Appendix G - Evaluation of Pressure Rating Methods Recommended by API RP 17TR8
Peer Review Comment Responses

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Disclaimer

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Argonne Project Team Response to Peer-Review Comments

Introduction and Background

This document is a response to peer-review comments of the Argonne report that addressed a trial application of API 17TR8 (first edition), a design guideline for high-pressure, high-temperature subsea equipment. The Argonne project and peer review[1] was funded by the Bureau of Safety and Environmental Enforcement (BSEE) at Argonne National Laboratory (Argonne). This project began in mid-2015 with the objective of applying relatively recent API guidelines and conducting instrumented physical tests to failure in a controlled environment.

The API document, 17TR8, incorporated the latest oil and gas industry thinking, including the use of ASME Section VIII, Division 3, methodology for high-pressure, high-temperature subsea equipment design. Specifically, this methodology includes elastic-plastic finite element analyses (FEA) for rated working pressures in excess of 15,000 psi. The technical report combines this analysis approach with other API guidance, but such combined guidance has not been validated fully in the public domain. To this end, Argonne conducted and reported the physical design, build, and test to failure of one typical component as one step toward validation.

Argonne contracted with Aiken Engineering to design, analyze, fabricate, and test a 3.25-inch bore component made according to regular practices used in the oil and gas industry. To be representative of typical subsea components and hardware, the tested hardware (of which two were made) had a flanged tubular section that transitioned to a cross-bored square cross section of the type that might occur in a valve. These components were ASTM A182 F-22, as are commonly used in the industry for such applications (although unclad). The final components were pressure-tested to failure, which occurred as expected in the tubular sections. The pressure testing was compared to pretest FEA predictions based on an analyst's interpretation of the API 17TR8 guidance and was presented in a technical report to BSEE. The subsequent peer review of this Argonne deliverable was conducted, directed, and overseen solely by BSEE staff.

Technical reports delivered to BSEE are subject to peer review in accordance with established agency policy. For the Argonne 17TR8 report, BSEE contracted with an organization to administer this process. The process began with the solicitation of technical reviewer candidates and concluded with a final peer-review report that compiled reviewer comments. That peer-review report contains a wide range of comments that are addressed in this present document.

Many reviewers' comments are specific to reported details and the scope of the Argonne project. Concurrently, several comments are peripheral to the actual scope of work undertaken for the BSEE-funded project. The latter include points about API 17TR8 and other standards, the intent of the ASME Boiler and Pressure Vessel Code (BPVC), and general topics associated with designing and building subsea components. Because many of these points are part of the motivation for the BSEE project and provide specific suggestions for future discussion and

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[1] Summary Report for the External Peer Review of *Evaluation of Pressure-Rating Methods Recommended by API RP 17TR8,* Prepared by ExDyna under BSEE Contract Number: BPA E14PA00008, Task Order Number: E17PB00021,(Task Order 9)**,** May 12, 1917.

projects, they have been included as part of Argonne's responses. The second section of this report addresses subjects in the peer review that are relevant to the project scope. The subcategories are the materials, design, and geometry of test bodies; FEA; burst tests; and miscellaneous subjects. The next response category is restated conclusions based on peer-review comments. This document concludes with noted responses beyond the review charges.

Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)

Opinions and Expanding Scope of Current Argonne Study

Among peer reviewers' comments, there are numerous opinions about the methodology of the Argonne study and the contents of the report. In some instances, there are contradictions among the reviewers. Generally, these contradicting opinions are pertinent to some parts of API 17TR8 and the incorporation of certain ASME Section VIII paragraphs. Several comments could enhance the Argonne study, provide beneficial information, and reduce uncertainties; however, an extension of the Argonne study is not a consideration at this time. Nevertheless, there is merit to recognizing these suggestions and opinions, as they have considerable relevance to defining and debating future validation and confirmation efforts. The Argonne team concurs with most of the subjects in this group.

Literature Review

The Argonne team concurs that a comprehensive, narrated technical review of validation literature with a detailed bibliography should be part of any technical report such as API 17TR8. The Argonne team understands that a complete package of such information was not available for public consumption despite previous requests for such information. As a package, such information could be useful to understand and communicate the basis and data of the study. Such a review could have explained the following:

- adopting the ASME 1.8 factor for subsea equipment when prior API guidelines and industry practice had been closer to 2.1.
- depending on fracture mechanics and crack-growth technology as a basis to offset the added conservatism associated with a 2.1 factor.
- improving clarity and intent about design factors being mean failure values rather than minimums below two standard deviations.
- removing technical doubts and uncertainties that exist because subsea situations differ from pressure-vessel designs.

Finally, such an information package (beyond the informative citations provided by a reviewer in the peer-review comments) could also aid analysts unaffiliated with the proceedings leading to API 17TR8 in applying guidance more consistent with intent.

Since only portions of the ASME BPVC are guidelines in 17TR8, the Argonne team does not agree that, because the BPVC Section VIII has been validated over many decades, 17TR8 is validated too. Validation is not necessarily transferable when a standard is modified by any other standard, at least not until a thorough analysis of the literature (and/or in conjunction with appropriate testing) has occurred for the entirety of the new situation. The API recognizes and accommodates this partial adoption of ASME BPVC in API 17TR8 Section 4.2.1.4, which reads as follows:

"Traditionally, the standard practice is to rely on the ASME BPVC to provide design guidance when the equipment's functional requirements go beyond the defined boundaries of the API specifications/standards. However, the problem then arises as to "how much of the ASME

BPVC does one follow"; 1) exact to the "letter" 2) use portions of the code that are applicable to the particular design or 3) following a parallel path using the ASME BPVC methods, but develop another set of design margins applicable to oilfield applications. Oilfield equipment are of complex geometry, far from simple cylindrical pressure vessel or piping union design. They are typically subjected to a variety of extreme external loading conditions and they are not explicitly addressed in ASME BPVC. This leads the equipment designer to rely on sound engineering practices and judgment, accompanied by unique validation prototype testing programs."

It is very likely that a thorough literature review, as suggested by the peer-reviewer comments, could not only further clarify the boundaries of the BPVC Section VIII applicability, but also lead to greater design consistency and assurances. Section 4.2.1.4 also helps explain why differences of opinion exist between BSEE project analysis and the methods a peer reviewer may have preferred. Sound engineering practice and judgment to one person may not be the same to another.

A fundamental premise of the Argonne study (as noted on page 6 of the project report) was to apply API 17TR8, First Edition[2], principles—including related guidance contained in specific normative references—as they existed in fully approved form at the onset of the BSEE-sponsored project. These principles specifically include:

- API 6A[3]/6X[4]/17D[5];
- ASME Division 2: 2013 Part 5 by Linear-Elastic FEA;
- ASME Division 2: 2013 Part 5 by Elastic-Plastic FEA; and
- ASME Division 3: 2013 Part KD by Elastic-Plastic FEA.

The Argonne report did discuss the evolution of particular standards and the relative impacts of differences on pressure-based design ratings. These comparisons were not intended to be a validation literature review, but rather a simple industry history providing a basis for comparisons with trial application of the 17TR8 guidance (through collapse pressure determination using FEA modeling). Ideally, a thorough literature review would not only quantify proposed design margins, but fully justify any departure from historical success. This appears to not have been done for the First Edition of 17TR8 and has not been made available to interested users.

ASME BPVC Is Guidance

The Argonne team agrees with identified limitations and cautions regarding the use of ASME BPVC methods in API 17TR8 for design verification and assessment. The ASME BPVC is not a design handbook. While there is a degree of specificity in API 17TR8, there is also considerable latitude on design verification of high-pressure, high-temperature (HPHT) subsea equipment applications. The normal expectation is that not all designers will follow exactly the same practices. The obvious goal is to assure that, when following verification guidelines, the resulting

[2] High-Pressure, High-Temperature Design Guidelines, API Technical Report 17TR8, First Edition, February 2015.
[3] API 6A, Specification for Wellhead and Christmas Tree Equipment, Twentieth Edition, October, 2010.
[4] API Standard 6X, Design Calculation for Pressure-Containing Equipment, First Edition, March 2014.
[5] API Specification 17D, Design and Operation of Subsea Production Systems-Subsea Wellhead and Tree Equipment, Second Edition 2011.

components are not prone to failure in service. This not only protects the environment, but also helps assure safe operations, including life safety.

Non-Pressure-Related Failure Modes

Obviously, a subsea component or even a portion of a component can have many failure modes other than pressure alone. However, pressure often (but not always) drives at least part of the design and remains a prominent factor in the manufacturing acceptance process. As a research-oriented project rather than a project intended to produce a production component, the scope of the BSEE-sponsored project never intended to explore other failure modes or to apply both forces and moments in an elevated temperature environment. To assure project objectives would be accomplished, informally, the Argonne team did look at non-pressure-related failure modes and agrees that exploring other failure modes and testing in other conditions would contribute significantly to the validation process. Failure modes and loading combinations other than pressure should be a consideration for future validation projects.

ASME BPVC Validation

The ASME BPVC has existed for decades and has been validated when all of a particular section and division are applied (Section VIII, Division 2 or Division 3 in this context). The Argonne team agrees that the BPVC is useful for analytical verification of subsea components. However, as discussed above, API 17TR8 does not adopt the entirety of either division for a variety of reasons, including complex geometry. Again, the ASME code is **not** a handbook of design, and thus the designer and analyst have an obligation to apply "*sound engineering practices and judgment*" to the situation at hand.

Aside from geometry differences (between pressure vessels and subsea equipment), the Argonne team believes other important differences also impact how much one can rely on BPVC methods for a particular subsea situation. These differences include the following:

- Subsea components do not have pressure-relief valves to limit maximum pressure loading. This difference could compromise the containment boundary in the subsea situation.
- Most pressure vessels are subject to in-service inspection. Many subsea components are not adequately accessible or retrievable for such inspections.
- There is not necessarily close parity between the forms of materials used for component manufacture. For example, subsea equipment bodies are forgings, while large pressure vessels tend to be combinations of rolled plates welded together. Fasteners in both applications are based on bar stock.
- Usually, temporal pressure vessel load and operating conditions are relatively easy to quantify compared to the subsea environment, where conditions for a particular well can vary greatly and unexpectedly from forecasts.

The materials for test articles of the BSEE-sponsored project were a rich chemistry F-22 forging that substantially exceeded the project's material specification (specified minimum yield of 75 ksi with actual yield in excess of 90 ksi). This material is substantially different from the listed ASME BPVC material and may not fall within the technical limitations of ASME methods for alternate materials.

Performance of Burst Test Is Expensive and Dangerous

The peer review includes several statements that burst tests of subsea equipment are impractical and unsafe. One example of this statement is given in comments on page 83 of the peer review. The Argonne study is evidence that this is not a correct statement. Two test bodies were tested to failure in a safe and practical manner, and the results were valuable. There is no doubt that burst tests must be properly planned, and adequate projectile containment structures must be provided. All major subsea equipment manufacturers have test bunkers designed to contain projectiles that might occur from bursts. Damage to the test bunker, if used, can be prevented by enclosing the test component in a simple and inexpensive fabricated containment that absorbs most or all of the released energy. The Argonne burst tests were conducted in an open, controlled-access area with containment and observing personnel isolated in a shielded area some distance from the test.

Statistical Relevance

The Argonne team wholly agrees; results from one or two tests are not statistically significant if one is seeking to quantify values that effectively establish and quantify safety margins. At the same time, one or a few full-scale tests provide far more confidence than no test results. Scaled tests can contribute, but there are nearly always scaling questions that are difficult to quantify beyond a reasonable doubt. The Argonne team believes the least uncertainty of any test outcome occurs when test articles have close similarity to a production version. This includes test materials being full scale, manufactured with identical processes and materials as the production item, and tested in representative conditions to the extent practical.

The Argonne team recognizes that full-scale testing to a statistically valid level can be very costly and time consuming. However, since there is considerable validation value derived from any number of full-scale tests (of an article prepared in accordance with commonly accepted industry practices and conventions), such testing is useful and advisable to validate a new or revised standard. This is particularly relevant when that standard relies upon excerpts from other standards or departs significantly from historical norms. The Argonne team's understanding is that there was no physical, testing-based validation information in the public domain for a subsea component prepared according to the guidelines of the First Edition of API 17TR8.

Standards Released Subsequent to BSEE Project Start

As explained above, the project finite element analyses and component fabrication were based on standards specifically called out in API 17TR8, First Edition. The particular guideline is somewhat unique in that normative references are to a particular version, yet many API standards endorse the "latest version" of anything listed without a date or version. In addition to normative references, API 17TR8 provides a bibliography of some references without dates, versions, or guidance on use. One such example the Argonne team found is API Specification 20B (Specification for Open Die Forgings for the Petroleum and Natural Gas Industries). This standard is listed, but is not cited specifically in the main text of the technical report (First Edition of 20E is dated August, 2012, and the latest is the second edition dated February, 2017). For such a situation, are this specification and others a requirement, guidance, or merely optional information? If the specification's content is important, then this specification and any others should be incorporated into the 17TR8 text where applicable. Potentially, this can become part of the next revision of API 17TR8.

Forged Products (the forging supplier for the BSEE project) regularly provides large and small forgings to the oil and gas industry and has the infrastructure and quality system associated with both versions of 20E. Additional, nonproprietary details of Forged Products heat treatment and forging work are provided as requested and are consistent with what would normally be publicly released.

Another concern of the reviewers pertained to the version of the AMSE BPVC, since 17TR8 references the 2013 edition. This revision was considered in the study, even though the 2015 edition was current at the time the study was performed. Again, a driving consideration was to apply API 17TR8 as it was written.

The original release of API 17TR8 is also the current release. A revision is in progress, and prelease information indicates that there will be additional requirements for materials and other aspects of HPHT equipment. The additional requirements in the revised TR8 were not considered in the Argonne study, and no responses are provided regarding new requirements.

Collapse Pressure and Strain Limit

Evaluation of strain limit (API 17 TR8, Fig. 1- Div. 3: KD-232) is beyond the scope of the Argonne project and would not have altered the comparisons reported. The Argonne team agrees this would be done as part of a full analysis of a production component designed in accordance with API 17TR8. Such a full analysis would similarly consider different failure modes, ratcheting, hydro-test, and fracture mechanics. The Argonne team's work focused on comparing global plastic-collapse predictions with physical testing as a step to validate 17TR8.

Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project)

Materials

Forging Reduction at Burst Region

For the valve bodies, Forged Products first forged the raw material (Heat AH450) to bloom, then reduced to a shaft that had a 16" diameter, was 51.60" long in the center, and had two identical square blocks at both ends (19.20" square by 27.20" long). Both the throat area and the single prolongation are from the middle section of the forging (shaft) that had experienced tremendous cross-section reduction (calculated to be around 12:1). For forgings, this amount of reduction will result in fine-grain structures before rough machining and heat-treating. The mechanical test results for the prolongation verified the strength of the materials in this area.

Heat-Treat Quenching and Grain Structure at Burst Region

The throat section is around 20" long, and the failure location during the burst testing was somewhere between 5" to 25" away from the prolongation piece. The heat-treat shop (Lone Star Heat-Treating Corp.) quenched the parts with the prolongation section facing the water jet, such that water flow was facilitated through the inside diameter. This area (flange/prolongation) received the most agitation and therefore experienced the most hardening. It takes less than 60 seconds for quenching thus the entire forging should be a bainitic microstructure. If some soft phases like pearlite were going to form (which is unlikely) due to the fast quench, it would be in the middle of the thick sections (end block) rather than the pipe section. Both the prolongation and thick sections should have high strengths and fully transformed bainite. For completeness, the quality assurance (QA)-verified heat treatment performed is summarized in the table below:

Process	Temperature (°F)	Time (hrs) at Temp	Cooling Method
Normalized	1750	6.0	Air cooled
Hardened	1700	6.0	Water 71–73°F
Tempered	1230	10.0	Water cooled

Material Properties from Prolongation

Material property verification tests were performed in accordance with ASTM A370. These tests were performed on test specimens taken from the prolongation. Longitudinal test specimens (parallel to the primary grain-flow direction) were obtained such that the tensile specimen gauge sections were at least ¼ T (where T is the thickness) and no less than 25 mm from the heat-treated surface. Charpy V-notch impact test specimens were also tested in the longitudinal direction. The specified material properties were as follows:

Material Property	Required Value by API 6A PSL 3
Yield strength (0.2% offset)	75,000 psi min
Ultimate tensile strength	95,000 psi min
Reduction of Area	35% min
Elongation in 2”	18% min
Brinell hardness	197–237 after finish machining
Charpy V-notch* @ 0ºF	40 ft-lbs (min ave of 3 specimens)
Charpy V-notch* @ 0ºF	30 ft-lbs (min single value)

* Full-sized specimens (10 x 10 mm)

Mechanical properties are expected to be the same or slightly lower in thicker sections and the same or slightly higher in thinner sections. Forged Products simulated the heat-treat and quench operations and compared them to Jominy end-quench tests. The hardenability results and tensile strength projections were consistent across the entire cross sections of the test pieces. Based on Forged Products' considerable experience with similar F22 heats, the tensile properties in the thinner section, where the intentional burst failure occurred, would be expected to be similar or slightly higher than those obtained from testing of the prolongation.

Post Burst Testing Material Examination

Posttest material investigations included optical metallography, a scanning electron microscopy examination. The objectives of this work were to:

1) investigate the microstructures of the material following the burst failure; and

2) determine if the burst failures originated at preexisting defects.

Samples were taken from three locations of the throat portions of both valve bodies. These locations were: at the burst, 180 degrees from the burst in the circumferential direction, and lastly at the flanged end farthest away from the burst. These tests were conducted at a third-party laboratory in Houston, TX, (Exova) that has considerable experience with oil and gas materials. Summaries of these investigations are noted here:

Metallographic samples were prepared for three orthogonal planes for the three sampling locations. This investigation showed that the grain-size average results varied between ASTM grain size 6 and 7. Microstructures were determined by Exova to be tempered martensite but there is uncertainty about this determination.[6] (Note: The forge shop had determined the structure was Bainite and there was no physical explanation likely to have caused any such structure change.) The “At Burst” locations showed elongated grain structures, as would be expected from plastically deformed material.

[6] The differences between Bainite and Martensite are subtle. An experienced third-party metallurgist could not positively determine the structure based on the available information but believes the post-test structure was most likely Bainite. Additional investigation might be more conclusive.

Examination for Preexisting Defects

Electron microscope examination of the fracture surfaces found no evidence of preexisting machining or material defects. Dimple rupture was noted at 400X and 1500X magnification examinations of the fracture faces.

Post-Failure Metallurgical Examination

The peer review includes queries about whether metallurgical examinations of the material at the rupture locations should have been performed. For example, on page 76 of the peer review, a reviewer makes the following statement:

"…..a metallurgical evaluation of the failed components should be conducted."

Although the data obtained from these examinations would be useful, post-failure examinations were beyond the scope of the study, which encompassed only determining whether there were preexisting flaws.

Design and Geometry of Test Bodies

Shapes of Test Bodies

The peer review includes comments about the shapes of the test bodies from the standpoint that the flanges and thick body sections served no purpose other than to resist pressure. For example, on page 79 of the peer review, one reviewer states the following:

"The thick body section with intersecting bores did not contribute any useful information regarding the proof test, in that the design was adjusted to assure the failure would occur in the neck region."

This is a true statement. The test bodies were designed so that plastic collapse would occur in the neck section and not in the thick section with cross bores or in the flanges. The thick section with cross-bores was included to represent test body materials that had experienced a wide range of elastic and plastic strains. Moreover, the values of strains throughout the test bodies were known from results of the FEA solutions. This provides metallurgists with material that has been exposed to known values of elastic and plastic strains. Material with this strain history could be useful in future studies.

Flanges, Bolts, and Seals

The peer review included several criticisms of the flanges, bolts, and seals. More than one reviewer criticized these components because they did not meet the ASME codes or API standards. For example, on page 60, a reviewer makes the following statement:

"The flanges used in this situation are standard size 20 ksi flanges based on Table B.43 of API 6A for 20 ksi rated working pressures. The analysis does show that the flanges meet the requirements of global collapse at these pressures. However, it is likely that the sizes and numbers of bolts used might not meet the requirements of ASME Section VIII-2."

Criticisms of the flanges, bolts, and seals because they did not meet ASME codes or for any other reason are unwarranted. Flange evaluation was not an objective or concern of this study.

The only purpose of the flanges was to provide a safe, non-failing means of connecting blinds to the four openings of the test bodies. There was no requirement that the Argonne study flanges meet the ASME codes or any other code for that matter.

Flanges have been extensively evaluated in countless studies since the 1930s. The flanges were included in the designs to provide removable blind closures for the internal bores. They were designed not to rupture or leak before burst of the cylindrical neck sections in the test bodies. In fact, the bolts would not meet either API or ASME standards, and they would absolutely not meet all NACE MR0175 requirements. The bolts successfully performed the functions for which they were designed.

FEA

Independent FEA

Page 81 in the peer review summarizes comments by one reviewer about an independent FEA that was performed for the large neck body. The collapse pressure from the independent FEA was 72,251 psi, as compared to a collapse pressure of 72,850 psi from the Argonne FEA. The difference between the two collapse pressures was only 0.82%, which is insignificant.

The results of the independent FEA validate the accuracy of the Argonne FEA for the large neck body. Since the input (other than dimensions) and methodologies of the FEA for the small neck body were identical to those of the large neck body, it is reasonable to assume that validation of the small neck body FEA would occur if an independent FEA were performed.

The preceding two paragraphs, in essence, validate the accuracy of the methodology, assumptions, and input of the Argonne FEAs. Queries about these elements of the Argonne FEAs should have little to no impact on analytical results. Even so, responses to the peer-review queries about the FEAs are provided in the following paragraphs.

Mesh Sensitivity

A query on page 78 of the peer review stated that no documentation of the mesh sensitivity studies were included in the report. This is a correct statement. However, it is not common practice in stress reports to document anything but the results of the mesh sensitivity study. Section 6.1 in the Argonne report states that the FEA solutions of two different mesh densities for both test bodies produce collapse pressures within 1% of each other. The adequacy of the mesh densities are also validated by the results of the independent FEA of the large test body.

UY Displacement Constraint

Page 67 of the peer review states that the Argonne report does not describe the UY displacement constraints in the FEA models. The FEA models have no cut planes normal to the y-axis, and all loads in the Y direction are in static equilibrium. This means that a UY constraint is not necessary other than to prevent drift in the Y direction due to computer round-off errors. To prevent drift, a single node in each model was constrained in the Y direction. The location of the node was not important. A listing of reaction forces from solutions of the FEAs showed that reaction forces in the Y direction were virtually zero. This result is confirmed by stress and displacement plots in Appendix B1 for the large neck body and Appendix B2 for the small neck body. If improper Y direction constraints were applied, hot spots would have appeared in the plots.

Model Dimensions

The original intent of the study was to use the as-built dimensions of the two test bodies. The first solutions of the two FEA models occurred before the test bodies were manufactured. This step was to validate the designs of the test bodies and to confirm that plastic collapse would occur in the neck sections. Obviously, as-built dimensions were not available before the test bodies were manufactured, so nominal dimensions were used for these models. After the two test bodies were manufactured, the as-built dimensions became available. These are listed in Appendix F of the Argonne report. The actual outside and inside diameter dimensions in the critical sections where failure occurred were within 0.50% of the nominal dimensions. Rebuilding and solving the FEA models with as-built dimensions would produce virtually identical collapse pressures. For this reason, all FEA solutions were performed with the nominal dimensions.

Elastic-Plastic Material Properties

There were several queries in the peer review regarding the elastic-plastic material properties used in the FEA solutions. The models used the true stress/true strain values that were obtained from a tensile test by Franklin Research Associates in Houston. The tensile test specimen was taken at a ¼ T location from the 12 x 2.25 x 6 qualification test coupon (QTC) provided by Forged Products. A plot of the true stress/true strain data is provided on page F-36 of the Argonne report. Additional information about the tensile test is provided on page F-35 of the report.

Von Mises Flow Rule

The peer review included several queries about the elastic-plastic material model used in the FEA solutions. As required in Divisions 2 and 3, “the von Mises yield function and associated flow rule” were utilized in the FEA models.[7]

Load-Displacement Curves

Page 80 of the peer review states that load-displacement curves from the FEA solutions were not provided in the Argonne report and that they would provide insight into the development of plastic hinges. Load-displacement curves were not included in the report because they would not serve any useful purpose during performance of the FEA or evaluation of the results. Load-displacement curves provide the FEA analyst with an indication of when plastic collapse is about to occur. This information would not be useful for this particular situation.

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[7] For clarification with regard to API 6a and API 6X: API 6A uses stress intensity for ratings based on the ASME methods. The allowable stress intensity is 2/3 the yield strength at the rated internal pressure. As an alternate 6A allows the use of von Mises stress at the bore and at the hydrostatic test pressure of 1.5 x the internal pressure. The allowable von Mises stress at the bore is the yield strength. The FEA analyst’s experience is that usually the von Mises stress method will produce lower pressure ratings for 20 ksi equipment. API 6X allows the use of either stress intensity or von Mises stress based on the ASME methods with a 2/3 Sy allowable stress.

FEA Solutions to Plastic Collapse

Page 64 includes the following criticism by a reviewer about the iterative solution methods used in the Argonne study:

“The report indicates that it is a requirement, when using elastic-plastic evaluation, to determine the maximum pressure rating for a component and then apply the design margin to it. This is an incorrect statement.”

This statement by the reviewer is not correct based on Paragraph 5.2.4.1 of ASME, Division 2 that states the following:

“Protection against plastic collapse is evaluated by determining the plastic collapse load of the component using an elastic-plastic stress analysis. The allowable load on the component is established by applying a design factor to the calculated plastic collapse load.”

Clearly, ASME states that the elastic-plastic solution should be performed until elastic-plastic collapse occurs.

Even so, both the method used in the Argonne study per ASME and the method suggested by one reviewer are acceptable and will provide correct results. However, the method used in Argonne study was precisely as specified in Paragraph 5.2.4.1 of ASME, Division 2.

Inaccurately Modeled Components

The peer review included several criticisms that the blind, bolts, nuts, and seals were not included in the FEA models. Reviewers’ concern was that disregarding these components may have affected the accuracy of the results. For example, on page 57 of the peer review, one reviewer states the following:

“The FEA models did not include all components of the assembly which was subjected to burst, such as the flange bolting, ring gasket, and blind flanges. These may not influence the results, but not including them raises the question of accuracy in the modeling.”

As previously stated, the only important results of the Argonne study were the plastic collapse pressures of the two test bodies. Both test bodies collapsed in the neck section at locations far enough away from the flanges that inaccurate modeling of the flanges did not affect the burst pressures. The method of modeling the flange components provided statically equivalent loads at the flanged ends of the test bodies. Saint Venant’s principle teaches that results far enough removed from statically equivalent features produce results that are the same as if accurate features were modeled. Figure B1.17 for the large neck test body and Figure B2.17 for the small neck test body unquestionably demonstrate that failure locations are far enough removed from the flanges. The stresses and strains in the neck sections, where burst occurred, were constant along the lengths near the locations of burst. They would not be constant along the lengths of the neck sections if end effects existed.

Burst Tests

Purpose of Strain Gages

The peer review includes numerous statements and queries about the strain gage results and how they could have or should have been used. Although remarks about strain gages by the peer reviewers are useful, no replies to these remarks are included in this response to the peer review. The reason is that the strain gage data was not a vital or necessary element for the conclusions or results of the Argonne study. Strain gages were applied to the test bodies simply to generate data that might be useful to BSEE or others. For example, BSEE might use the strain gage data from the differential pressure tests to study the effects of differential pressure.

One use of the strain gage data was to provide a visual indication about strain behavior as internal pressure increased during the burst tests. Although this provided a warning as to when burst was going to occur, it was certainly not essential to know during the burst test.

The strain gage data was also used to validate the accuracy of the FEA models at lower pressures when strains in the cylindrical neck section were linear with pressure. This validation is described in Section 6.4 of the Argonne report. As shown in Appendix D of the report, calculated strains were within 4% of measured values. Model validation using the strain gage data was not done because it was required, but because the data was available. Stresses and strains in the cylindrical neck section could be accurately validated using simple strength-of-materials calculations.

Several strain gages separated from the test vessels during hydro-testing, and even more were lost as pressure increased to failure. Strain gages characteristically fail at high strains. There are other strain-measurement methods, but there are also practical limitations to using these when performing a test to failure inside a safety containment shield.

Only Two Burst Tests Performed

The peer review includes numerous comments, queries, and questions about the accuracy of the conclusions since they are based on only two burst tests. For example, on page 58 of the peer review, one reviewer makes the following statement:

“The two component evaluations conducted are insufficient in number to demonstrate that the analytically predicted collapse pressure vs the proof test provide a statistical distribution range of data.”

It is obviously true that two data points are not a large enough sampling to perform statistical analysis. However, API 17TR8 does not include references to test data that would justify their methodology and acceptance criteria. As stated previously, the two test results from the Argonne study may not be statistically significant, but they clearly show that elastic-plastic FEA may not be conservative in all cases and for all equipment. The results of the Argonne study surely indicate that more tests to failure should be performed and compared with elastic-plastic FEA results. This is especially the case for more complex equipment with multibody contacts and moving components, which are common in HPHT subsea equipment.

Pressure Ratings by Hydro-test

On page 65 in the peer review, a reviewer correctly states that pressure rating by hydro-test using Division 3 rules should not be based on pressure, but the pressure when strain at the OD is 2%. Review of the FEA results from the neck section of the two test bodies at burst pressure shows that strains on the OD were greater than 2%. The net effect is that the Division 3 pressure ratings based on burst will be less than those stated in the Argonne report and by API criteria. This reinforces the statements on page 28 of the Argonne report that pressure ratings based on Division 3 hydro-test procedures produce ratings less than those from elastic-plastic FEA with a 1.8 load factor.

Proof Testing Contradiction

A comparison of burst pressure is useful to physically quantify the accuracy of analytical methods independent of whether API, ASME, or any other guidance prohibits or requires a test to failure for design validation. The Argonne team is not suggesting that components must be validated this way. However, since there is apparently a conflict between ASME guidelines and API (as identified by the peer reviewers), this matter should be reconciled by the appropriate technical committees.

Miscellaneous

Least Conservative Pressure Rating

On page 75 of the peer review, a reviewer makes the following statement about the Argonne report:

"One statement in Section 9.1 on page 24 states that 'the least conservative pressure ratings were determined by ASME: VIII-3 elastic-plastic analysis.' This is not correct. Table 9.2 shows that the least conservative margin calculated is 1.74 based on linear-elastic analysis by ASME Section VIII…"

The reviewer improperly quoted the sentence from the Argonne report. The following is the actual sentence from the report:

""For all test components but the small neck test body, the least conservative pressure ratings were determined by Division 3 elastic-plastic analysis."

The criticism of the Argonne report by the reviewer is not deserved.

Histogram Load Sequence

One reviewer makes the following statement on page 85 of the peer review:

"It's possible to review the load histogram and evaluate a worst-case loading sequence for fatigue analysis. There can also be multiple load sequences run to verify a worst case."

Fatigue load histograms of environmentally induced loads on HPHT subsea equipment must be statistically defined because of the random nature of these loads. Fatigue load histograms can consist of several hundred load bins with various combinations of tension, bending moment, and shear. Fatigue textbooks and even ASME, Division 3, state that the sequence of load application has a significant effect on fracture mechanics calculations.

Developing a sequence of loads that will produce conservative predictions of crack growth by fracture mechanics will not be so simple and may be impractical. Furthermore, validation that a load sequence produces conservative fracture mechanics calculations will not be a simple task. The sequence of environmental loads on subsea equipment should be carefully evaluated and reported by experts in both fracture mechanics and in environmental loads that are applied to subsea equipment.

Elastic-Plastic FEA as an Allowable Method by API

On page 75 of the peer review, one reviewer states that the statement in the Argonne report that elastic-plastic FEA was not allowed prior to 2015 is misleading. The reason given by that reviewer was that BSEE was reviewing analysis by elastic-plastic methods prior to 2015. The intent of the statement in the Argonne report was that API did not explicitly allow elastic-plastic FEA prior to 2015. Publication of API 17TR8 was the first API document related to subsea equipment that allowed elastic-plastic FEA.

Comparison of Subsea Equipment and Pressure Vessels

A reviewer in page 56 of the peer review states that it is a misconception that subsea equipment is unique and completely different from other equipment that contains internal pressure, operates at high temperatures, and is exposed to a corrosive environment and subjected to highly cyclical loads. Text in API 17TR8 does not support the “misconception” asserted by the reviewer. As stated previously, the following statement is in Section 4.2.1.4 in API 17TR8:

> “….. Oilfield equipment are of complex geometry, far from a simple cylindrical pressure vessel or piping union design. They are typically subjected to a variety of extreme external loading conditions and they are not explicitly addressed in ASME BPVC…..”

Section 4.3 in API 17TR8 provides additional statements that subsea equipment is exposed to loads different from those included in the ASME BPVC.

Linear-Elastic as a “Gold Standard”

On page 82 of the peer review, a reviewer makes the following statement:

“It would seem that the linear-elastic methods are being used as a ‘gold standard’ which the newer, more rigorous modern methods are being held to.”

This is an incorrect statement. The Argonne study did not conclude or state that the “newer, more rigorous modern methods” adopted in API 17TR8 should produce the same load ratings as those from linear-elastic analysis. Historically, the subsea industry has rated subsea equipment using linear-elastic analysis. Furthermore, subsea equipment rated by this method has operated successfully for several decades. The Argonne study simply pointed out that load ratings from some more modern methods are higher and thereby less conservative. Since equipment based on more modern methods has not been validated by extensive successful operation, it must be validated by engineering studies or load tests.

Numerical Analysis Compared to Test Results

On page 74 of the peer review, Richard Biel states the following:

"The report draws a false conclusion from Table 6.1 that the numerical analysis should exactly match the results of the physical test."

This was not a conclusion of the report. It would be unfounded to make this conclusion when comparing any analysis results with test results. Theoretical results from scientific and engineering studies rarely match test results exactly.

Plastic Collapse and Ultimate Tensile Strength

A comment by a reviewer on page 63 of the peer review states that it is a gross simplification that the elastic-plastic analysis is solely based on tensile strength, as is stated in the Argonne report. It is true that yield strength and other variables do affect the plastic collapse load from an elastic-plastic analysis. However, the ultimate tensile strength is the most dominant material property that controls the burst pressure. Simple engineering studies will confirm this is true. Therefore, it is not a "gross simplification" to state that the burst pressure is predominately controlled by the tensile strength.

No FMECA

Page 68 in the peer review includes a statement by one reviewer that a FMECA should have been performed to identify all failure modes. As a part of the design process, an informal FMECA was performed to identify all possible modes of failure and to assure that failure would occur in the neck sections of the two test bodies. Since the Argonne study was a research project and not a design project, the FMECA was not included in the report.

"Design Margin" Term

The Argonne report uses the terms *margin of safety* and *factor-of-safety* when comparing load ratings to failure loads. Two reviewers, both from the pressure-vessel industry, strongly state that the Argonne report should use the term *design margin* rather than the terms *factor-of-safety* or *margin of safety*. *Design margin* is the term used in the pressure-vessel industry. However, different industries use different terms when describing the margin between operating loads and failure loads. For example, *stress utilization* is the most common term to describe this margin in the subsea industry.

Restated Conclusions Based on Peer-Review Comments

10.0 Conclusions

The following are the important conclusions of the Argonne study. These conclusions are based on results of the elastic-plastic FEA and hydro-tests that were performed as part of this study. The conclusions apply to HPHT subsea equipment rated for 20 ksi or less. No consideration has been given to equipment rated for pressures greater than 20 ksi. However, there is no apparent reason that these conclusions would not apply to equipment rated for pressures higher than 20 ksi.

These conclusions were marginally revised after the consideration of peer-review comments. The majority of the revisions are in the discussion section after each conclusion. These revisions were made to clarify a few misunderstandings that were evident from the peer-review comments. The content of the conclusions themselves has not substantially changed.

The Division 3 elastic-plastic method is not recommended for HPHT subsea equipment as published with a 1.8 design load factor until supplementary validation is performed.

ASME, Division 3, allows a 1.8 load factor for calculating load ratings based on elastic-plastic FEA. This is lower than the 2.4 load factor allowed by ASME, Division 2. The Argonne study shows that the equivalent load factor for existing subsea equipment is about 2.1 for simple shapes. Decades of successful operating experience show that the equivalent load factor of 2.1 has produced safe, reliable subsea equipment.

Pressure-vessel experts working with ASME have determined that a 1.8 load factor is suitable for pressure vessels designed and manufactured in accordance with the rules in Division 3. The Argonne study did not consider pressure vessels and does not question the use of a 1.8 load factor for Division 3 pressure vessels.

Nonetheless, just because a 1.8 load factor is suitable for pressure vessels does not mean it is suitable for HPHT subsea equipment. Many important characteristics of HPHT subsea equipment are significantly different from pressure vessels, as acknowledged in the following quote from Section 4.2.1.4 in TR8:

> *"….Oilfield equipment are of complex geometry, far from a simple cylindrical pressure vessel or piping union design. They are typically subjected to a variety of extreme external loading conditions and they are not explicitly addressed in ASME BPVC……"*

Another important consideration is that TR8 does not require that all the rules and requirements in Division 3 be used. TR8 adopts only a small part of Division 3.

A 1.8 load factor may produce HPHT equipment that is reliable and safe for subsea operation. However, TR8 does not provide any references validating that a 1.8 load factor is suitable for HPHT subsea equipment. Until scientific studies or tests are offered that validate the suitability of a 1.8 load factor for HPHT subsea equipment, it is recommended that a larger load factor be used for HPHT subsea equipment.

The Division 3 elastic-plastic method with a design load factor of 2.1 is recommended to calculate load ratings for HPHT subsea equipment.

This recommendation is based on the results of the Argonne study and the validation data currently available in the public domain. If scientific studies or tests exist in the public domain that validate a 1.8 load factor, then it is recommended that the TR8 committee publish a paper presenting this work so that it can be peer-reviewed. If the TR8 committee cannot do this, then the committee should commission appropriate scientific studies or tests validating that a 1.8 load factor is adequate for HPHT subsea equipment.

A Division 3 analysis with a design load factor of 1.8 is acceptable if the factor is applied to results of a load test, and validation is provided that demonstrates the additional requirements in TR8 and Division 3 sufficiently reduce the risk of failure.

Paragraph KD-1254 in Division 3 provides a procedure for rating equipment based on a proof test. This confirms that a proof test to failure is acceptable by Division 3 as a means to pressure-rate equipment.

The design load factor in Division 2 is 2.4, which is 33% greater than the design load factor of 1.8 in Division 3. ASME and TR8 state that this reduction in the margin of safety is validated by additional requirements, such as fracture mechanics in Division 3. HPHT subsea equipment in general has more complex shapes, more multibody contacts of components, and different materials as compared to pressure vessels. Before a load rating for HPHT subsea equipment is determined by dividing the test loads by a design load factor of 1.8, the user should confirm that the reduction in margin of safety has been validated.

For a Division 2 linear-elastic analysis, it is recommended that stress intensities are compared with allowable stresses and not von Mises stresses until supplementary validation is performed.

The Division 2 linear-elastic method is an acceptable method in TR8 to rate HPHT subsea equipment for pressures of 20 ksi or less. Division 2 allows that von Mises stresses be compared with allowable stresses, whereas API historically has compared stress intensities with allowable stresses.

The Argonne study revealed that the use of von Mises stresses allows higher pressure ratings for subsea equipment. Since subsea equipment has historically been rated using linear-elastic analysis with stress intensity, the design margins based on von Mises stresses will be lower than the design margins of historically successful equipment. The safety of reduced design margins based on the use of von Mises stresses should be investigated before the subsea industry makes this change. Until this issue is investigated, it is recommended that the HPHT subsea industry continue using stress intensities.

Note that this is not a question about the accuracy of von Mises stress, but about the safety of reduced margins of safety. Scientific studies and tests have confirmed that von Mises stress is a more accurate predictor of yield than stress intensity. Stress intensity is always greater than or equal to von Mises stress.

It is recommended that the subsea industry compare collapse pressures from FEA with burst pressures from hydro-tests for a variety of subsea equipment.

For numerous subsea components, the subsea industry should compare the collapse pressures from elastic-plastic FEA with the actual burst pressures from hydro-tests. This is necessary to validate the accuracy of collapse pressures by FEA. The reason for this recommendation is that the Argonne study showed that collapse pressures from FEA were higher than burst pressures for the two test bodies that were evaluated in this study.

This is an especially concerning outcome for subsea equipment because the two test bodies in this study were simple shapes. Many subsea components have much more complex geometries, and many have geometries with multibody contacts. It is possible that more complex shapes with multibody contacts will be even less conservative than the simple shapes evaluated in this study.

The subsea industry should confirm that performing the fracture mechanics analysis required by Division 3 justifies reduction of the design load factor to 1.8.

Reduction of the design margin based on performance of fracture mechanics may not be suitable for HPHT subsea equipment. The following are two important reasons this is true:

1. Division 3 justifies the reduction of the design load factor based on the requirement of fracture mechanics analysis. The purpose of a fracture mechanics analysis is to ensure that defects do not propagate to the critical crack size and cause a rapid, brittle failure. This may not be a critical failure mode for subsea equipment. TR8 requires that all pressure-containing components meet the material requirements in API 6A and NACE MR0175. Material that meets the requirements of these two codes will be ductile, have high impact strengths, and have high fracture toughness. Materials with these properties are not susceptible to brittle failures. Operating history confirms that subsea equipment made of materials that meet these requirements are not susceptible to brittle fractures. A reduced design margin should not be justified by requiring an analysis to prevent brittle failure if brittle fracture has historically not been a problem and is not expected to be a problem in the future.
2. To perform a fracture mechanics analysis, Division 3 requires a load histogram with loads in the same sequence that they will be applied in service. This is usually easy for the pressure vessels for which Division 3 was written. However, developing a load histogram with loads in the proper sequence may not be practical or perhaps even possible for HPHT subsea equipment. The reason is that the highly cyclic loads on subsea equipment capable of causing fatigue cracks are randomly applied by the environment. This means that load histograms for subsea equipment must be statistically defined in load bins with a percent occurrence time for each load bin. The sequence of application is random and unpredictable. It may be possible to convert a statistically based load histogram into a conservative sequence. However, this has not been demonstrated in a published and peer-reviewed format. This should be done before subsea equipment design margins are reduced based on fracture mechanics analysis.

Comments Outside of Peer Review Charge

One reviewer chose to go beyond the charge questions provided as guidance for the peer reviewers. Specifically this reviewer commented on the competence of the performer. There are no Argonne project team responses to these comments.

Appendix A- Cross Tabulation of Responses to Peer-Review Report Text as Tabulated in Section 4.2[8]

The following table tabulates peer review comments with the responses provided in the foregoing text. When paragraphs appear on two pages, that paragraph is referenced as one paragraph for comment tabulation purposes.

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
	56	1	DP[9]	None needed	
	56	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Opinions and Expanding Scope of Current Argonne Study
	56	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
	56	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Comparison of Subsea Equipment and Pressure Vessels
	56	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
	56	5	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Least Conservative Pressure Rating
	56	5	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Linear-Elastic as a "Gold Standard"

[8] Section 4.2 is peer-reviewer comments arranged by charge questions. These comments appear on pages 56-87 inclusive.
[9] Reviewer Key: DP = Dan Peters, PB = Paul Bunch, and RB = Richard Bihl.

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
	56	5	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
	56	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Only Two Burst Tests Performed
	56	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	No FMECA
	56	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Least Conservative Pressure Rating
	56	6	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Collapse Pressure and Strain Limit
	57	1	PB	Introduction and Background	Introduction and Background
	57	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
	57	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Inaccurately Modeled Components
	57	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
	57	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
	57	3	PB	None needed	
	58	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project)-Materials	Materials

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
	58	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
	58	3	PB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
	58	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Plastic Collapse and Ultimate Tensile Strength
	58	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Pressure Ratings by Hydro-test
	58	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Only Two Burst Tests Performed
	58	4	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
	58	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Performance of Burst Test Is Expensive and Dangerous
	58	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
	59	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
	59	2	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
	59	3	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
	59	4	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term
	59	5	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) –FEA	Independent FEA
	59	6	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) –FEA	FEA Solutions to Plastic Collapse
	59	6	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
	60	1	RB	Comments Outside of Peer Review Charge	Comments Outside of Peer Review Charge
	60	1	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term
1.1.1	60	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
1.1.1	60	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
1.1.1	60	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Opinions and Expanding Scope of Current Argonne Study
1.1.1	60	5	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.1	60	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Standards Released Subsequent to BSEE Project Start

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.1	60	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.1	61	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Standards Released Subsequent to BSEE Project Start
1.1.1	61	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.1	61	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
1.1.1	61	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.1	61	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.1	61	5	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.2	62	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term
1.1.2	62	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.2	62	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Linear-Elastic as a “Gold Standard”
1.1.2	63	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.2	63	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.2	63	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.2	63	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Plastic Collapse and Ultimate Tensile Strength
1.1.2	63	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.2	63	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.2	63	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.2	64	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Standards Released Subsequent to BSEE Project Start
1.1.2	64	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Von Mises Flow Rule
1.1.2	64	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Pressure Ratings by Hydro-test
1.1.2	64	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Plastic Collapse and Ultimate Tensile Strength
1.1.2	64	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.2	64	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Pressure Ratings by Hydro-test
1.1.2	64	2	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.3	64	3	DP	None needed	
1.1.3	64	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	FEA Solutions to Plastic Collapse
1.1.3	64	5	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.3	65	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Pressure Ratings by Hydro-test
1.1.3	65	2	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.3	65	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.3	65	4	RB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
1.1.3	65	4	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.4	66	1	DP	None needed	
1.1.4	66	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Model Dimensions

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.4	66	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Forging Reduction at Burst Region
1.1.4	66	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Heat-Treat Quenching and Grain Structure at Burst Region
1.1.4	66	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.4	66	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
1.1.4	67	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.4	67	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	UY Displacement Constraint
1.1.4	67	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Von Mises Flow Rule
1.1.4	67	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
1.1.4	67	5	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
1.1.4	67	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Model Dimensions
1.1.4	67	7	RB	Argonne Project Team Responses (Not Directly Relevant to	Non-pressure-Related Failure

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
				BSEE/Argonne Project Scope)	Modes
1.1.5	67	8	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.5	67	8	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.5	68	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
1.1.5	68	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Von Mises Flow Rule
1.1.5	68	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	No FMECA
1.1.5	68	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
1.1.5	69	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Inaccurately Modeled Components
1.1.5	68	2	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.5	68	2	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Least Conservative Pressure Rating
1.1.6	68	3	PB	None needed	
1.1.6	68	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.6	69	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.6	69	5	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Heat-Treat Quenching and Grain Structure at Burst Region
1.1.6	70	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.6	70	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Post Burst Testing Material Examination
1.1.6	70	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Standards Released Subsequent to BSEE Project Start
1.1.6	70	2	PB	Forged Products Table in Report	
1.1.6	70	3	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.6	70	4	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.7	70	5	DP	None needed	
1.1.7	71	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Post-Failure Metallurgical Examination
1.1.7	71	2	DP	No welding on test articles	
1.1.7	71	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Forging Reduction at Burst Region

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.7	71	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Heat-Treat Quenching and Grain Structure at Burst Region
1.1.7	71	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Examination for Preexisting Defects
1.1.7	71	5	PB	None needed	
1.1.7	71	6	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Forging Reduction at Burst Region
1.1.7	71	6	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Heat-Treat Quenching and Grain Structure at Burst Region
1.1.8	72	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
1.1.8	72	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.8	72	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.8	72	3	DP	None needed	
1.1.8	72	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.8	72	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.8	72	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.8	73	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
1.1.8	73	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.8	73	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Heat-Treat Quenching and Grain Structure at Burst Region
1.1.8	73	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
1.1.8	73	3	PB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
1.1.8	73	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
1.1.8	73	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.8	74	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.8	74	2	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Numerical Analysis Compared to Test Results
1.1.9	74	3	DP	None needed	
1.1.9	74	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Elastic-Plastic FEA as an Allowable Method by API
1.1.9	75	1	DP	None needed	

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.9	75	2	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.9	75	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Least Conservative Pressure Rating
1.1.9	75	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.9	75	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.9	75	5	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Elastic-Plastic FEA as an Allowable Method by API
1.1.9	76	1	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
1.1.9	75	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.9	76	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
1.1.9	76	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
1.1.9	76	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Histogram Load Sequence
1.1.9	76	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
1.1.9	76	3	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Comparison of Subsea Equipment and Pressure Vessels
1.1.9	76	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Examination for Preexisting Defects
1.1.9	76	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Post-Failure Metallurgical Examination
1.1.9	77	1	PB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
1.1.9	77	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
1.1.9	77	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.9	77	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
1.1.9	77	2	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
1.1.9	77	2	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
1.1.9	77	2	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
2.2.1	77	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
2.2.1	77	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
2.2.1	78	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
2.2.1	78	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
2.2.1	78	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Mesh Sensitivity
2.2.1	78	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
2.2.1	78	4	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Independent FEA
2.2.1	78	4	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
2.2.2	79	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Mesh Sensitivity
2.2.2	79	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Shapes of Test Bodies
2.2.2	79	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
2.2.2	79	3	DP	Argonne Project Team Responses (Not Directly Relevant to	Non-pressure-Related Failure

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
				BSEE/Argonne Project Scope)	Modes
2.2.2	79	4	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Independent FEA
2.2.2	79	5	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
2.2.2	79	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Shapes of Test Bodies
2.2.2	79	6	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Histogram Load Sequence
2.2.2	79	7	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Model Dimensions
2.2.2	80	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
2.2.2	80	2	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Independent FEA
2.2.2	80	2	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
2.2.2	80	3	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Load-Displacement Curves
2.2.2	80	4	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
3	80	5	DP	None needed	
3	81	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
3	81	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
3	81	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Von Mises Flow Rule
3	81	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Independent FEA
3	81	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Design and Geometry of Test Bodies	Flanges, Bolts, and Seals
3	81	5	RB	None needed	
4	82	1	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
4	82	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Linear-Elastic as a "Gold Standard"
4	82	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
4	82	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Independent FEA
4	82	5	RB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
3	82	5	RB	Comments Outside of Peer Review Charge	Comments Outside of Peer Review Charge
5	83	1	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Linear-Elastic as a “Gold Standard”
5	83	2	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term
5	83	3	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Performance of Burst Test Is Expensive and Dangerous
5	83	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
5	83	3	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Comparison of Subsea Equipment and Pressure Vessels
5	83	4	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Proof Testing Contradiction
5	83	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Performance of Burst Test Is Expensive and Dangerous
5	84	1	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Burst Tests	Purpose of Strain Gages
5	84	2	PB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
5	84	3	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
6	84	4	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
6	84	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
6	84	4	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
6	84	5	DP	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Comparison of Subsea Equipment and Pressure Vessels
6	84	5	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
6	84	6	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
6	85	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
6	85	1	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
6	85	2	PB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	Histogram Load Sequence
6	85	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
6	85	4	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
6	85	5	RB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments

Peer Review Report Subsection	Peer Review Report Page	Peer Review Report Paragraph	Peer Reviewer	Response Report Heading with Subsection as Applicable	Response Report Subsection
7	86	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
7	86	2	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
7	86	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
7	86	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
7	86	4	PB	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
7	86	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Performance of Burst Test Is Expensive and Dangerous
7	86	6	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
7	86	6	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
8	87	1	DP	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Non-pressure-Related Failure Modes
8	87	2	DP	Restated Conclusions Based on Peer-Review Comments	Restated Conclusions Based on Peer-Review Comments
8	87	3	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Statistical Relevance
8	87	4	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review

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8	87	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
8	87	5	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	Literature Review
8	87	6	PB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Validation
8	87	7	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -FEA	Elastic-Plastic Material Properties
8	87	7	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Materials	Material Properties from Prolongation
8	87	7	RB	Argonne Project Team Responses (Not Directly Relevant to BSEE/Argonne Project Scope)	ASME BPVC Is Guidance
8	87	8	RB	Argonne Project Team Responses (Directly Relevant to BSEE/Argonne Project) -Miscellaneous	“Design Margin” Term