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July 15, 2016

Doug Morris  
Chief Office of Offshore Regulatory Programs  
Bureau of Safety and Environmental Enforcement  
U.S. Department of the Interior  
1849 C Street, NW  
Washington, DC 20240

Via email

Dear Mr. Morris:

Thank you for your engagement with API on March 31, 2016 and June 22, 2016 regarding Subsea BOP bolting. API and Industry are committed to improving training, operating procedures, technology and industry standards.

As mentioned in our previous meetings, API and industry see this as ongoing work that may evolve as new information becomes available. However, Industry requests that BSEE acknowledge that the proposed actions are consistent with BSEE's expectations and BSEE agrees to continue to work with Industry in a collaborative manner in order to eliminate these types of failure.

In summary, during our meetings in March and June, API presented a summary of proposed actions to be taken by Industry, which are complimentary with the direction of the API standards work outlined below. These include the following:

- Industry defined "critical bolting" as bolting that the failure of which could result in loss of containment of wellbore fluids to the environment;
- Voluntary industry adoption of API 20 E/F for critical BOP bolting;
- Voluntary industry upgrade of critical bolting with hardness > 35 HRC;
- Enhanced QAQC of 3rd party manufactured bolting (i.e., sampling, 20 E/F requirements);
- Updated make-up procedures, with additional engineering rigor and oversight;
- Elimination of electroplated Zinc coatings for subsea/marine applications; and
- Enhanced failure reporting with wider distribution.

Related to failure reporting, we also ask that BSEE share its data on subsea bop bolting failures so that we can have an informed and more comprehensive conversation around how we can address this issue

more holistically. BSEE's sharing such data with industry will benefit all parties by increasing transparency and cooperation between the two entities.

As additional background, API has been actively engaged with BSEE since the release of its QC-Fit Evaluation of Connector and Bolt Failures in August of 2014. API has several standards, recommended practices, programs and research initiatives related to this topic including, but not limited to:

- *API 16A Specification for Drill Through Equipment*
- *API Specification 20E Specification for Alloy and Carbon Steel Bolting for Use in the Petroleum and Natural Gas Industries*
- *API Specification 20F Corrosion Resistant Bolting for Use in the Petroleum and Natural Gas Industries*
- *API Specification Q1 Specification for Quality Management Systems Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*
- *API Specification Q2 Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries*
- *API RP 75 Recommended Practice for Development of a Safety and Environmental Management Program for Offshore Operations and Facilities*
- The Center for Offshore Safety
- API's sponsored research on corrosion resistant alloys and hydrogen embrittlement

As with all our standards, API will continue to work with government regulators and others to monitor and evaluate additional action as appropriate.

To further our discussion on this critical subject, we invited BSEE to present the report findings and recommendations at a Technical Session during the API Exploration and Production Winter Standards Meeting in New Orleans on January 27, 2015. BSEE's participation was valuable as API worked to develop an integrated plan forward to address the report's recommendations.

Since that time API and industry have worked with BSEE, outside experts and stakeholders through our ANSI-accredited, standards-setting process to achieve the goals identified in BSEE's QC-FIT Report 2014-01. We formed a multi-segment task group to review BSEE's report, industry standards and practices, and relevant research and data associated with the use of connectors and bolts in subsea operations, and to identify the critical gaps for improving standards, practices and operations. This multi-segment task group looked at all types of bolting failures, including fatigue, that could occur in the upstream oil and gas industry, determined the contributing factors, identified current mitigations and recommended changes to industry standards. As a result of that work, six API standards subcommittees were tasked to review recommendations into API standards and specifications. As these recommendations are considered by subcommittees, changes are already in progress to many of the published standards and are expected to be released to industry in the near future. Additionally, API is interfacing with ASTM to promote revision of ASTM specifications that were identified as potential issues during the multi-segment task group's work. Overall, we are taking both an active and holistic approach across our signature safety programs to determine if enhancements are required to further strengthen our documented audit and certification programs.

In summary, we respectfully request BSEE confirm these actions are aligned with the Agency's expectations. API appreciates the opportunity to work with BSEE to continue discussing our shared

objective of safe operations. If you have any questions or to further this discussion, please contact me by phone at (202)682-8439, or by e-mail at [hopkinsh@api.org](mailto:hopkinsh@api.org).

Sincerely,

A handwritten signature in cursive script that reads "Holly A. Hopkins".

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Holly A. Hopkins

cc: Lars Herbst, GOM Regional Director

Attachments



# Proposed Industry Response to BSEE Bolting Safety Alert 318

**Thursday  
March 31<sup>st</sup>, 2016**





## Attendees - Introductions

BP	Trent Fleece
Shell	Jose Meraz
Anadarko	Ken Armagost
TOI	JP Buisine
Diamond	Jon Shoemaker
Pacific	Peter Bennett
Maersk	Martin Carnie
NOV	Frank Springett
Cameron	Frederic Oleron
GE	Louise Goetz
API	Holly Hopkins
OOC	Scherie Douglas

Operators who participated in development of slidepack:

- BP, Shell, Anadarko, ExxonMobil, Cobalt, LLOG, Hess, Apache, ENI, Stone, BHP, Murphy

Rig Contractors who participated in development of slidepack:

- TOI, Diamond, Pacific, Maersk, Seadrill, Atwood, Ensco, Noble, Rowan, Stena



## Meeting Purpose – Address Safety Alert 318

1. The intent of the proposed actions presented in this slide pack are to address the recommendations made by BSEE in Safety Alert 318 for Subsea BOP bolting
2. Our goal today is to engage BSEE and seek endorsement for a proposed set of prioritized actions (with timing) to improve subsea BOP bolted connection reliability
3. The proposed actions presented today are to be taken in parallel with other work currently underway by API Standards committees:
  - a) API work initiated by the 2014 QC-FIT report findings
  - b) API work will establish bolting requirements in API 16 A, 16 C, 16 F, 20 E, 20 F and Standard 53



Safety Alert No. 318  
02 February 2016

Contact: Douglas Morris  
Phone: (202) 208-3974  
Email: Douglas.Morris@bsee.gov

## Connector and Bolt Failures

**Overview:** BSEE is aware of a recurring problem of connector and bolt failures in various components used in risers and subsea blowout preventers used in offshore operations. These failures are of great concern to BSEE due to their frequency and the potential for a catastrophic event. A previous occurrence of bolt failures in December 2012 prompted a global recall of the bolts associated and a temporary cessation of drilling activities. The fact that these failures involved equipment from three primary manufacturers suggests that this may be a systemic industry problem that requires immediate attention.

**Recommendations:** At a minimum, operators should work with the original equipment manufacturer (OEM) to:

- Verify that there is complete documentation that demonstrates that all components that are currently in service satisfy the metallurgical properties specified by the OEM and the latest industry standards.
- Verify that all installation and maintenance procedures (including torque processes and values) satisfy OEM requirements and ensure that these practices are effectively implemented.
- Report any failures to OEMs and appropriate industry organizations in a timely manner to ensure the prompt transmission of relevant data to the industry.

BSEE is continuing to work with various organizations to evaluate these failures and determine if additional long-term action is needed to prevent additional failures. Additional information will be provided as it becomes available on [bsee.gov/bolts](http://bsee.gov/bolts).





## Background

1. August 2014 - BSEE QC-Fit report on Vetco Connector bolting failure
  - QC-Fit Report references failures below:
    - a) 2003 (May) – Discoverer Enterprise Riser failure
    - b) 2012 (Nov) – Discoverer India BSR bolt failure
    - c) 2012/2013 – Vetco connector body bolt failure – QC-Fit Report
2. January 2016 – Director Salerno letter to API to address bolting failures
  - a) 2015 (Dec) – reference to GoM Rig BSR bolt failure
3. February 2016 – BSEE Safety Alert issued to GoM Operators
  - a) 3 recommendations in Safety Alert – specifies Operators working with OEMs
4. February 2016 – BSEE QC-Fit Report Addendum issued
  - a) 2014 (Jul) – GoM Rig API flange bolt failure report
5. March 2016 – Doug Morris SPE Presentation
  - a) BSEE Fact Sheet posted

Note – BSEE report uses the terms connector or fastener in reference to bolting





## Clarifications - Definition

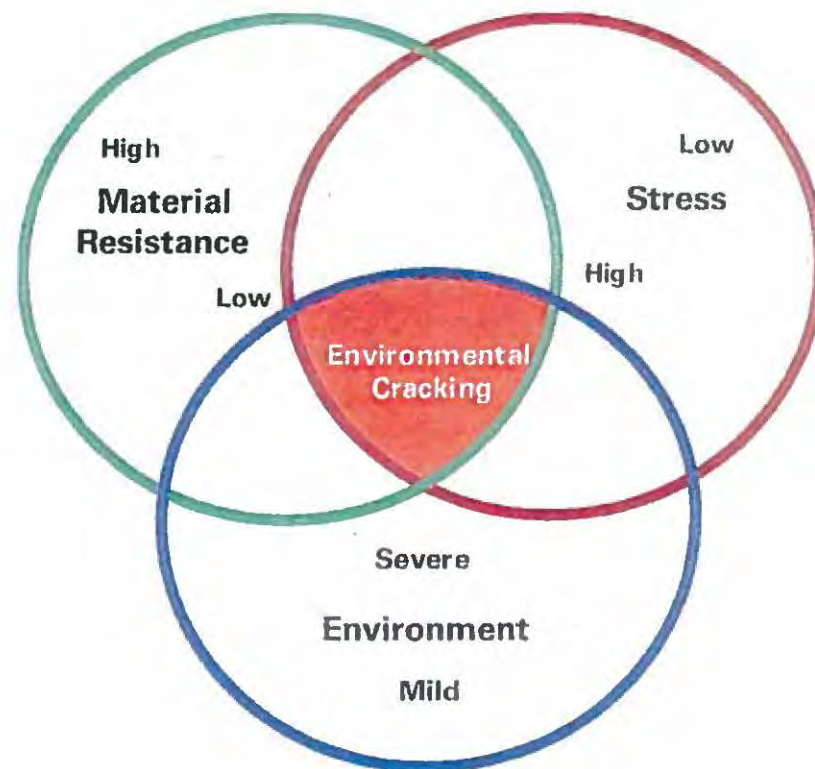
1. Based on information provided by the QC-Fit report, and the RCAs performed on the Industry failures, the following elements are common;
  - a) 4140/4340 carbon and alloy steel
  - b) > 125 ksi high yield strength steel
  - c) > 35 HRC hardness
  - d) Zinc (Zinc Chromate) plated
  
2. The actions in this slide pack are intended to address failed bolting due to:
  - a) Steel properties outside of OEM/Industry specification
  - b) Improper make-up (procedure, torque, coefficient of friction etc.)
  - c) Design of the bolting system



# Environmentally Assisted Cracking (EAC)

EAC, which includes Hydrogen Embrittlement, requires three conditions to exist to lead to failure.

EAC may cause the material to fail at loads significantly below the rated strength of the material







# API 20 E/F Specification

1. API 20 E/F is an API specification with requirements for the qualification, production and documentation of carbon, alloy steel and corrosion resistant alloy (CRA) bolting used in the petroleum and natural gas industries
2. Key topics covered in 20 E/F
  - a) Raw Material requirements
  - b) Manufacturing controls (including forging, thread forming)
  - c) Heat treatment
  - d) Microstructure
  - e) Hardness ( $\leq 34$  HRC)
  - f) Testing (NDE, dimensional, visual, sampling of heat lots)
  - g) Traceability
  - h) Licensed manufacturers
3. Per API 20E, the definition of bolting – Section 3.1.1:
  - a) All-thread studs, tap-end studs, double-ended studs, headed bolts, cap screws, screws, and nuts





## Clarifications - Definition

1. Proposal to BSEE is to take action in 2 Phases:
  - a) Phase 1 – Near Term – alloy steel bolting > 35 HRC
    - Phase 1 would not focus on L7, B7, L7M, B7M and L43 ASTM studs
  - b) Phase 2 – Longer Term – alloy steel bolting  $\leq$  35 HRC
  
2. Define 'critical' subsea BOP bolting as bolting that the failure of which could result in loss of containment of wellbore fluids to the environment:
  - a) API drill through flange bolting
  - b) BOP side outlet API flange bolting
  - c) Bonnet bolting (bonnet to body bolts)
  - d) Wellhead and LMRP Connector primary load path body bolting
  - e) Blind Shear Ram (BSR) primary load path bolting
  - f) Riser primary load path bolting



# Action 1 – Phase 1 – Critical Bolting > 35 HRC

*Verify that there is complete documentation that demonstrates that all components that are currently in service satisfy the metallurgical properties specified by the OEM and the latest industry standards.*

## Proposed Action:

1. All 3 major OEMs have issued Statement of Fact that all critical bolt material meets the OEM specification or relevant ASTM specification at the time of manufacture
2. All critical bolting MTRs will be provided to the equipment owner
  - a) MTRs per ASTM, API 20 E/F requirements or OEM specification
  - b) Rig Contractor/Operator to send marking/traceability information to OEM for currently installed bolting as required
  - c) Begin 2<sup>nd</sup> Quarter 2016
3. Operators/Rig Contractors/OEMs shall audit the documentation package to verify completeness





## Action 2 – Phase 1 – Critical Bolting

*Verify that all installation and maintenance procedures (including torque processes and values) satisfy OEM requirements and ensure that these practices are effectively implemented.*

### Proposed Action:

1. All 3 OEMs to issue Engineering Bulletin clarifying make-up procedure for BOP critical bolting. EB at a minimum will address the following (EB to be issued by 2<sup>nd</sup> quarter, 2016):
  - a) Confirm latest revision of procedure to be utilized
  - b) Number of passes to final torque
  - c) Type of thread compound to be utilized
  - d) Make-up pattern clearly identified
  - e) Number of threads above the nut (where applicable, i.e. 18.75" API Flange)
  - f) Calibration of torque wrench per OEM specification
2. Rig Contractors to review OEM Engineering Bulletin and demonstrate compliance to Operators, with focus on torque processes, torque values, and associated records and create a plan to address any gaps as soon as reasonably practicable
  - a) The intent is to have someone in a supervisory position removed from the job verify the crew performing the work is doing the work correctly (procedure, equipment, etc.)
  - b) Supervisory personnel examples – Toolpusher, Maintenance Supervisor, OIM, Subsea Supervisor etc.





## Action 3 – Phase 1 – Critical Bolting

*Report any failures to OEMs and appropriate industry organizations in a timely manner to ensure the prompt transmission of relevant data to the industry.*

### Proposed Action:

1. Rig contractors, Operators and OEMs are now participating in the industry IOGP/IADC BOP Reliability JIP “BOP Defect and Failure Analysis Database” (Capgemini Database) which will capture BOP equipment failures
  - a) OEMs have issued Standard 53 failure reporting requirements
2. OEMs to conduct an Root Cause Analysis (RCA) on any failed or defective critical bolting. RCA to be supplied to Rig Contractor >> Operator >> BSEE
  - a) Would include any cracked bolt in critical application
  - b) Note, IOGP RCA JIP in process of being rolled out – RCA guidance document
3. OEM to issue notification to industry within 7 days of any critical bolting failure to notify Equipment Owners
  - a) The intent of a notification is not to address root cause which will take time to complete





# Other Actions – Critical Bolting > 35 HRC

## Proposed Industry Actions:

1. Operator, Rig Contractor and OEM – develop a plan and commence a bolting replacement program for bolting with hardness > 35 HRC\*
  - a) Replacement bolts manufactured to API 20 E/F spec
  - b) Anticipated to be completed during 2016/17
  - c) \*note – > 35 HRC high yield strength alloy steel – not applicable to Inconel, MP35N or other similar corrosion resistant materials as per API/ASTM specifications
2. OEMs to voluntarily adopt API 20 E/F BSL 3 for BOP critical bolting orders placed after May 1, 2016
3. Metallic electroplated coatings (zinc, magnesium, aluminum) will not be in OEM specifications or utilized
  - a) Zinc/Nickel plating allowed in the short term due to its resistance to Hydrogen Embrittlement
4. OEMs to review any design requirements for bolting > 35 HRC
5. OEMs to update QAQC process that requires independent testing of a sample from received bolts from 3<sup>rd</sup> party manufacturers that will verify material and mechanical properties are within OEM or industry specifications





# Longer Term Actions Critical Bolting < 35 HRC

1. For lower yield strength and lower hardness bolting, Rig Contractors to work on a bolt replacement plan to identify and replace critical bolting with API 20 E/F specification bolts. Typically this will be done during 5 or 10 year major BOP inspection/maintenance.
  - a) ASTM A 193/320 L7, B7, L7M, B7M and L43 ASTM bolting
2. Industry groups (API/ASTM) to review and implement recommendations from API bolting workgroup
  - a) Recommend API to add 20 E/F requirements for critical BOP bolting to API 16 A, 16 AR, C, F design requirements
  - b) Recommend API to add make-up requirements to Standard 53
3. Metallic electroplated coatings (zinc, magnesium, aluminum) will not be in OEM specifications or utilized
4. OEMs to review design load cases of critical bolts to verify material requirements as required
5. Riser bolting will be examined over the longer term due to the design changes implemented after the industry failure in 2003



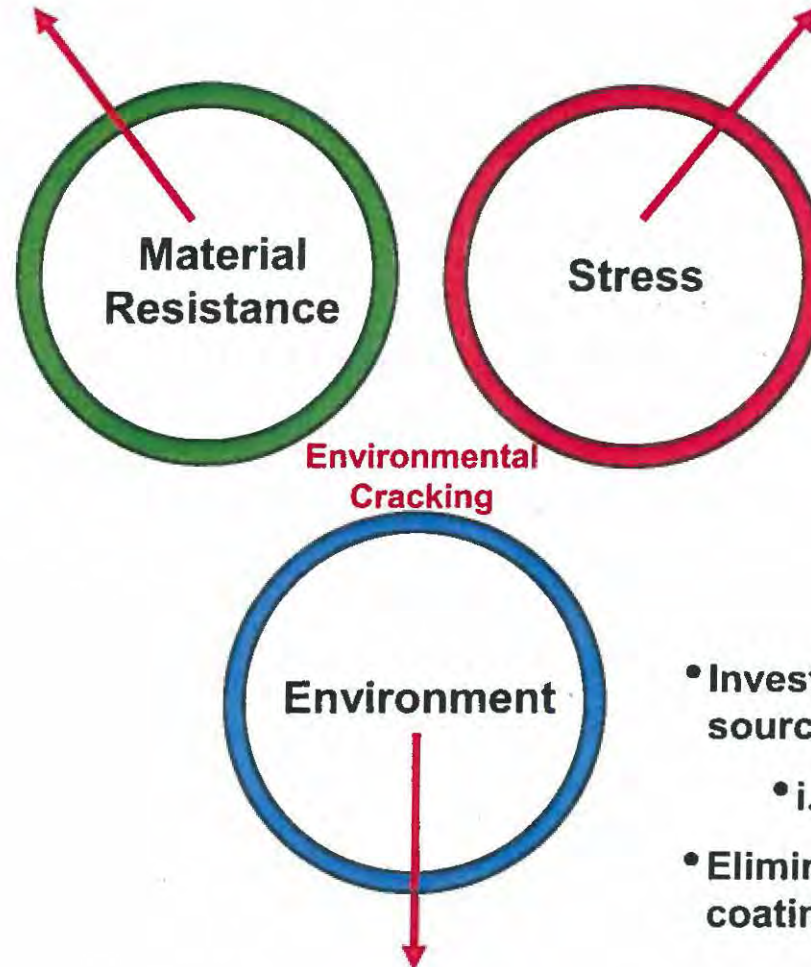


## Summary of actions taken by Industry

1. Engaged 15 Operators, 10 Rig Contractors and 3 OEMs
2. The summary of actions taken by this workgroup:
  - a) Defined “critical bolting” as bolting that the failure of which could result in loss of containment of wellbore fluids to the environment
  - b) Voluntary industry adoption of API 20 E/F for critical BOP bolting
  - c) Voluntary industry upgrade of critical bolting with hardness > 35 HRC
  - d) Enhanced QAQC of 3<sup>rd</sup> party manufactured bolting (i.e., sampling, 20 E/F requirements)
  - e) Updated make-up procedures, with additional engineering rigor and oversight
  - f) Elimination of electroplated Zinc coatings
  - g) Enhanced failure reporting with wider distribution
  - h) Consistent with the direction of API standards work

# Plans to Mitigate EAC

- Hardness  $\leq$  34 HRC
- QAQC verifying material specifications
- 20E manufacturing and testing requirements



- Update make-up engineering guidance
- Perform torque at rig per procedure with additional oversight

- Investigate and minimize probable sources of environmental cracking
  - i.e. Hydrogen sources
- Eliminate electrodeposited (Zinc) coating on bolting





# Back Up Slides

Safety Alert No. 318  
02 February 2016

Contact: Douglas Morris  
Phone: (202) 208-3974  
Email: Douglas.Morris@bsee.gov

## Connector and Bolt Failures

**Overview:** BSEE is aware of a recurring problem of connector and bolt failures in various components used in risers and subsea blowout preventers used in offshore operations. These failures are of great concern to BSEE due to their frequency and the potential for a catastrophic event. A previous occurrence of bolt failures in December 2012 prompted a global recall of the bolts associated and a temporary cessation of drilling activities. The fact that these failures involved equipment from three primary manufacturers suggests that this may be a systemic industry problem that requires immediate attention.

**Recommendations:** At a minimum, operators should work with the original equipment manufacturer (OEM) to:

- Verify that there is complete documentation that demonstrates that all components that are currently in service satisfy the metallurgical properties specified by the OEM and the latest industry standards.
- Verify that all installation and maintenance procedures (including torque processes and values) satisfy OEM requirements and ensure that these practices are effectively implemented.
- Report any failures to OEMs and appropriate industry organizations in a timely manner to ensure the prompt transmission of relevant data to the industry.

BSEE is continuing to work with various organizations to evaluate these failures and determine if additional long-term action is needed to prevent additional failures. Additional information will be provided as it becomes available on [bsee.gov/bolts](http://bsee.gov/bolts).

A Safety Alert is a tool used by BSEE to inform the offshore oil and gas industry of the circumstances surrounding an accident or a near miss. It also contains recommendations that should help prevent the recurrence of such an incident on the Outer Continental Shelf.





## Potential MTR Audit Example

3 operators to partner with 3 Rig Contractors to audit 3 OEMs

Operator 1/RC 1 to audit NOV BOP stack on RC 1 Rig

Operator 2/RC 2 to audit GE stack on RC 2 Rig

Operator 3/RC 3 to audit Cameron on RC 3Rig

Could perform operator audit on OEM manufacturing facility

- Audit TOR to be agreed upon prior to audit
- Overhaul/Repair facilities



# **Proposed Industry Response to BSEE Bolting Safety Alert 318**

## **API Bolting Workgroup - BSEE Meeting #2**

**Wednesday  
June 22, 2016**





# Attendees - Introductions

- BP Trent Fleece
- Shell Jose Meraz
- Anadarko Ken Armagost
- Chevron Frank Gallander
- TOI Rob Turlak
- Diamond Jon Shoemaker
- Pacific Peter Bennett
- Maersk Martin Carnie
- NOV Chris Johnson
- Cameron Frederic Oleron
- GE Louise Goetz,  
Eric Larson
- API Holly Hopkins
- API David Miller

# June 22, 2016 Meeting Agenda

- I. Call to Order, Housekeeping and Safety Items, Anti-Trust Guidelines
- II. New/Ongoing Issues
  1. Update from API Standards Work & QAQC Work
  2. Follow up from March 31<sup>st</sup> meeting
    - a) General discussion from BSEE on the proposed Industry action plan provided
    - b) Address BSEE questions from March 31<sup>st</sup> meeting
      - i. BSEE would like to know the population impacted of > 35 HRC
      - ii. BSEE would like to know the timeline for the replacement of this bolting
      - iii. BSEE asked what could be done to check the integrity of this bolting before their replacement
    - c) Any other items/actions
  3. GE BSR bolting failure
    - a) Discussion on differences between the GE BSR bolt failure and previous bolt failures
    - b) Update on GE BSR RCA





# June 22, 2016 Meeting Agenda (continued)

## 4. BSEE Update

- a) National Academy Task
- b) Bolting Workshop – who/when/where/agenda
- c) Documentation of known bolt failures

## 5. Research

- a) Industry to date/planned
- b) BSEE to date/planned

## III. Any Other Business

## IV. Review Action Items

## V. Plans for Next Meeting

## VI. Adjourn

# Standards - API Multi-Segment Bolting Task Group

Initial driver for Formation of the TG

- QC-FIT Evaluation of Connector and Bolt Failures  
Summary of Findings – BSEE 2014-01 Report

Charge of TG

- Evaluate types of bolting failures likely to occur in the upstream oil and gas industry and report findings and recommendations to CSOEM
- Determine contributing factors, identifying current mitigations and recommend changes to industry standards



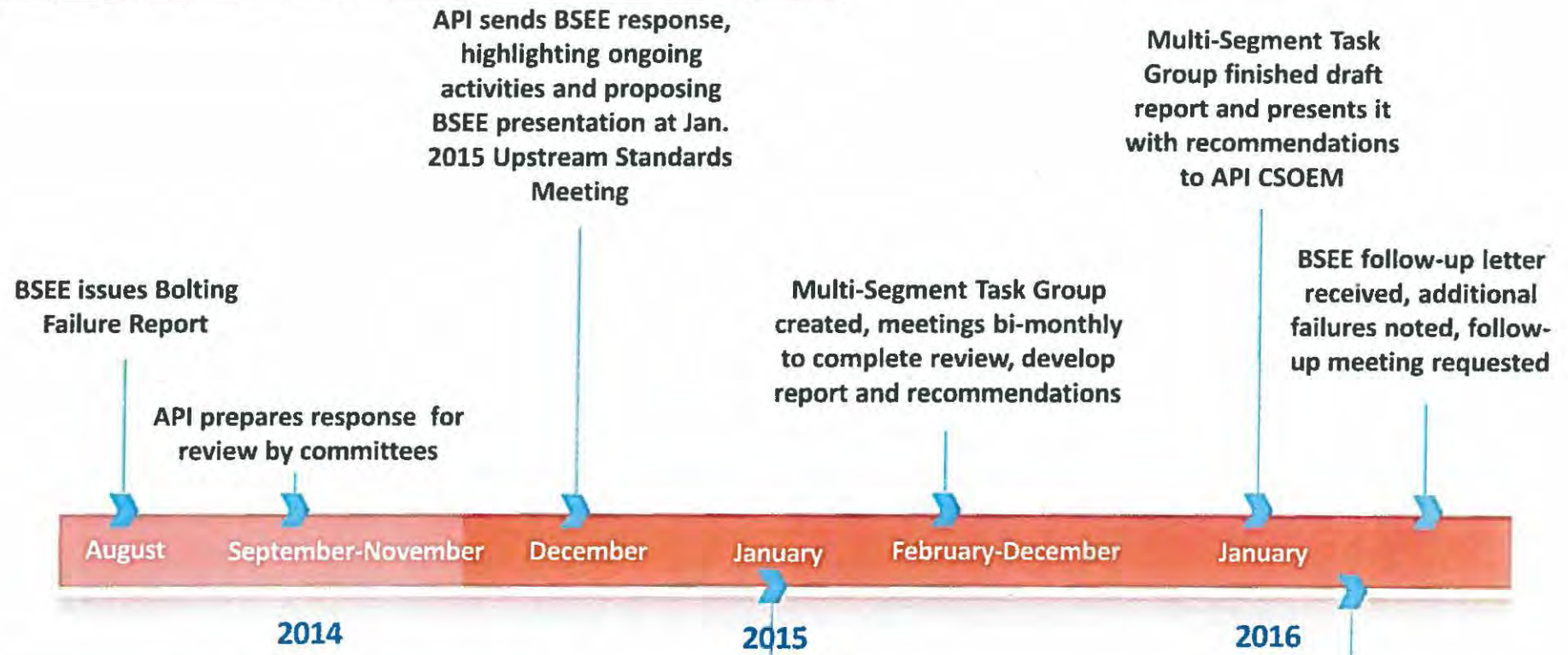


# Approach of the Task Group

- Identify failure mechanisms that effect bolting in the oil and gas industry
- Identify contributing factors and associated processes around those failure mechanisms
- Identify existing mitigations across the industry including both API and other industry controls
- Make recommendations where current mitigations are deemed to be inadequate



**Bolts Timeline – future activities shown in red**



**Comments:**

- Initial report – August 2014
- Multi-Segment Task Group includes 24 subject matter experts from oil companies, manufacturers, class societies, service & supply companies and drilling contractors

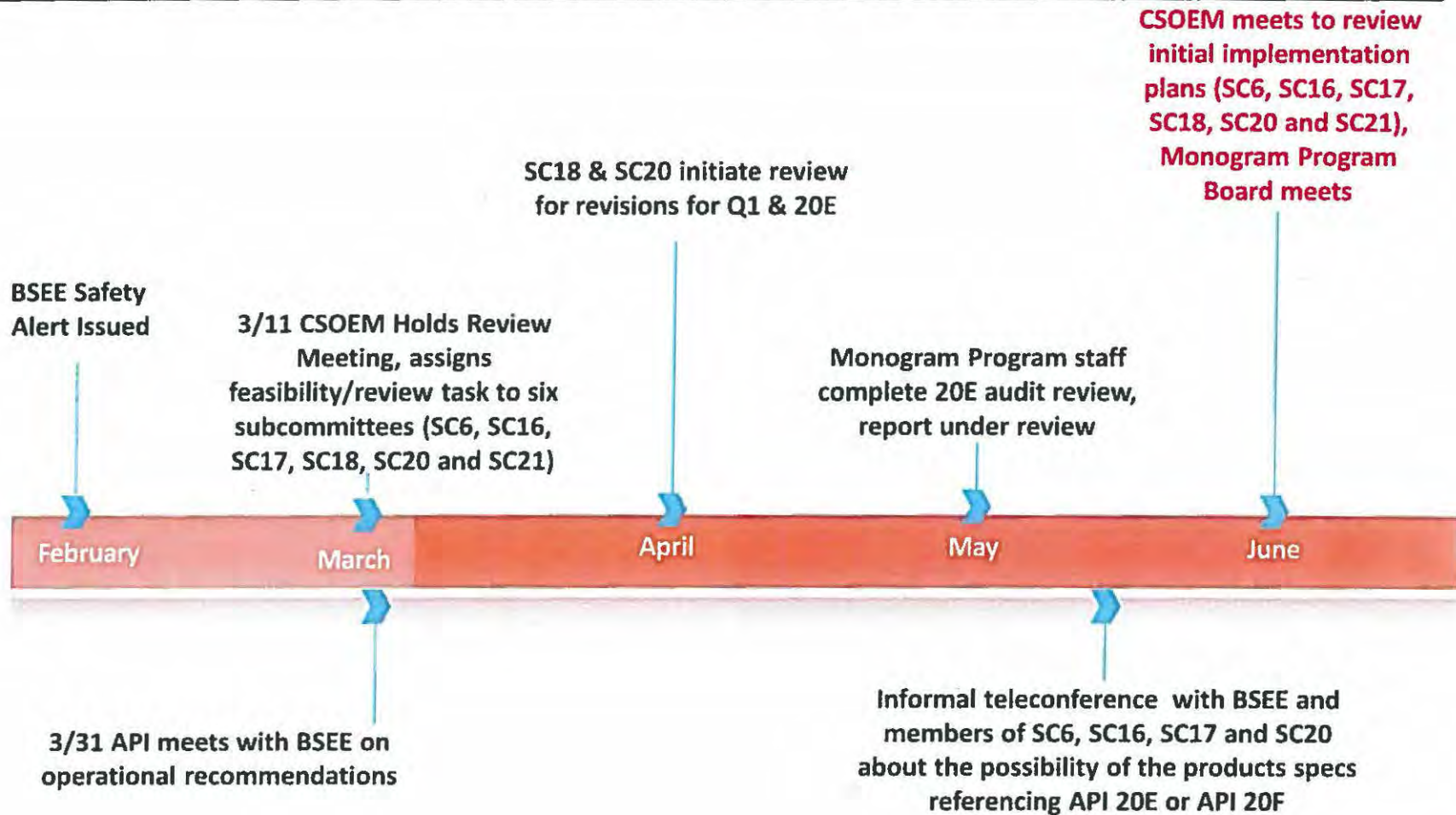
BSEE presents report, API Agrees to form Multi-Segment Task Group to review report and make recommendations

CSOEM reviews report and recommendations, requests final comments to Task Group Chair by Feb. 18 with final report and comments by Feb 29. Initial implementation plan required by June





**Bolts Timeline – 2016 and Recommendation Status – future activities shown in red**



- Comments:**
- 20E, 2<sup>nd</sup> edition ballot issued May 31.
  - **Q1 revisions ballot by September**

## 20E Monogram Study - Background and Process

- First Spec 20E *Alloy and Carbon Steel Bolting for Use in the Petroleum and Natural Gas Industries* audit in October 2013, first license in November 2013
- Review Monogram/APIQR program audit reports related to
  - Identify possible trends in non-conformities related to raw materials provided to API Spec 20E licensees by their suppliers
  - Where possible, differentiate between technical (API Spec 20E) and quality management process (API Spec Q1) issues
  - Recommend possible improvements in API Spec 20E, API Spec Q1, and other API standards to address BSEE concerns about quality control over materials and processes provided by suppliers
  - Identify ways to improve auditing of licensees and their suppliers





## **Findings – Frequency of API Spec 20E NCs by Section and Requirements**

- **Record Retention Requirements**
- **Qualification of Procurement Sources**
- **Marking Process Requirements**
- **Technical nature of the API Spec 20E non-conformities cited show auditors**
  - **Used API product questionnaire**
  - **Verified Spec 20E requirements**



## Findings – Percentage of Total NCs Documented Against API Spec Q1

- **Purchasing Requirements and Qualification of Suppliers**
- **QMS Monitoring and Calibration of Measuring Processes**
- **API Spec Q1 satisfied 20E requirements in control of**
  - Production process
  - Documents and records
  - Monitoring and measuring devices





# March 31, 2016 Proposed Action Plan

## Summary of Proposed Actions to be Taken by Industry:

- a) Defined “critical bolting” as bolting that the failure of which could result in loss of containment of wellbore fluids to the environment
- b) Voluntary industry adoption of API 20 E/F for critical BOP bolting
- c) Voluntary industry upgrade of critical bolting with hardness > 35 HRC
- d) Enhanced QAQC of 3<sup>rd</sup> party manufactured bolting (i.e., sampling, 20 E/F requirements)
- e) Updated make-up procedures, with additional engineering rigor and oversight
- f) Elimination of electroplated Zinc coatings
- g) Enhanced failure reporting with wider distribution
- h) Consistent with the direction of API standards work

## March 31, 2016 BSEE Question Follow-Up

1. Question - Population of critical bolting > 35 HRC critical bolting
  - a) Based on analysis, <5% of critical BOP bolting > 35 HRC
    - i. GE PNI on upgrade to wellhead and LMRP connector bolting (spec 34-38 HRC, replacement  $\leq$  34 HRC) (PNI included in backup)
    - ii. NOV PIB on replacement of all > 35 HRC bolting (PIB in backup)
    - iii. Cameron – no specified critical bolting > 35 HRC
2. Question - BSEE would like to know the timeline for the replacement of this bolting
  - a) As proposed during March 31<sup>st</sup> meeting, conducting replacement of >35 HRC through 2016/2017
3. Question - BSEE asked what could be done to check the integrity of this bolting before their replacement.
  - a) Pressure testing per API53 verifies the integrity of the bolted connections
  - b) Many Rig Contractors perform spot checks on bolts to verify torque values during between well maintenance (BWM)



# Bolting Failure Classification

## Bolting Failure Category 1 – brittle failure

- a) Typically associated with EAC (Environmentally assisted cracking, of which Hydrogen Embrittlement (HE) is included)
- b) Can be due to material out of specification
- c) The focus of the multi-segment task group, QC-Fit reports, and the historical critical bolting failures

## Bolting Failure Category 2 –Overload of material beyond rated yield strength

- a) Typically ductile overload of the material
- b) Can be a bolting design issue
- c) Can be influenced by something not accounted for in design
- d) The recent GE BSR bolting failures may fall within this category

*Improper make-up can contribute to failure of either of the first 2 categories*

- a) *3 OEMs working on (or have published) updated make-up guidance as proposed in the March 31, 2016 meeting*
- b) *Additional rig contractor oversight on critical connections*



Bureau of Safety and Environmental Enforcement

# **BSEE Bolts Technical Evaluation Approach**

**Dr. Candi Hudson  
BSEE - API Meeting  
Houston, Texas  
June 22, 2016**

**“To promote safety, protect the environment and conserve resources offshore through vigorous regulatory oversight and enforcement.”**



# **BSEE Research Activities**

- **National Academy of Science (NAS) Bolts Root Cause Analysis (RCA) Workshop**
- **BSEE Current Bolts Research & Analysis**
  - **Lawrence Berkeley National Laboratory (LBNL)**
  - **National Aeronautics and Space Administration**
- **QC-FIT Evaluation**
- **Future Research Project**

# NAS Bolts RCA Workshop

- Past NAS work for BSEE
  - Best Available Safest Technology (BAST) (Sept. 2013)
  - Real Time Monitoring (RTM) (April 2015)
- NAS Bolts RCA workshop approach is to seek expert opinion and input on bolts issue for critical components
- Bolts issue is of high importance for critical components such as: Blowout Prevent (BOP), Blind Shear Ram (BSR), Lower Marine Riser Package (LMRP), H4 Connector Bolts, Pipelines, etc.
- Safety and environment protection is very important.



# NAS Bolts RCA Workshop

- NAS Bolt RCA Workshop Details:
  - Who: Industry (Public) meeting
    - NAS selects the Industry Bolt Subject Matter Experts
    - NAS elects the chair person
    - Chair to host the meeting
    - Anyone can attend
  - When: Late 3<sup>rd</sup> or early 4<sup>th</sup> Quarter 2016
  - Where: Washington, DC

# NAS Bolt RCA Workshop Themes

- Evaluate connectors (bolts) currently in use for offshore oil and natural gas operations
  - Selection of design factors, fatigue cyclic loading, connectors and bolt manufacture, etc.
  - Bolt/bolt equipment Manufacture processing condition factors: raw material, forging, heat treatments, machining, coatings, etc., associated design standards
  - Material properties requirements: mechanical properties (Yield Strength, Ultimate Tensile Strength, Hardness), coatings, corrosion performance, and cathodic protection
- Focus on issues that have potential industry wide (global) impact(s)



# NAS Bolt RCA Workshop Themes

- Identify gaps in industry requirements, best practices, standards and regulations for offshore oil and gas.
- Draw upon bolt usage strategies across other industries :
  - Onshore oil and gas,
  - Refineries
  - Pipeline,
  - Aerospace, aviation,
  - Nuclear, military, naval (submarine and ship),
  - Automotive and jurisdictions;
- QA/QC concerns that may impact safety and the environment on the OCS
- Quality Management Systems (QMS)

# BSEE Attempt to form a Bolt JIP

- BSEE met with industry and tried to develop a Bolt Joint Industry Project (JIP) through DNV in 2015
- 6 industry participants were initially interested.
- Goal was to initiate work based on BSEE GE H4 Connector QC-FIT Report's conclusions and recommendations.
- Potential industry participants withdrew from the Bolt JIP
- BSEE initiated other measures to address Bolt concerns on its' own



# BSEE Current Bolts Research

- BSEE Initiated Research Activities
  - Lawrence Berkeley National Laboratory (LBNL)
  - National Aeronautics and Space Administration
- Results from these activities will dictate any future BSEE research projects
- BSEE is monitoring industry research/standards activities

# Lawrence Berkeley National Laboratory (LBNL)

## Bolts Research

- BSEE has a five year Inter Agency Agreement (IAA) with Department of Energy (DOE) - Argonne National laboratory (ANL)
- BSEE thru ANL contracted LBNL to conduct research on bolts because of their materials science expertise with focus in following areas:
  - GE QC-FIT - Quality management process was limited to prime contractor or 1<sup>st</sup> tier level and did not address to 2<sup>nd</sup> and 3<sup>rd</sup> sub-tier levels
  - Variation in standards (material properties)
  - Inconsistency in material properties
  - Zinc coating process and post heat treatment process relating to Hydrogen Embrittlement
- Global standards evaluation and gap analysis:
  - API, ASTM, ISO, etc.
- LBNL to conduct mechanical testing of BSR bolt failure



# National Aeronautics and Space Administration (NASA)

- BSEE has a five year agreement with NASA focusing on the following areas:
  - Quantitative Risk Assessment
  - Best Available Safest Technology
  - Failure Analysis and Testing Services associated with QC FIT evaluations
    - Bolts

## QC – FIT: GE H4 Connector Bolts failure on LMRP

- Connector and Bolt Failure evaluation:
  - Contributing factors for the cause of the bolt failure:
    - Inconsistencies across industry standards for material properties requirements related to fasteners (bolts/connectors)
      - Hardness, YS, UTS
    - Industry Standards with different material property requirements
      - Zinc Electroplating and Post Heat Treatment issues
    - QMS audited to 1<sup>st</sup> tier subcontracted vendors but not further down to 2<sup>nd</sup>, 3<sup>rd</sup> tier and lower sub-contracted vendors.



## QC – FIT: GE H4 Connector Bolts failure on LMRP

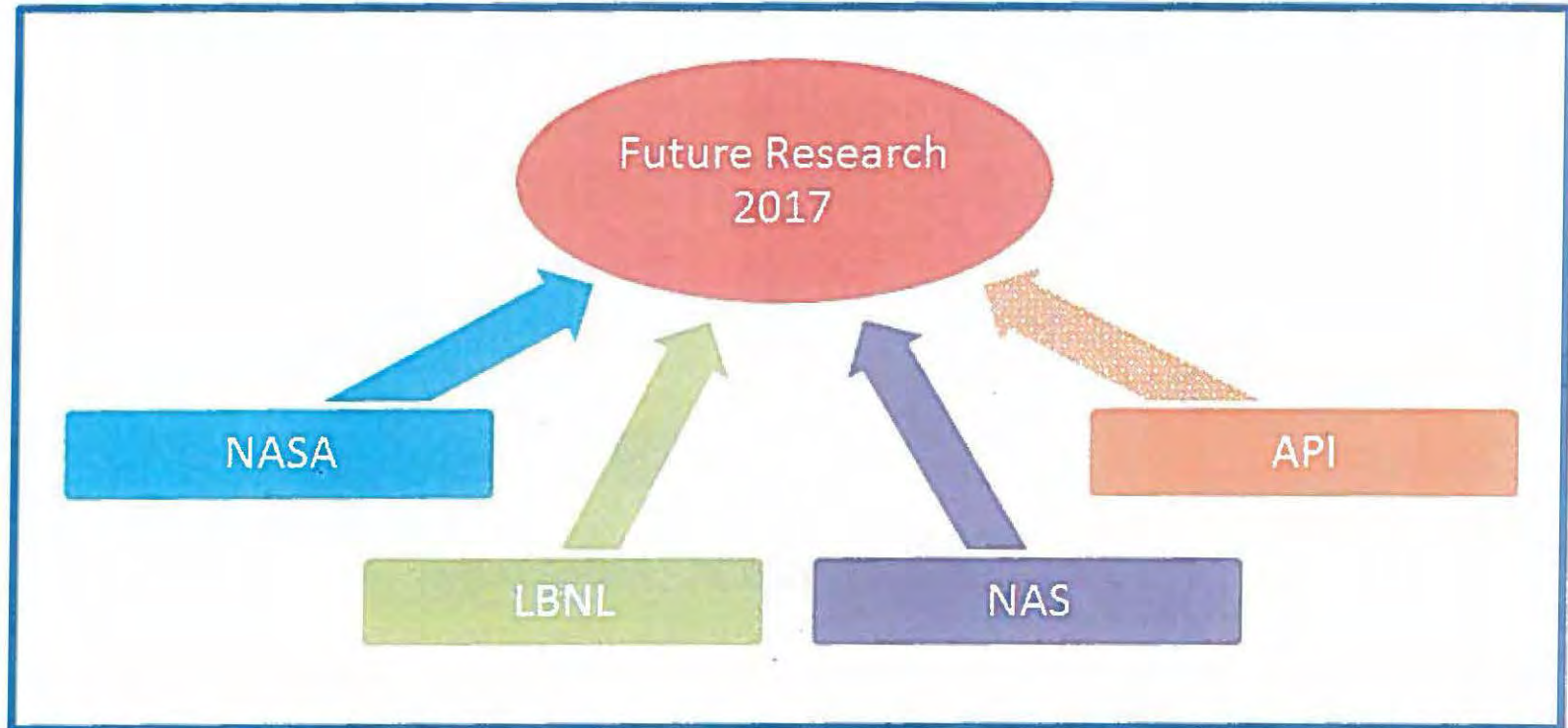
- Connector and Bolt Failure evaluation:
  - Recommendations:
    - Consistent material property requirements for fasteners among standards
      - Material Properties (Hardness, YS, UTS)
      - Coatings
    - OEM needs robust QMS oversight of 2<sup>nd</sup>, 3<sup>rd</sup>, and lower tier subcontracted vendors (Quality Standards)
    - OEM to perform qualification and audit of 2<sup>nd</sup>, 3<sup>rd</sup>, and lower tier sub-contracted vendors

# Bolts Summary Overview

- Public NAS Bolt RCA Workshop
  - Identify gaps in industry requirements, best practices, standards and regulations
- LBNL to conduct
  - Research on bolts
    - Material properties, gap analysis, variation in standards
  - Material testing to validate material properties for failed component
- NASA to conduct
  - Failure analysis and materials testing associated with QC-FIT evaluations
- Results from the above activities will be shared for the benefit of the industry.
- Outcome of these activities may dictate future research on bolts



# Future Bolts Research





BSEE Website: [www.bsee.gov](http://www.bsee.gov)



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Bureau of Safety and  
Environmental Enforcement

“To promote safety, protect the  
environment and conserve  
resources offshore through vigorous  
regulatory oversight and  
enforcement.”



# Industry Research

- Hydrogen Embrittlement Research  
Funded and/or Sponsored by API
  - 5 Completed
- Corrosion-resistant Alloy Research  
Funded and/or Sponsored by API
  - 13 Completed
  - 5 Ongoing

- Any Other Business
- Review Action Items
- Plans for Next Meeting / Next Steps