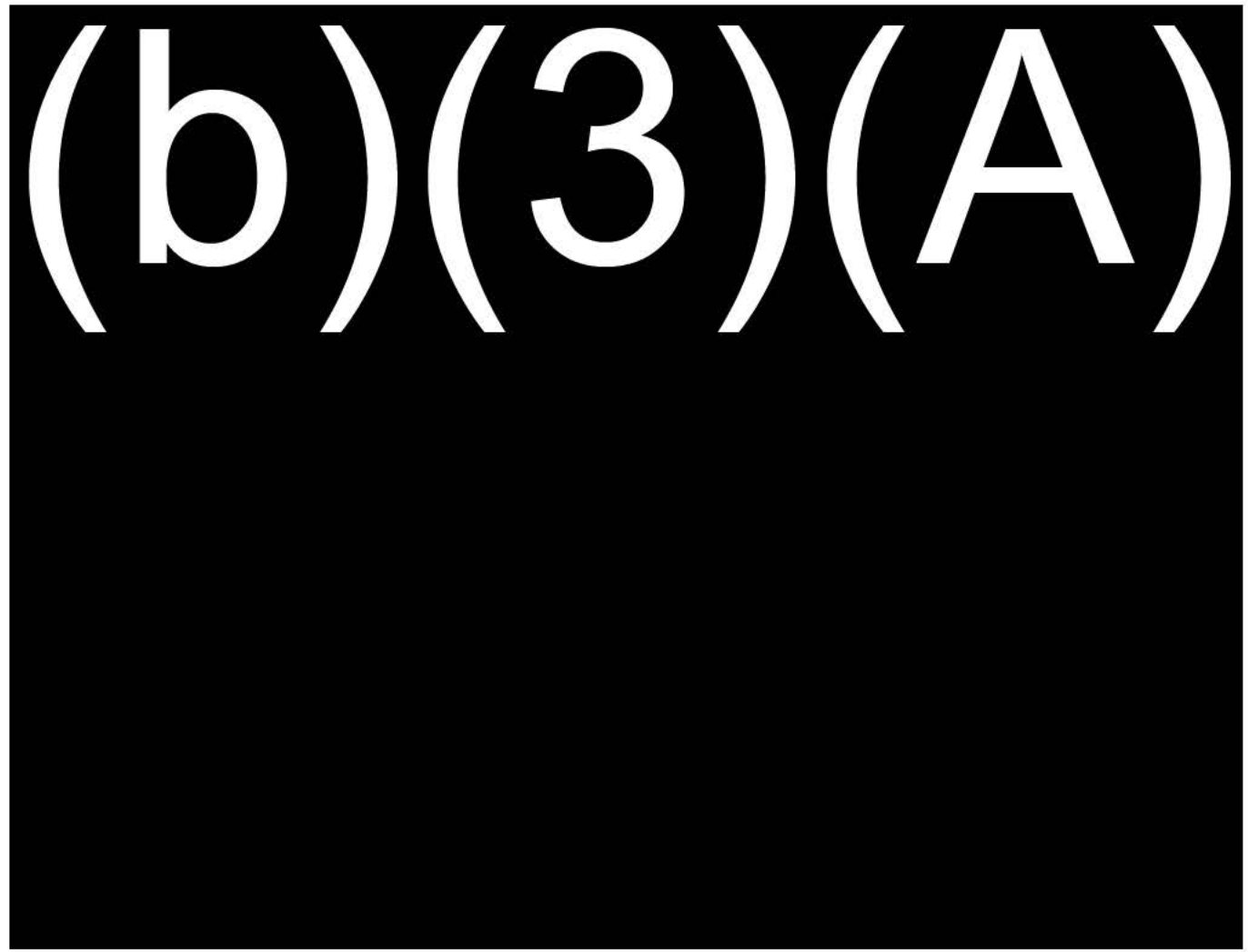
Our most significant recommendations (and those required prior to defueling) are in the lower access tunnel (LAT) adjacent to the Red Hill tanks. These recommendations fall into the following main areas:

1. In order to prevent surge loads, provide pressure equalization across both the inboard (skin) valve and outboard valve at a select number of tanks (required at three tanks for defueling as a minimum)
2. In the event a surge load still occurs, provide lateral and axial restraints at a select number of locations for fuel pipelines along with reconnection of piping laterals at odd-numbered tanks and supplementary thrust force mitigation at pipe bends and header end points
3. Additional support and restraints for the F-24 pipeline, in the event of impact or surge loads
4. If lateral piping is ever disconnected at even-numbered tanks, provide protection to Dresser couplings

SGH

By-pass Lines Around Isolation Valves

- Help prevent surge by equalizing the pressure across the mainline valve prior to it being opened
- Protects the valve seat, actuator and shaft against high differential pressure damage by allowing equalization
- Common practice throughout the petrochemical industry



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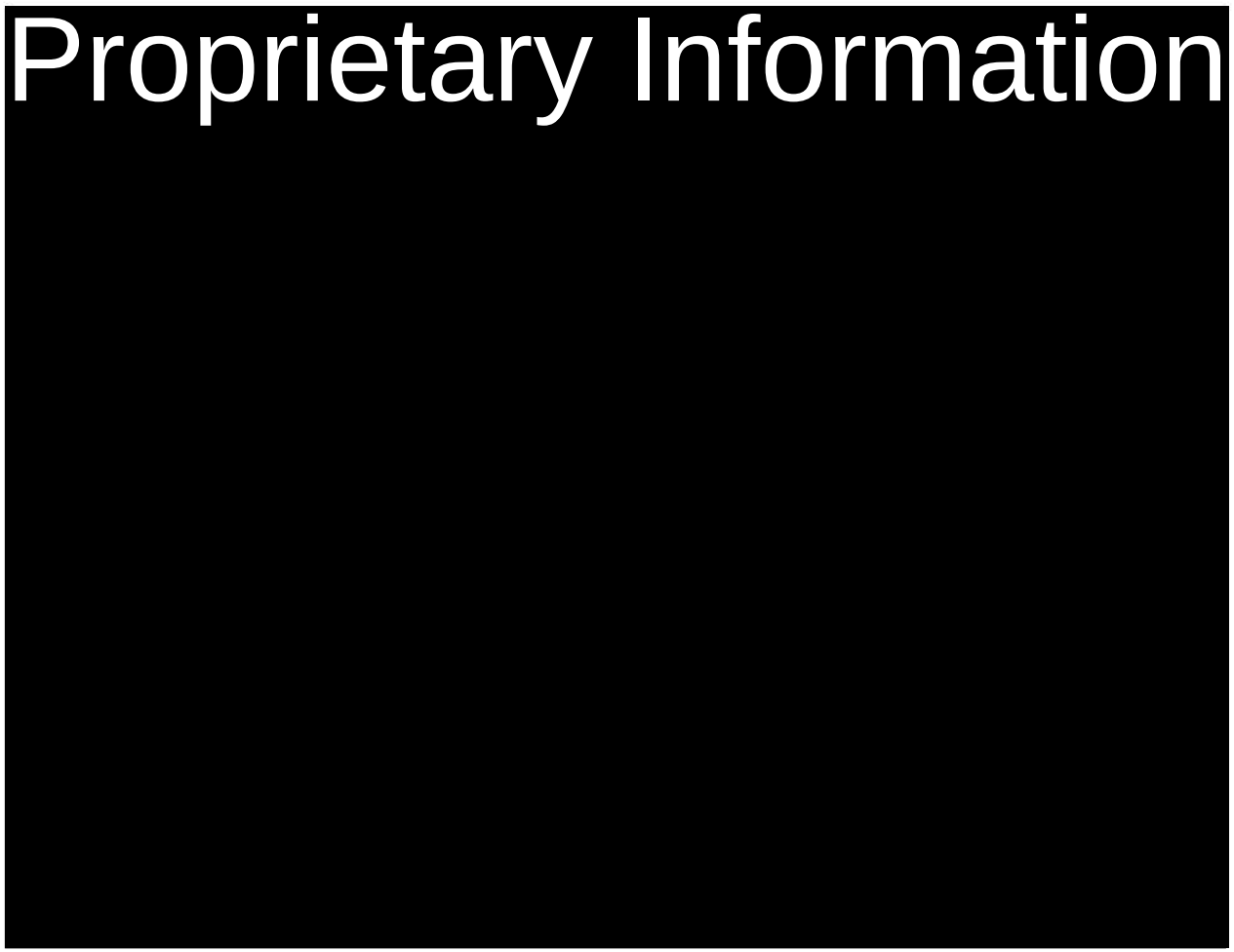
By-pass Line – Industry Example

Proprietary Information



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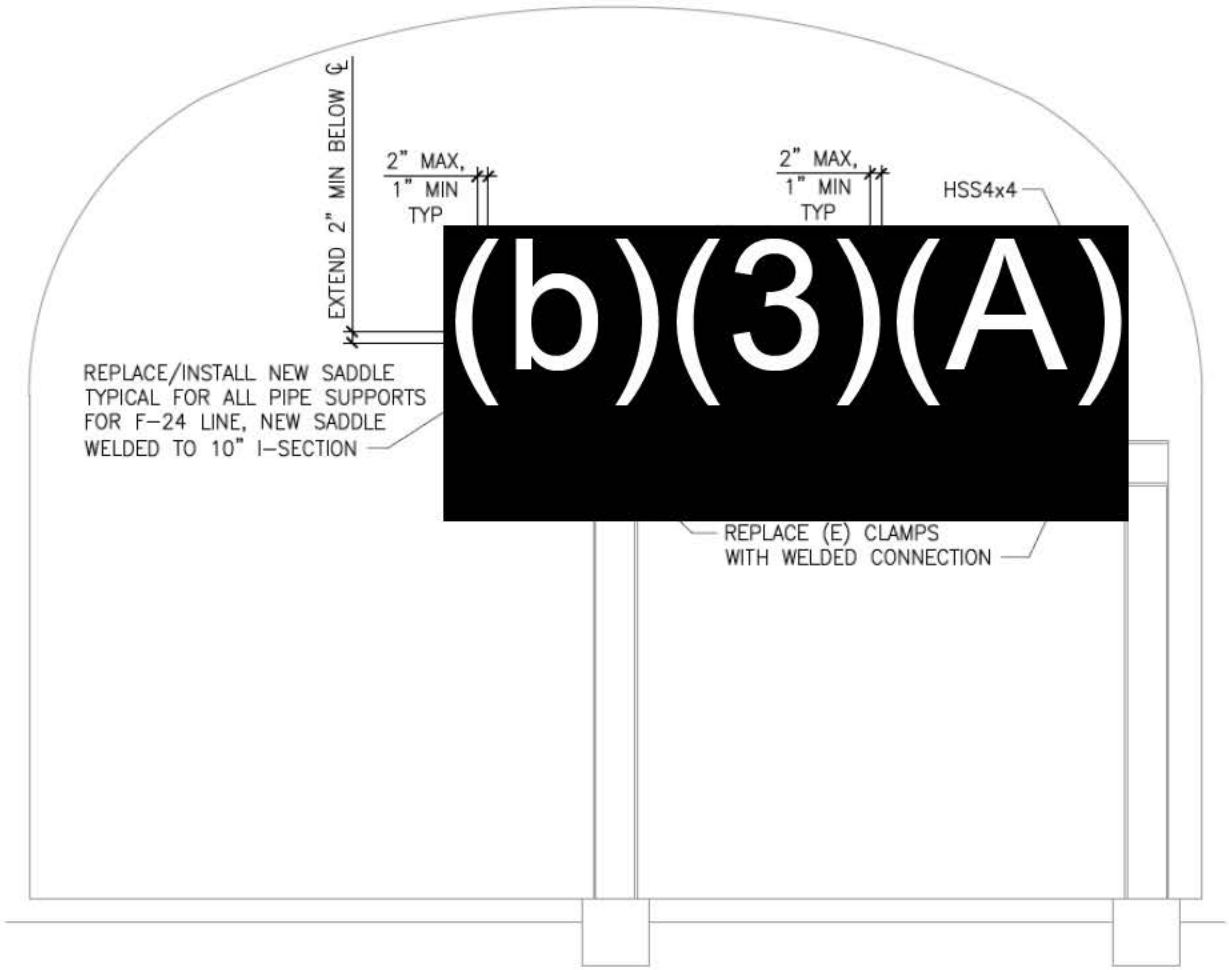
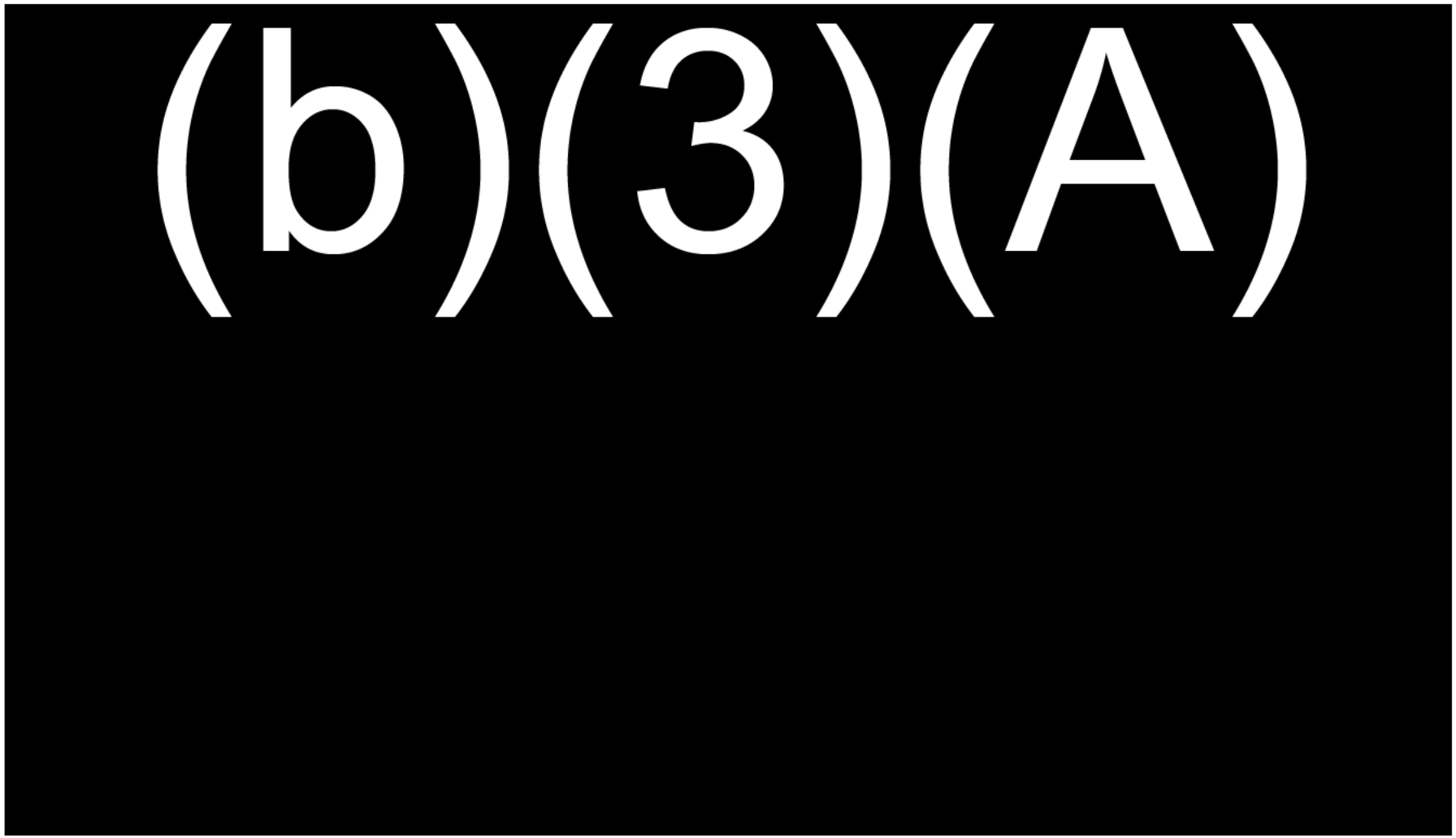
Pipeline Lateral Restraints in the Red Hill Tunnels

- Increase lateral load resistance and redundancy of the pipe supports
- Lower the impact of surge loads on the piping systems
- In addition, restrain F-24 line at 20+ locations



Axial Restraint Concept to Resist Postulated Surge Loads



Additional Structural Integrity and Design Improvement Recommendations

- Design improvement and repairs include numerous examples of:
  - Maintenance issues and repair of corroded piping
  - Damaged coating
  - Damaged/reconfigured pipe supports
  - Missing bracing
  - Corroded pipe supports
- Overconstrained piping and stairways at a number of aboveground storage tanks
- Degraded pier structures
- Follow up on items identified as being in need of repair from past inspection reports and others

Mitigation Priority Distribution Based on Observations and Analyses

D1 (Defueling)	P1 (High)	P2 (Low)	P3 (Maintenance)	Comment Only	Total
35	91	78	24	19	247

Mitigation Priority	D1 - defuel, P1 - high, P2 - low, P3 - maintenance
Observation Severity	H - high, M - medium, L - low
Observation Type	CD - coating damage; CR - corrosion; DV - design variation; LI - lack of integrity; MB - missing member; PD - physical damage; WD - weld defect; LP - load path; IR - improper restraint (missing pipe supports etc.); IC - interaction of components (contact risk, over restrained pipes by the tanks, stress concentration etc.); OT - other

Lower Access Tunnel (LAT)
Piping and Mechanical (PM)
Harbor Tunnel (HT)
(b)(3)(A) Pumphouse (PH)
Lower Yard Tunnel (LYT)
Above Ground Storage Tanks (AST)
Valve Stations (VS)
Valve Chambers (VC)
Hickam (HK)
Above Ground Piping (AGP)
Hotel Pier (HP)
Kilo Pier (KP)
Sierra Pier (SP)
Mike Pier (MP)
Bravo Pier (BP)

Priority – D1 (Examples)

All Observations - Master List							Recommendation						
Item	Component	Location	Description	Photograph	Observation Type	Severity	Description	Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering and Lead Abatement Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-40	Structural	(b)(3)(A)	Existing column is heavily corroded at the base		CR	H	Replace column and anchorage	D1	No	[redacted]	As soon as practicable		RMMR Service Order RHL-PND-601
AGP-1	Pipe		Crevice corrosion and deep pits at pipe support contact	(b)(3)(A)	CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	We were unable to measure the worst section loss at this location; we understand that POND conducted ILI and determined that local section loss >50% required local replacement	RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-2	Pipe		Crevice corrosion and deep pits at pipe support contact		CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	We were unable to measure the worst location; we understand that POND conducted ILI and determined that local section loss >50% required local replacement. Our FFS evaluation agrees that >50% section loss requires replacement.	RMMR Service Order PRL-PND-677N & PRL-PND-683E
HP-14	Pipe		PVC FOR line potentially with Nitrile seals (blue)		LI	H	Replace PVC with appropriate materials	D1	Review by SGH recommended	[redacted]	As soon as practicable	Condition looks unchanged from 2016 observation report. Conduit box and cable are hanging off the front side of Hotel Pier (red).	FY23 NAVFAC SRM project

Priority – P1 (Examples)

All Observations - Master List							Recommendation						
Item	Component	Location	Description	Photograph	Observation Type	Severity	Description	Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering and Lead Abatement Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-17	Structural	(b)(3)(A)	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	[redacted]	12-24mo		
LAT-31	Structural		Improper vertical support of (b)(3)(A) pipe	(b)(3)(A)	LP	H	Repair as per SGH retrofit concept drawings	P1	Yes	[redacted]	12-24mo		
HT-33	Structural		Column bases corroded (Harbor Tunnel)		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo		RMMR Service Order RHL-PND-618 includes 510, 600
PH-1	Window		Control room window facing pumphouse gallery is not blast resistant		OT	H	Provide blast and fire-resistant door, window and framing to protect operators	P1	Yes	[redacted]	12-24mo	Building wall and door can also be critical. There is also fire risk in this area.	

SGH

Priority – P1 (Examples)

All Observations - Master List							Recommendation						
Item	Component	Location	Description	Photograph	Observation Type	Severity	Description	Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering and Lead Abatement Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
MP-3	Pipe	(b)(3)(A)	Spalled Concrete and Exposed Reinforcing	(b)(3)(A)	PD/CR	H	Repair as appropriate to re-establish design margin.	P1	Yes	[redacted]	12-24mo	Note that the 2018 Pier Inspection report classifies the system as fair, however we recommend further evaluation.	Marine Solutions Inc. 2018 Inspection Report
MP-6	Structural		Spalled Concrete at the Underside of Deck		PD/CR	H	Repair as appropriate to re-establish design margin.	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however we recommend further evaluation.	
MP-10	Structural		Spalled Concrete and Exposed Rebar		PD/CR	H	Repair as appropriate to re-establish design margin.	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however we recommend further evaluation.	

SUMMARY OF ASSESSMENT

- We deem it safe to defuel the facility (and to operate the balance of the JBPHH facility) with the recommendations that we are providing
- Our recommendations include:
  - Any modifications that affect the loading or structural response of tanks, structures or piping systems should be engineered in a coordinated manner
  - Independent third-party verification of design changes, repairs and modifications currently being planned and implemented should be employed
  - A more robust facility specific integrity management program and anomaly tracking system should be implemented
  - A risk-based process safety management system should be adopted

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