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December 9, 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 letter of August 25, 2016 and engagement with API on September 20, 2016 and October 7, 2016 regarding Subsea BOP bolting. API and Industry are committed to improving training, operating procedures, technology and industry standards.

Attached is a detailed and comprehensive update to track the progress of implementation of the voluntary industry actions to address the issues related to subsea bolts and fasteners. As we have discussed, this is ongoing work that may evolve as new information becomes available.

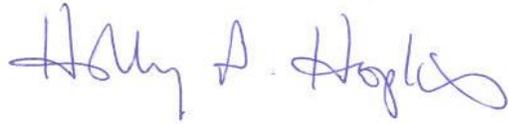
The attachment tracks the following:

- Research sponsored by API related to this topic;
- Activity by the standards task groups and subcommittees to implement the recommendations in the API Multi Segment Task Group Report on Bolting Failures;
- Voluntary industry adoption of API 20 E/F for critical BOP bolting;
- Voluntary industry replacement of critical bolting having a hardness of >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, API has shared your request with our membership to proactively release any relevant data and studies as soon as possible to BSEE or through the SafeOCS program. Sharing data by both BSEE and the industry will benefit all parties by increasing transparency and cooperation between the two entities.

API appreciates the opportunity to work with BSEE to continue discussing our shared objective of safe operations. As can be seen by the significant progress we've made as an Industry in 2016, we believe that by working in a spirit of cooperation, we can better understand our common goals and implement actions to help achieve our shared safety objectives. We would be happy to meet with you and/or your staff to provide a detailed review of this work. 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.

Sincerely,

A handwritten signature in blue ink that reads "Holly A. Hopkins". The signature is fluid and cursive, with the first name "Holly" being the most prominent.

Holly A. Hopkins

cc: Lars Herbst, GOM Regional Director

Attachment



AMERICAN PETROLEUM INSTITUTE

November 30, 2016

API 3Q 2016 UPDATE ON INDUSTRY ACTIVITIES ON SUBSEA BOLTS AND CONNECTORS

Background

On August 11, 2014 the Bureau of Safety and Environmental Enforcement (BSEE) released a technical Review of Connector and Bolt Failures following the failure of connectors and bolts used in critical equipment. The technical review, entitled Evaluation of Connector and Bolt Failures, was completed by the bureau's Quality Control-Failure Incident Team (QC-FIT) and submitted to BSEE Director Brian Salerno. The objective of the technical assessment was to document and evaluate failures of the connectors, studs and other components used in critical equipment and determine if there were industry wide issues that need to be addressed by the industry or BSEE. This report addressed a December 2012 incident which prompted a global recall of the bolts associated with the H4 connector bolts.

In response to the QC-Fit Report, API held a Technical Session during the API Exploration and Production Winter Standards Meeting in New Orleans on January 27, 2015. BSEE was invited by API to present their report findings and recommendations. After the Technical Session, an API multi-segment task group was formed to review the detailed recommendations in the report and determine next steps. The final report of the task group was shared with BSEE in March of 2016 and is now being implemented.

An incident in February of 2014 involving a lower marine riser package (LMRP) connector leak prompted BSEE to issue an Addendum to the QC-FIT report, with the new information from this incident.

As a result of these ongoing incidents BSEE issued a Safety Alert regarding Connector and Bolt Failures on February 2, 2016. Additionally, BSEE held a public forum on offshore connector equipment failures, including connector bolt failures that have occurred on the OCS on August 29, 2016, in Washington, DC.

To address the February 2016 safety alert API formed a workgroup which has met with BSEE on March 31, June 22, September 20, and October 7, 2016 to improve safety offshore as it relates to bolts. This work focuses on subsea BOP bolting and 4 specific areas: 1) Materials/Standards; 2) QA/QC – API Monogram Program; 3) Operations; and 4) Research.

API provides this detailed and comprehensive update to track the progress and implementation of the voluntary industry actions to address the issues related to subsea bolts and connectors. This is ongoing work that may evolve as new information becomes available and this is the first of regular quarterly reports.

Progress on Research, Materials/Standards and QA/QC

		Topic	Discussion
1	Research	API sponsored research	API has approved a 2017 project to perform testing to determine susceptibility to environmental hydrogen embrittlement of selected materials and coatings. In addition, API has conducted 4 projects related to hydrogen embrittlement and 21 projects related to corrosion resistant alloys.
2	Materials and Standards	API 20E 2nd Edition	Ballot closed (7/12/2016), in comment resolution.
		API 20F 2nd Edition	TG to have first meeting in early December.
		API 16A 4th Edition	Out for ballot and requires API 20E and API 20F for bolts. Ballot closed 11/28/2016, in comment resolution
		API 16AR 1st Edition	In publication process and requires API 20E and API 20F for pressure controlling bolting, closure bolting and pressure retaining bolting.
		API 16C 3rd Edition	Being drafted.
		API 16F 2nd Edition	Ballot closed (10/6/2016), in comment resolution and requires API 20E and API 20F.
		API 6A 21st Edition	Being drafted and will require API 20E bolts.
		API 6D 24th Edition	API 20E is a recommendation in published document.
		API 6DSS 3rd Edition	Out for ballot and requires API 20E and API 20F for pressure boundary bolts. Ballot closed 11/30/2016, in comment resolution
		API 64 3rd Edition	Out for ballot and requires API 20E and API 20F for primary bolting for diverter equipment and utility bolting. Ballot closed 12/9/2016, in comment resolution

		Topic	Discussion
3	TG Recommendations	TGR-1 - SC21	Recommendation to resolve ASTM B633 and F1941 conflicts - ASTM Subcommittee B08.06 (Soft Metals) ballot to revise B633 closed October 19th. The proposed revision would essentially make B633 consistent with F1941 (bake threshold 39 HRC) with regard to hydrogen embrittlement prevention requirements. The ballot drew (as expected) negative votes (5) and is being worked per the ASTM process.
		TGR-3 - SC21	Recommendation to prohibit zinc electrocoating and investigate better short term storage corrosion protection - A detailed spreadsheet covering the coatings the group has identified as candidates for short term corrosion resistance has been drafted and is under review, as is the prohibition of zinc electroplating for subsea marine applications.
		TGR-4 - SC21	Recommendation to create an overarching document on selection of proper bolting materials - An initial draft of the document has been developed and is under review.
		TGR-8 - SC21	Recommendation to disallow use of B7 or L7 grades above 2.5" diameter - The group presented their findings on the recommendation at the TG meeting on 11/30/2016. The group will prepare a concise explanation of their decision along with recommendations.
		TGR-18 - SC21	Recommendation to incorporate 20E and 20F requirements in product specs and resolve existing conflicting properties such as hardness - A Group is working to establish requirements for a maximum hardness for bolting material. Testing will occur in 2017.

		Topic	Discussion
		TGR-2 - SC20	Recommendation to expand 20E to more adequately cover the requirements of plating and coating as well as move the supplemental requirements for plating and coating into the body of the document, making them standard requirements. Work is complete and contained in balloted 20E, 2nd edition.
		TGR-9 - SC20	Recommendation that volumetric expansion be added in 20E where bolts exceed 2.5" diameter - Done for API 20E. Will be considered by the API 20F TG.
		TGR-11 - SC20	Recommendation to revise 20F to restrict use of sulfur based lubricants - Will be considered by the API 20F TG.
		TGR-17 - SC20	Recommendation - Strengthen heat treat requirements - Done for API 20E. Will be considered by the API 20F TG.
		TGR-20 - SC20	Recommendation to review supplier controls for 20E and 20F - Done for API 20E. Will be considered by the API 20F TG.
		TGR-19 - SC18	Recommendation to form TG to review QC-FIT report and determine if recommendations to Q1 are needed - Done, TG formed.
		TGR-3, TGR-5/TGR-12, TGR-6, TGR-16, TGR-18 - SC17	
		TGR-13 - SC17	<p>Recommendation to provide guidance on when and how to perform a fatigue sensitivity analysis - A workgroup seeks to address TGR-13/-14 through a Technical Report (TR), where a focused and comprehensive discussion on the subject matter is most appropriate. The proposed Table of Contents as follows:</p> <ul style="list-style-type: none"> a. Issue to address: Fatigue sensitive bolting b. Bolting material/fatigue properties (address TGR-13)

		Topic	Discussion
			<ul style="list-style-type: none"> c. Fatigue bolting designs (i.e. bolting stress allowable, fatigue, preload, etc.) d. Propose manufacturing practices to progress current industry practices (address TGR-14) <ul style="list-style-type: none"> i. Material manufacturing ii. Vickers vs. HRC / Locations of testing iii. First article qualifications e. Bolting material testing program for fatigue properties (eventual request to SC21)
		<p>TGR-14 - SC17</p>	<p>Recommendation to involve relevant SCs in the use of BSL-3 in fatigue sensitive applications - Workgroup seeks to address TGR-13/-14 through a Technical Report (TR), where a focused and comprehensive discussion on the subject matter is most appropriate. The proposed Table of Contents as follows:</p> <ul style="list-style-type: none"> a. Issue to address: Fatigue sensitive bolting b. Bolting material/fatigue properties (address TGR-13) c. Fatigue bolting designs (i.e. bolting stress allowable, fatigue, preload, etc.) d. Propose manufacturing practices to progress current industry practices (address TGR-14) <ul style="list-style-type: none"> i. Material manufacturing ii. Vickers vs. HRC / Locations of testing iii. First article qualifications e. Bolting material testing program for fatigue properties (eventual request to SC21)

		Topic	Discussion
		<p>TGR-3, TGR-5/TGR-12, TGR-6, TGR-13, TGR-14, TGR-15, TGR-16 - SC16</p> <p>TGR-18 - SC16</p> <p>TGR-3, TGR-5/TGR-12, TGR-6, TGR-7/TGR-10, TGR-13, TGR-14, TGR-16 - SC6</p> <p>TGR-18 - SC6</p>	<p>In process for API 16A, API 16AR, API 16C, API 16F and API 64</p> <p>Recommendation to update relevant specs with regards to bolting - see above status. In process for API 6A and API 6DSS. API 20E is currently just a recommendation in API 6D.</p>
4	QAQC	API Q1 9th Edition, Addendum 2	Ballot closed (11/18/2016), in comment resolution.

Progress on Equipment Manufactures Operations

	Topic	Discussion	OEM 1	OEM 2	OEM 3	OEM 1 Comments	OEM 2 Comments	OEM 3 Comments
	Near Term Deliverables							
1	Bulletin Identifying critical BOP bolting > 35 HRC	Attach any EB/PNI identifying critical bolting > 35 HRC	Feb-16	Product Information Bulletin D4516545916 Released February 24, 2016	Completed - 10/2016	Product Notification & Improvement 16-008 issued 9/2016 Product Notification & Improvement 16-009 issued 9/2016 Product Notification & Improvement 16-010 issued 10/2016		PA 40832 was generated in response to BSEE Safety Alert 318. OEM does not provide bolts for pressure containing/pressure controlling with hardness greater than 35 HRC. See attachment.
2	Part Numbers for API 20 E/F replacement Bolting for critical BOP bolting > 35 HRC	Attach any EB/PNI identifying part numbers for critical bolting > 35 HRC	In Progress	All replacement bolting for critical BOP bolting meet API 20E BSL-3	Completed - 10/2016	Product Notification & Improvement 16-008 issued 9/2016 Product Notification & Improvement 16-009 issued 9/2016 Product Notification & Improvement 16-010 issued 10/2016		OEM has generated critical bolting part numbers for compliance to API 20E, BSL-3. These are available to our customers and more are being generated as needed. A few part numbers have been set up for 20F at this moment as CRA bolting is not normally provided in BOP equipment for critical bolting. See attachment with sample bolting part numbers.

	Topic	Discussion	OEM 1	OEM 2	OEM 3	OEM 1 Comments	OEM 2 Comments	OEM 3 Comments
3	Bulletin updating Torque Application	Attach any EB/PNI identifying updated Torque guidance for critical bolting	Mar-16	D4516545916 Released February 24, 2016	In-progress	Estimated 60% complete and issued.	Torque requirements called out in Product Information Bulletin	EB-962D, released on March 2016. See attachment.
4	Internal process for enhanced failure reporting of critical bolting	Attach any example of updated failure reporting process. Attach any example of enhanced failure reporting related to critical BOP bolting	1990's	We have fairly robust lines of communication on failures as is. Attached is an excerpt from Product Information Bulletin D4516545916.	In-progress	Estimated 75% complete; real time drilling information website active	Customers should also refer to previous OEM Product Information Bulletins and Safety Alerts for any additional information related to this issue and information regarding safe operation, maintenance, and inspection criteria	OEM has internal procedure called Field Performance Report (FPR) for capturing field performance failures of OEM equipment. This FPR is the mechanism used to initiate an investigation and determine the Root Cause of the failure. In addition, OEM has a system to communicate Product Advisories (PA) and Safety Alerts (SA) as well as Engineering Bulletins (EB) to our customers if deemed necessary resulting from an FPR investigation or internal reviews. The guidelines for these procedures are outlined in OEM Engineering Procedure EP-307 (FPRs), CEP-030 (SAs/PAs) and EP-204

	Topic	Discussion	OEM 1	OEM 2	OEM 3	OEM 1 Comments	OEM 2 Comments	OEM 3 Comments
								(EBs). These procedures are considered "Confidential" and cannot be distributed outside of OEM.
5	Updated QAQC standards for bolt manufacturing	Attach any example of updated QA process	Aug-15	Bolts specified to API 20E BSL-3	Completed - 10/2016			Quality Plans (QP-000112-09) have been created for Pressure Containing and Primary Load Bearing Oil and Gas Equipment Used in Subsea Applications: API 6a, API 17D and API 20E. Bolting Specification BSL-3. QP-000112-09 is considered "Confidential" and cannot be distributed outside of OEM.
	Longer Term Deliverables							

	Topic	Discussion	OEM 1	OEM 2	OEM 3	OEM 1 Comments	OEM 2 Comments	OEM 3 Comments
A1	Part numbers for API 20 E/F replacement bolting for all critical BOP bolting	Attach any EB/PNI identifying part numbers for critical bolting	In-Progress	16543557-001, 16569565-001, 16569606-001, 165004, 16587680-001, 16587681-001, 16587682-001	Completed - 10/2016	Product Notification & Improvement 16-008 issued 9/2016 Product Notification & Improvement 16-009 issued 9/2016 Product Notification & Improvement 16-010 issued 10/2016	All part numbers referenced in Product Information Bulletin D4516545916	OEM has generated critical bolting part numbers for compliance to API 20E, BSL-3. These are available to our customers and more are being generated as needed. A few part numbers have been set up for 20F at this moment as CRA bolting is not normally provided in BOP equipment for critical bolting. See attachment with sample bolting part numbers.
A2	Replacement bolting coating specified	Attach any EB/PNI identifying replacement coating	In-Progress	N/A	Completed - 10/2016	Product Notification & Improvement 16-010 issued 10/2016		OEM is engaging different vendors to find alternatives to electrodeposited zinc plating.

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 1 BOP 1	Rig 2 BOP 1	Rig 3 BOP 1	Rig 4 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%	0%	0%	In-progress
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%	0%	0%	Not Started
3	Rig Procedure for torquing of critical bolting	Can include example rig procedure	In-progress	July 15, 2014	In-progress	In-progress
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	2015 Training in Rig maint. Sys. 100% participation in GOM	July 20, 2016	2015 Training in Rig maint. Sys. 100% participation in GOM	Completed
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit		July 15, 2014		Not Started
			PA 40832 from OEM	July 15, 2014	PA 40832 from OEM	
			Completed October 2016	July 15, 2014	Completed October 2016	
			Completed October 2016	July 15, 2014	Completed October 2016	
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	In place since 2015	March 15, 2016	In place since 2015	90%
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	0%	0%	In-progress
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	0%	Not Started

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 4 BOP 2	Rig 5 BOP 1	Rig 5 BOP 2	Rig 6 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	In-progress	0%	0%	0%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	Not Started	0%	0%	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	March 9, 2015	March 9, 2015	In-progress
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	Completed	July 20, 2016	July 20, 2016	We use OEM failure reporting system
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	Not Started	In-progress	In-progress	In-progress
				In-progress	In-progress	
				In-progress	In-progress	
				Not Started	Not Started	
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	90%	March 15, 2016	March 15, 2016	PMs are setup within our maintenance program for the required inspections.
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	In-progress	0%	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	Not Started	0%	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 7 BOP 1	Rig 7 BOP 2	Rig 8 BOP 1	Rig 9 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	Not Started	Not Started	0%	0%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	Not Started	Not Started	0%	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	November 1, 2016	November 1, 2016	In-progress	Completed - Oct 4, 2016
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	November 1, 2016	November 1, 2016	2015 Training in Rig maint. Sys. 100% participation in GOM	IOGP Failure reporting
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	November 1, 2016	November 1, 2016	 Completed October 2016 Completed October 2016	 PIB Issued YES Complete
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	50% In Process	50% In Process	In place since 2014	Complete phased array inspection on 90% of all critical bolting
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	Not Started	Not Started	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	Not Started	Not Started	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 9 BOP 2	Rig 10 BOP 1	Rig 10 BOP 2	Rig 11 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%	0%	0%	0%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%	0%	0%	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	Completed - Oct 5, 2016	March 9, 2015	March 9, 2015	Completed - Oct 3, 2016
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	IOGP Failure reporting	July 20, 2016	July 20, 2016	IOGP Failure reporting
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit		Not Started	Not Started	
			PIB Issued	In-progress	In-progress	PIB Issued
			YES	In-progress	In-progress	YES
			Complete	Not Started	Not Started	Complete
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	Complete phased array inspection on 90% of all critical bolting	March 15, 2016	March 15, 2016	Complete phased array inspection on all critical bolting
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	0%	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 12 BOP 1	Rig 12 BOP 2	Rig 13 BOP 1	Rig 14 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%	0%	0%	100%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%	0%	0%	100%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	In-progress	In-progress	In-progress
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	Using OEM Failure Reporting Methods. IOGP Reporting Process in development	Using OEM Failure Reporting Methods. IOGP Reporting Process in development	May 8, 2015	In-Progress
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress	In-progress	In-progress	In-progress
			Started	Started	February 24, 2016	
			Started	Started	May 4, 2016	
			Not Started	Not Started	In-progress	
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	In progress	In progress	December 9, 2015	Completed
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	0%	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 14 BOP 2	Rig 15 BOP 1	Rig 15 BOP 2	Rig 16 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	100%	0%	0%	100%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	100%	0%	0%	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	In-progress	In-progress	In-Progress
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	In-Progress	Using OEM Failure Reporting Methods. IOGP Reporting Process in development	Using OEM Failure Reporting Methods. IOGP Reporting Process in development	In-Progress
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress	In-progress Started Started Not Started	In-progress Started Started Not Started	In-progress
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	Completed	In progress	In progress	Completed
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	0%	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 17 BOP 1	Rig 17 BOP 2	Rig 18 BOP 1	Rig 18 BOP 2
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%	0%	Not Started	Not Started
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%	0%	Not Started	Not Started
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	March 9, 2015	March 9, 2015	November 1, 2016	November 1, 2016
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	July 20, 2016	July 20, 2016	November 1, 2016	November 1, 2016
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress	In-progress	November 1, 2016	November 1, 2016
			In-progress	In-progress		
			In-progress	In-progress		
			Not Started	Not Started		
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	March 15, 2016	4244400%	50% In Process	50% In Process
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	0%	Not Started	Not Started
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	Not Started	Not Started

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 19 BOP 1	Rig 20 BOP 1	Rig 21 BOP 1	Rig 21 BOP 2
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	100%	100%	Not Started	Not Started
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	100%	100%	Not Started	Not Started
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	Completed March 29, 2016	November 1, 2016	November 1, 2016
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	In-Progress	Completed July 28, 2016	November 1, 2016	November 1, 2016
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress	Completed April 1, 2016 Completed February 18, 2016 Completed April 1, 2016	November 1, 2016	November 1, 2016
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	Completed	Completed April 1, 2016	50% In Process	50% In Process
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	20%	Not Started	Not Started
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	0%	Not Started	Not Started

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 22 BOP 1	Rig 23 BOP 1	Rig 23 BOP 2	Rig 24 BOP 1
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	100%	100%	100%	0%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	100%	100%	100%	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	In-progress	In-progress	In-progress
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	In-Progress	In-Progress	In-Progress	Using OEM Failure Reporting Methods. IOGP Reporting Process in development
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress	In-progress	In-progress	In-progress Started Started Not Started
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	Completed	Completed	Completed	In progress
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	20%	0%	0%	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	20%	0%	0%	0%

Progress on Equipment Owner Operations

Item	Topic	Discussion	Rig 24 BOP 2	Rig 25 BOP 1	Rig 26 BOP 1	Rig 26 BOP 2
			Status	Status	Status	Status
Near Term Deliverables						
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%	0%	Not Started	Not Started
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%	0%	Not Started	Not Started
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	In-progress	In-progress	November 1, 2016	November 1, 2016
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	Using OEM Failure Reporting Methods. IOGP Reporting Process in development	Complete	November 1, 2016	November 1, 2016
5	MTR review for installed critical bolting: - OEM SOF critical bolting per relevant specification - MTRs per relevant specification - Bolting audit to verify MTR information	Can include letter from OEM, example of MTR audit	In-progress Started Started Not Started	In-progress	November 1, 2016	November 1, 2016
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	In progress	Critical bolting section added to PM Structure in the PM system and new PM tasks added to cover.	50% In Process	50% In Process
Longer Term Deliverables						
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%	waiting quote	Not Started	Not Started
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%	waiting quote	Not Started	Not Started

			Rig 27 BOP 1
Item	Topic	Discussion	Comments
Near Term Deliverables			
1	Replacement 20 E/F bolts for all > 35 HRC critical bolting ordered	List by rig the % of API 20 E replacement bolts ordered	0%
2	Replacement 20 E/F bolts for all > 35 HRC critical bolting installed	List by rig the % of API 20 E bolts installed on the BOP	0%
3	Rig Procedure for torqueing of critical bolting	Can include example rig procedure	July 15, 2014
4	Internal process for enhanced failure reporting of critical bolts (IOGP Failure reporting procedure)	Can include example procedure for compliance with IOGP Failure reporting	July 20, 2016
5	MTR review for installed critical bolting:	Can include letter from OEM, example of MTR audit	Not Started
	- OEM SOF critical bolting per relevant specification		4262800%
	- MTRs per relevant specification		In Progress
	- Bolting audit to verify MTR information		Not Started
6	Preventative maintenance (PM) for BOP bolting API Std 53	Can include PM for BOP bolting maintenance. Example of NDE performed on BOP bolts	March 15, 2016
Longer Term Deliverables			
A1	Critical bolting API 20 E/F replacement bolts ordered	List by rig % of bolts ordered	0%
A2	Critical bolting API 20 E/F replacement bolts installed	List by rig % of bolts installed/replaced	0%

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Make-up Procedure for End Connections of Drilling Equipment and Structural Bolting

1.0 Scope

This procedure applies to pressure containing closure bolting of end connections (flange, studded, hub), including all API 6A flanges and Other End Connectors (OEC), i.e.: **Company** Clamps, Fast Clamps, etc. Additionally, this procedure addresses structural bolting make-up requirements for non-pressure containing bolting in a Drilling BOP Stack. Refer to the following EBs for Ram BOP bonnet bolt closure torque values:

- EB 560 D – Bonnet Bolt Torque Requirements for U BOPs with U, UL or UM Bonnets
- EB 851 D – Bonnet Bolt Torque for Seal Carrier BOP Bonnets: U, UL/UM & TL
- EB 919 D – **Company** U BOP Bonnet Bolt Make-Up Guidelines

2.0 Application Points

This procedure is applicable on initial assembly of equipment and any time an end connection is broken and made-up. It is also recommended that make-up of pressure containing closure bolting (i.e. end connections, bonnet bolting, etc.) be repeated or verified following routine maintenance inspections. Refer to section 8.0.

3.0 Lubrication

It is essential that threads and bolt/nut faces be well lubricated. **Company** clamps and fast clamps also require lubrication on the hub-clamp contact area. Acceptable lubricants include one of the following:

- 'Molykote® G-Rapid Plus Paste'
- 'Sweeney 503 Molypaste'

NOTE: FASTENERS COATED WITH XYLAN/PTFE COMPOUND IN ACCORDANCE WITH A COMPANY PROCEDURE DO NOT REQUIRE LUBRICATION.

Metal ring gaskets should be coated with a light oil prior to assembly.

4.0 Painting

For Surface applications, mating (contacting) flange faces, nut bearing surfaces and the contacting surface of the flange or structure may be coated with a rust-preventative primer or treatment prior to assembly.

For Subsea applications, the nut bearing surface and contacting surface of the flange or structure shall be left bare but lubricated. Refer to section 3.0.

Xylan or PTFE compound coated fasteners should not be painted once the connection is made up as the paint will not adhere.

5.0 Importance of Preload

All connections are designed such that the recommended torque figure for studs/nuts/bolts gives a pre-load on the connection greater than the separation load resulting from the working pressure within the component.

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If the correct torque figure is not used this could result in:

- a. If the fasteners are under-torqued, separation of the connection could result, this in turn could lead to leakage and, in the worst case, catastrophic failure of the connection caused by cyclic stress and fatigue.
- b. If the fasteners are over-torqued, this could result in the fasteners being taken past their YIELD STRENGTH, plastically deforming it, which could result in a catastrophic failure of the fastener.

6.0 General Make-Up Guidelines

1. Fully check all parts issued against the Bill of Material or Operation and Maintenance Manual requirements.
2. Fully inspect all parts prior to assembly, paying particular attention to threads on the fasteners and the gasket sealing areas.
3. Fully clean gaskets and associated ring grooves.
4. Install outlet studs.
5. Lightly coat ring type gaskets with lubricant prior to assembly. Acceptable lubricants are described in section 3.0. Only a light coat of lubricant shall be used.
6. Prior to fitting nuts onto studs or screwing bolts into outlet connections ensure that the stud/bolt thread is fully greased using the approved lubricant. It is also very important to ensure that the collars on the nuts and the underside of bolt heads are fully lubricated using the same grease as used on the threads.
7. When installing nuts always ensure that they are free running and that any stamping/identification marks are visible.
8. Prior to using any torque equipment always check the calibration date. Equipment must be within calibration date.
9. The ASME B31.3 requirement for misalignment is that the faces shall not be in excess of 0.3 degrees out of parallel to each other prior to torquing. See Figure 1.

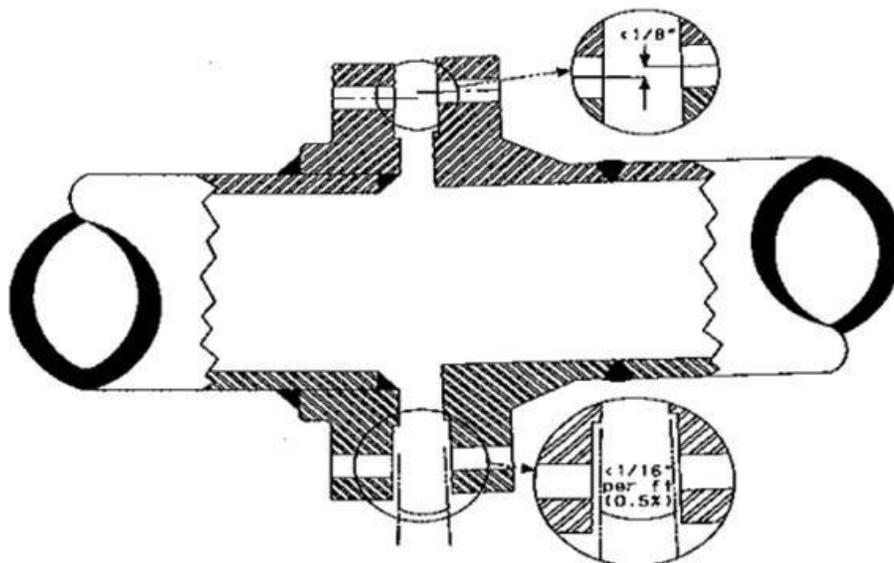


Figure 1 – Flange Alignment Requirements per ASME B31.3

10. It is essential that Bolting shall be torqued up as evenly as possible, alternating between bolts in a star (criss-cross) pattern for bonnets and API flanges see Figure 2. Alternate between opposite sides of each clamp half for **Company** clamps and fast clamps. The mating faces should be maintained as parallel as is practical during make-up to ensure concentricity of the mating components and correct gasket seating.
11. Start by hand tightening nuts.

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12. Apply 25% of full torque in sequence per Figure 2.
13. Apply 50% of full torque in sequence per Figure 2.
14. Apply 75% of full torque in sequence per Figure 2.
15. Apply full torque in sequence per Figure 2.
16. After a connection is fully made-up revisit all studs/nuts/bolts to ensure that each one has the correct torque value, if not re-torque.
Note: this check can be made by progressively working around the bolt pattern.
17. After torqueing, all studs must protrude through nuts as shown in Figure 3.

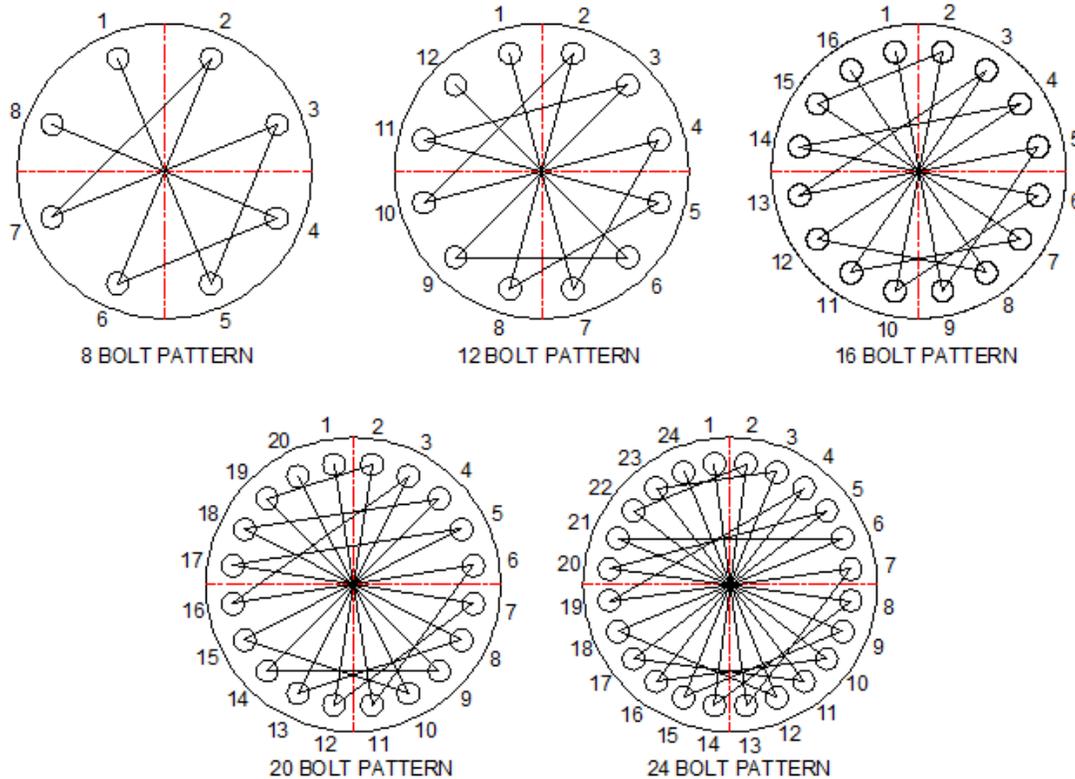


Figure 2 – Typical Criss-Cross Make-up Technique

Criss-Cross Torque Sequence:

- 8 Bolt: 1, 5, 3, 7, 2, 6, 4, 8
- 12 Bolt: 1, 7, 4, 10, 2, 8, 5, 11, 3, 9, 6, 12
- 16 Bolt: 1, 9, 5, 13, 3, 11, 7, 15, 2, 10, 6, 14, 4, 12, 8, 16
- 20 Bolt: 1, 11, 6, 16, 3, 13, 8, 18, 4, 14, 9, 19, 2, 12, 7, 17, 5, 15, 10, 20
- 24 Bolt: 1, 13, 7, 19, 4, 16, 10, 22, 2, 14, 8, 20, 5, 17, 11, 23, 3, 15, 9, 21, 6, 18, 12, 24

NOTE: IT IS ESSENTIAL THAT THE STUD CHAMFER PROTRUDES OUT OF THE NUT WHEN THE CONNECTION IS FULLY TORQUED. ENGAGEMENT OF THE STUDS OF AT LEAST 1 DIAMETER INTO THE BLOCK OR BODY SHOULD ALSO BE ACHIEVED.

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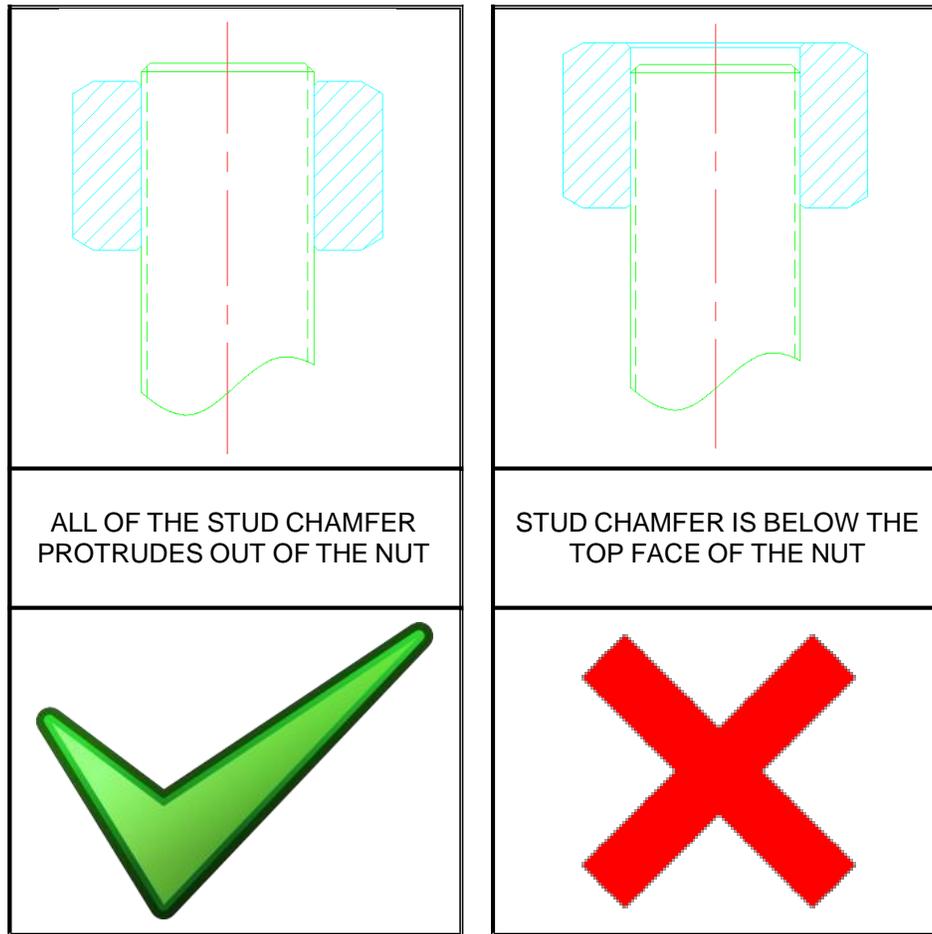


Figure 3 – Stud Protrusion after Torqueing

7.0 Make-up Torque

Table 1 list recommended make-up torques for closure bolting. These values are derived from recommended make-up torque equations published in API Specifications 6A, 19th ed. but are specific for connections that use ‘Molykote® G-Rapid Plus Paste’ lubricant or ‘Sweeney 503 Molypaste’ lubricant. The recommended torques are calculated to achieve a tensile stress in the bolts of approximately 50% of bolt minimum yield strength.

1. Always check the revision status of the procedure to ensure that the correct document is being used.
2. Always read the Bill of Material or Operations and Maintenance Manual fully to ensure:
 - a. That the correct size of fastener is known.
 - b. That the correct material is known e.g. B7, L7, etc.
3. This document is to be used for all torque related issues EXCEPT when the assembly procedure or Rig Book specifies differently.
4. Record Torque values, lubricant used, bolt information, etc. Use Torque Record Sheet in Figure 6.
5. Record stud/bolt/nut information using Record Sheet in Figure 7.

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8.0 Torque Validation

It is recommended that the final make-up of ALL Pressure Containing connection bolting is recorded on the Torque Record Sheet in Figure 6 by the individual performing the torquing operations.

Pressure Containing Connections are defined as:

- a. Studded, bolted or clamped connections which utilize a RING TYPE JOINT Gasket (e.g. **R, RX, BX, AX, VX and CX types**).
- b. Other studded, bolted or clamp connections which contains Wellbore fluid or penetrations into the Wellbore envelope. The Wellbore being the area of the equipment where produced or injected fluid may enter during the equipment operation. Should confirmation be required as to whether a joint contains wellbore fluid, contact Engineering.

The Validation Process is required at the following stages of Assembly and Test:

PRIOR TO WORKING PRESSURE CONNECTION TEST OF PREVIOUSLY TESTED SUB ASSEMBLIES

Any connection that will receive a working pressure test utilizing previously assembled or subassemblies shall require a Validation Sheet to be completed. It is recommended that at least 20% of torqued fasteners need to be independently checked by a competent person. After completion of the validation sheet a Torque tag or marking may be attached on each connection to provide a visual indicator that the connection has been torqued, see Figure 4 and Figure 5 for the positioning of the tags.

NOTE: Tags can become detached during test, cleaning and painting operations, after viewing the records sheet, these can be re tagged.

Tag should be positioned near a nut, away from damaged paint and applied on a grease free surface. Positioning of the tag should give maximum visibility. The tag is not a tamper proof device, only a visual aid.

IF IN DOUBT, ASK!

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Figure 4 – Tag on Flange Face



Figure 5 – Tag on Side of Flange

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Table 1 – Recommended Make-up Torques for Pressure Containing Connections

Bolt / Stud Size		Pressure Containing (ft-lbs) (FOR ALL CONNECTIONS EXCEPT THOSE IN Table 2)					
		B7 / L7 ASTM A453 Gr 660 Inconel 718		B7M / L7M		125k Yield Material	
		API 6A BM LUB	API 6A FLUORO*	API 6A BM LUB	API 6A FLUORO*	API 6A BM LUB	API 6A FLUORO*
		<i>Ref</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
0.50"-13UNC	1	41	35	31	27	**	**
0.625"-11UNC	2	80	68	61	52	**	**
0.75"-10UNC	3	139	118	106	90	**	**
0.875"-9UNC	4	221	188	168	143	**	**
1.00"-8UN	5	328	279	250	213	**	**
1.125"-8UN	6	472	401	360	305	**	**
1.25"-8UN(1)	7	653	553	497	421	**	**
1.375"-8UN(1)	8	874	739	666	563	**	**
1.50"-8UN(1)	9	1141	962	869	733	**	**
1.625"-8UN(1)	10	1456	1226	1109	934	**	**
1.75"-8UN	11	1825	1534	1390	1169	**	**
1.875"-8UN	12	2250	1890	1715	1440	**	**
2.00"-8UN	13	2738	2297	2086	1750	**	**
2.25"-8UN	14	3913	3276	2981	2496	5310 ^{***}	4446 ^{***}
2.50"-8UN	15	5382	4500	4101	3429	**	**
2.625"-8UN	16	5644	4716	4753	3968	**	**
2.75"-8UN	17	6496	5424	5470	4564	**	**
3.00"-8UN	18	8448	7047	7114	5929	12700 ^{***}	10571 ^{***}
3.25"-8UN	19	10757	8965	9059	7543	**	**
3.75"-8UN	20	16562	13782	13947	11595	**	**
3.875"-8UN	21	18282	15208	15395	12795	**	**
4.00"-8UN	22	20117	16730	16941	14057	**	**
4.50"-8UN	23	28684	23806	24155	20047	**	**
4.75"-8UN	24	33755	28001	28425	23580	**	**

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Instructions for using torque Table 1:

To find the torque to be applied, read down 'Bolt/Stud Size' column to find the relevant size to be tightened, then across to find the relevant column for bolt material and coating.

NOTE: All studs and nuts have a rust protection coating/plating except grade 718/660 studs, which are to be uncoated.

COLUMN A/B: Gives 50% yield for bolt strength of 105 ksi for bolt size ≤ 2.50 " and 95 ksi for bolt size > 2.50 " (B7/L7/ASTM A453Gr660 / Inconel 718 Full strength bolts/studs)

COLUMN C/D: Gives 50% yield for bolt strength of 80 ksi (B7M/L7M Reduced strength bolts/studs)

COLUMN E/F: Gives 57% yield for bolt strength of 125 ksi

[BM LUB] Column Heading = Bare Metal with 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503Molypaste'.

[FLUORO] Column Heading = Fluoropolymer coated

(1) Note: If making up the following API flanges: 13-5/8 – 2k, 16-3/4 – 2k, 21-1/4 – 2k, 13-5/8 – 3k, see Table 2 for torque values.

* Note: If nuts are uncoated, apply 'Molykote® G-Rapid Plus Paste' or 'Sweeney 503 Molypaste' to the nut bearing face.

** Note: These values can be provided upon request by **Company** Engineering (Houston).

*** Note: These values are based on a 57% yield due to greater bending moment forces.

Figures for [BM LUB] 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503 Molypaste' lubricant have been calculated using equations for torque from API 6A Annex D along with a coefficient of friction of **0.085**.

Figures for [FLUORO] Fluoropolymer coated studs have been taken from API 6A Annex D based on a coefficient of friction of **0.07**.

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Table 2 below is for API flanges where the bolt stress should not be made up beyond 40 ksi regardless of bolt material.

Table 2 – Recommended Make-up Torque for Special Connections

FLANGE SIZE/RATING	BOLT/STUD SIZE	BOLT TORQUE (ft-lbs)	
		BM LUB	FLUORO
		G	H
13-5/8" 2000 PSI	1.25"-8UN	497	421
16-3/4" 2000 PSI	1.50"-8UN	869	733
21-1/4" 2000 PSI	1.625"-8UN	1109	934
13-5/8" 3000 PSI	1.375"-8UN	666	563

COLUMN G/H: Gives a bolt stress of 40 ksi. (All bolt/stud materials).

[BM LUB] Column Heading = Bare Metal with 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503 Molypaste' lubricant.

[FLUORO] Column Heading = Fluoropolymer coated.

Table 3 – Recommended Make-up Torques for Structural Connections

Bolt/Stud Size	Make-up Torque for Structural Connections (ft-lbs)										
	GRADE 2		GRADE 5		GRADE 8		GRADE B7/L7		GRADE B7M/L7M		
	BM LUB	FLUORO	BM LUB	FLUORO	BM LUB	FLUORO	BM LUB	FLUORO	BM LUB	FLUORO	
Ref	I	J	K	L	M	N	O	P	Q	R	
0.250"-20UNC	1	3	2	5	4	6	6	5	4	4	3
0.375"-16UNC	2	10	8	15	13	22	19	18	15	13	11
0.50"-13UNC	3	22	19	36	31	51	44	41	35	31	27
0.625"-11UNC	4	43	37	70	60	99	85	80	68	61	52
0.75"-10UNC	5	75	64	122	104	172	147	139	118	106	90
0.875"-9UNC	6	76	64	193	165	273	233	220	188	168	143
1.00"-8UN	7	112	96	287	245	406	346	328	279	250	213
1.125"-8UN	8	162	137	364	309	584	496	472	401	360	305
1.25"-8UN	9	224	190	504	426	808	684	653	553	497	421
1.375"-8UN	10	300	253	674	570	1082	915	874	739	666	563
1.50"-8UN	11	391	330	880	742	1412	1191	1141	962	869	733
1.625"-8UN	12	-	-	804	677	1803	1518	1456	1226	1109	934
1.75"-8UN	13	-	-	1008	848	2259	1900	1825	1534	1390	1169
1.875"-8UN	14	-	-	1243	1044	2786	2340	2251	1890	1715	1440
2.00"-8UN	15	-	-	1512	1269	3390	2844	2738	2297	2086	1750
2.25"-8UN	16	-	-	2161	1810	4844	4056	3913	3276	2981	2496
2.50"-8UN	17	-	-	2973	2486	6664	5572	5382	4500	4101	3429
2.625"-8UN	18	-	-	3446	2879	6832	5708	5644	4716	4753	3971
2.75"-8UN	19	-	-	3966	3312	7863	6566	6496	5424	5470	4568
3.00"-8UN	20	-	-	5158	4303	10227	8531	8448	7047	7114	5934
3.25"-8UN	21	-	-	-	-	13022	10852	10757	8965	9059	7549
3.75"-8UN	22	-	-	-	-	20048	16683	16562	13782	13947	11606
3.875"-8UN	23	-	-	-	-	22131	18410	18282	15208	15395	12807
4.00"-8UN	24	-	-	-	-	24352	20252	20117	16730	16941	14088

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Table 3 (Cont.) – Recommended Make-up Torques for Structural Connections

Bolt/Stud Size	Make-up Torque for Structural Connections (ft-lbs)								
	Ref	GRADE L43		GRADE 718/660		GRADE B8		GRADE B8M	
		S	T	U	V	W	X	Y	Z
0.250"-20UNC	1	5	4	5	4	5	4	5	4
0.375"-16UNC	2	18	15	18	15	17	14	16	14
0.50"-13UNC	3	41	35	41	35	39	34	37	32
0.625"-11UNC	4	80	68	80	68	76	65	72	62
0.75"-10UNC	5	139	118	139	118	132	113	126	107
0.875"-9UNC	6	220	188	220	188	168	143	168	143
1.00"-8UN	7	328	279	328	279	250	213	250	213
1.125"-8UN	8	472	401	472	401	292	248	292	248
1.25"-8UN	9	653	553	653	553	404	342	404	342
1.375"-8UN	10	874	739	874	739	416	352	416	352
1.50"-8UN	11	1141	962	1141	962	543	458	543	458
1.625"-8UN	12	1456	1226	1456	1226	-	-	-	-
1.75"-8UN	13	1825	1534	1825	1534	-	-	-	-
1.875"-8UN	14	2251	1890	2251	1890	-	-	-	-
2.00"-8UN	15	2738	2297	2738	2297	-	-	-	-
2.25"-8UN	16	3913	3276	3913	3276	-	-	-	-
2.50"-8UN	17	5382	4500	5382	4500	-	-	-	-
2.625"-8UN	18	6238	5212	6238	5212	-	-	-	-
2.75"-8UN	19	7180	5995	7180	5995	-	-	-	-
3.00"-8UN	20	9338	7789	9338	7789	-	-	-	-
3.25"-8UN	21	11889	9908	11889	9908	-	-	-	-
3.75"-8UN	22	18305	15232	18305	15232	-	-	-	-
3.875"-8UN	23	20206	16809	20206	16809	-	-	-	-
4.00"-8UN	24	22235	18491	22235	18491	-	-	-	-

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Instructions for using the torque Table 3:

To find the torque to be applied, read down 'Bolt/Stud Size' column to find the relevant size to be tightened, then across to find the relevant column for bolt material and coating. NOTE: All studs and nuts have a rust protection coating/plating except grade 718/660 studs, which are to be uncoated.

COLUMN I/J: Gives 50% yield for bolt strength of 57 ksi for bolt size $\leq \frac{3}{4}$ " and 36 ksi for bolt size $\frac{7}{8}$ " - 1 $\frac{1}{2}$ ". (SAE J429 Grade 2)

COLUMN K/L: Gives 50% yield for bolt strength of 92 ksi for bolt size ≤ 1 ", 81 ksi for bolt size $1 \frac{1}{8}$ " - 1 $\frac{1}{2}$ " and 58 ksi for bolt size 1 $\frac{5}{8}$ " - 3". (SAE J429 Grade 5/ASTM A449 Type 1)

COLUMN M/N: Gives 50% yield for bolt strength of 130 ksi for bolt size $\leq 2 \frac{1}{2}$ " and 115 ksi for bolt sizes 2 $\frac{5}{8}$ " - 4" (SAE J429 Grade 8/ASTM A354 Grade BD)

COLUMN O/P: Gives 50% yield for bolt strength of 105 ksi for bolt size ≤ 2.50 " and 95 ksi for bolt size 2 $\frac{5}{8}$ " - 4" (ASME SA193/ASTM A193 Grade B7, ASME SA320/ASTM A320 Grade L7)

COLUMN Q/R: Gives 50% yield for bolt strength of 80 ksi for bolt size ≤ 4 " (ASME SA193/ASTM A193 Grade B7M) and $\leq 2 \frac{1}{2}$ " (ASME SA320/ASTM A320 Grade L7M).

COLUMN S/T: Gives 50% yield for bolt strength of 105 ksi for bolt size ≤ 4 " (ASME SA320/ASTM A320 L43).

COLUMN U/V: Gives 50% yield for bolt strength of 105 ksi for bolt size ≤ 4 " (API 6A718)

COLUMN W/X: Gives 50% yield for bolt strength of 100 ksi for bolt size $\leq \frac{3}{4}$ ", 80 ksi for bolt size $\frac{7}{8}$ " - 1", 65 ksi for bolt size 1 $\frac{1}{8}$ " - 1 $\frac{1}{4}$ " and 50 ksi for bolt size 1 $\frac{3}{8}$ " - 1 $\frac{1}{2}$ ". (ASME SA193/ASTM A193 Grade B8, Type 304, Class 2)

COLUMN Y/Z: Gives 50% yield for bolt strength of 95 ksi for bolt size $\leq \frac{3}{4}$ ", 80 ksi for bolt size $\frac{7}{8}$ " - 1", 65 ksi for bolt size 1 $\frac{1}{8}$ " - 1 $\frac{1}{4}$ " and 50 ksi for bolt size 1 $\frac{3}{8}$ " - 1 $\frac{1}{2}$ ". (ASME SA193/ASTM A193 Grade B8M, Type 316, Class 2)

[BM LUB] Column Heading = Bare Metal with 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503 Molypaste' lubricant.

[FLUORO] Column Heading = Fluoropolymer coated

Note: If nuts are uncoated, apply 'Molykote® G-Rapid Plus Paste' or 'Sweeney 503 Molypaste' to the nut bearing face.

Figures for [BM LUB] 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503 Molypaste' lubricant have been calculated using equations for torque from API 6A Annex D along with a coefficient of friction of **0.085**.

Figures for [FLUORO] Fluoropolymer coated studs have been taken from API 6A Annex D based on a coefficient of friction of **0.07**.

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Table 4 – Recommended Make-Up Torques for Typical Code 62 Flanges

FLANGE SIZE	BOLT SIZE	BOLT TORQUE (ft-lbs) BM LUB
		AA
1/2"	.312"-18UN	10
3/4"	.375"-16UN	18
1"	.438"-14UN	28
1-1/4"	.500"-13UN	41
1-1/2"	.625"-11UN	80
2"	.750"-10UN	139

Instructions for using the torque Table 4:

COLUMN AA: Gives 50% yield for a bolt strength of 105 ksi (SST 17-4 HH1150 material)

[BM LUB] Column Heading = Bare Metal with 'Molykote® G-Rapid Plus Paste' lubricant or 'Sweeney 503 Molypaste' lubricant.

Refer to Rig Book procedure for special torque requirements. This document MUST be read in conjunction with the relevant assembly procedure.

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Figure 7 – Stud/Bolt Record Sheet

Stud/Bolt Information				
Connection Description:				
	Stud/Bolt Marking (i.e. L7, L7M, Part Number, etc)	Stud/Bolt Marking Heat Number (if available)	Stud/Bolt Yield Strength (if known)	MTRs available (Yes/No)
Stud/bolt #1				
Stud/bolt #2				
Stud/bolt #3				
Stud/bolt #4				
Stud/bolt #5				
Stud/bolt #6				
Stud/bolt #7				
Stud/bolt #8				
Stud/bolt #9				
Stud/bolt #10				
Stud/bolt #11				
Stud/bolt #12				
Stud/bolt #13				
Stud/bolt #14				
Stud/bolt #15				
Stud/bolt #16				
Stud/bolt #17				
Stud/bolt #18				
Stud/bolt #19				
Stud/bolt #20				
Stud/bolt #21				
Stud/bolt #22				
Stud/bolt #23				
Stud/bolt #24				

API 20E Riser Bolting

Product Notification & Improvement

PNI – Product Notification
& Improvement -

used to notify the customer of a new or revised product that is available at the customer's option.

Scope

This PNI introduces HMF riser locking bolts and threaded inserts that are compliant with API 20E BSL-3.

API 20E & 20F H4 Connector Bolting

Product Notification & Improvement

PNI – Product Notification
& Improvement -

used to notify the customer of a new or revised product that is available at the customer's option.

Scope

This PNI introduces primary load path bolting for H4 connectors that are compliant to API 20E BSL-3.

7. IDENTIFICATION

7.1. Each stud shall be permanently marked with the following information at the location noted by flag 7.1 on the drawing below:

-  Part Number and Revision Level
- Manufacturers Identification Symbol or Name
- Unique Heat treat lot identification *
- Material Grade Symbol per ASTM A320
- API 20E BSL Level
- API Monogram (if Applicable)**

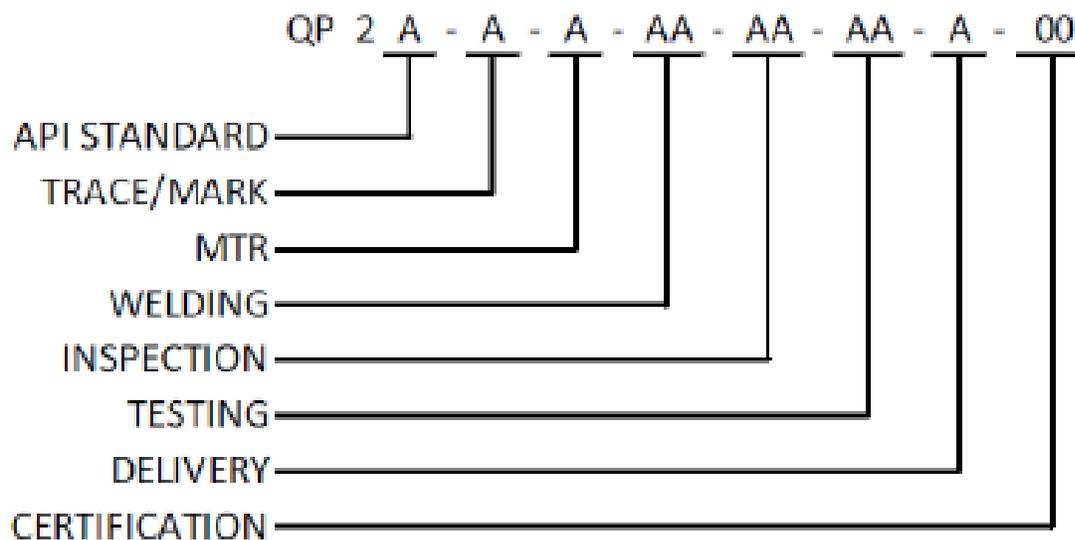
* Heat lot is defined as bolting or raw material of a single heat and diameter, heat treated together as a single austenitizing, quenching, tempering, and stress relieving charge. (API 20E)

** API monogram only applies in part numbers ending in a "M" as described in Section 6.2.

Q2 part number may be marked at the end of the stud

4 Procedure

The Quality requirements are identifiable through the Title of the Quality Plan as follows:



Each of the notations above is specifically called out in Annex A.

CERTIFIED TEST REPORT REQUIREMENTS

THE FOLLOWING ITEMS SHALL BE REPORTED IN ALL CASES:

Vendor Checklist¹

- Purchase Order Number
- Part Number (including revision level)
- Quantity of Parts
- Statement of compliance to the designated VGS number including revision level²
- Name of Melt Source (Mill) and Heat Treat Facility (if different from Mill)
- Vendor Manufacturing Plan Number and Revision Level
- Specific BSL level
- Mill Chemistry & Mill Heat Number
- Melt Practice
- Hot work Reduction Ratio
- Copies of original Heat Treatment Report including times, temperatures and quench media
- Heat Treatment Lot Number(s)
- Results of Tensile testing
- Results of Impact testing
- Results of Hardness tests
- Results of mechanical tests performed by raw material supplier
- Results of mechanical tests performed by bolting manufacturer (BSL 2 & 3 only)
- Results of macrostructure and microstructure tests
- Results of Dimensional and Visual Inspection
- Results of Non-Destructive Examination
- Coating (if applicable - including details of hydrogen control)

¹ These spaces are provided so that the vendor may copy this page and use it as a checklist when preparing the Certified Test Report. As stated previously, if the Certified Test Report does not contain all the information required by

<p><u>Enter the frequency for maintenance by clicking below:</u> <i>In Between Well</i></p>	<p><u>Enter the work center that will carry out this maintenance by clicking below:</u> SUBSEA</p> <p><u>Enter the estimated hours to complete this maintenance by clicking below:</u> 6hr</p> <p><u>Task:</u> EOW, Critical Bolting</p> <p><u>Justification:</u> - MD WCE O&M Standard - M_CPH-1171-26281_EN_Section_2.0 - API Specification 20E</p> <p><u>Content:</u> Following task to be performed with reference to: - Company's Manual - OM11023-STK Rev.A</p> <p>Reminder:</p> <ul style="list-style-type: none"> - All pressure and timing data shall be recorded via work table and/or charts then uploaded within the parameters of MD CMMS. - Record the batch/serial number for any new elastomers and upload to MD CMMS. - Record serial number for any critical components changed. - Photograph all equipment inspections and upload photos to MD CMMS. - Ensure all torque and pressure measuring equipment used has been calibrated within the past 12 months. <ol style="list-style-type: none"> 1. Clean and visually inspect critical bolting and Xylan coating for damage and/or substantial corrosion. <p>NOTE: Substantial corrosion shall be defined as corrosion that leads to significant material loss that would otherwise reduce the capacity of the fastener.</p> <ol style="list-style-type: none"> 2. Visually inspect all exposed critical bolting for signs of improper make-up; if suspect, torque the fastener to OEM specification utilizing OEM approved lubricant(s). 3. If applicable, any critical bolting connections broken during maintenance shall be re-torqued subsequent component pressure testing. Torque values shall be recorded and signed off by verifier (OIM, Maintenance Supervisor, Subsea Supervisor, etc.) and logged in the MD CMMS. <p>NOTE: OEM recommended lubricant(s) and torque value(s) shall be used. Apply torque marking compound for future reference.</p> <p><u>Reporting Requirements:</u> - All findings to be recorded in work order completion text. - As required by API, all well control equipment failures to be reported to the OEM utilizing Well Control Equipment Failure Reporting System, raise a notification and inform regional WCE superintendent.</p>
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<p><u>Enter the frequency for maintenance by clicking below:</u> 5 Yearly</p>	<p><u>Enter the work center that will carry out this maintenance by clicking below:</u> SUBSEA</p> <p><u>Enter the estimated hours to complete this maintenance by clicking below:</u> 36hr</p> <p><u>Task:</u> 5 Yearly, Critical Bolting</p> <p><u>Justification:</u> - MD WCE O&M Standard - M_CPH-1171-26281_EN_Section_2.0 - API Specification 20E</p> <p><u>Content:</u> Following task to be performed with reference to: - Company Operator's Manual - OM11023-STK Rev.A</p> <p>Reminder:</p> <ul style="list-style-type: none"> - All pressure and timing data shall be recorded via work table and/or charts then uploaded within the parameters of MD CMMS. - Record the batch/serial number for any new elastomers and upload to MD CMMS. - Record serial number for any critical components changed. - Photograph all equipment inspections and upload photos to MD CMMS. - Ensure all torque and pressure measuring equipment used has been calibrated within the past 12 months. <ol style="list-style-type: none"> 1. Conduct non-destructive testing (NDT) on all critical and load bearing connections. Upon completion, update critical bolting tracking spreadsheet. Note: Careful selection of NDT techniques shall be considered for studs that have special coatings to avoid remove of the coatings. 2. Replace critical bolting with API Specification 20E bolts during 5 yearly overhaul of major components. <p><u>Reporting Requirements:</u> - All findings to be recorded in work order completion text. - As required by API, all well control equipment failures to be reported to the OEM utilizing Well Control Equipment Failure Reporting System, raise a notification and inform regional WCE superintendent.</p>
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PRODUCT ADVISORY

PA 40832

02/18/2016

Authorized Use Only

Company Drilling System Response to BSEE Safety Alert No. 318-Connector and Bolt Failures

SCOPE:

This Product Advisory is **Company's** response to *BSEE Safety Alert No. 318 Connector and Bolt Failures* dated February 02, 2016 (the "Safety Alert").

ISSUE:

On February 02, 2016 **Company** received the Safety Alert which expressed concern for bolt failures in connectors, risers, and subsea blowout preventers. The Safety Alert states, in part, "...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.*

REQUIREMENTS/RECOMM ENDATIONS:

Company manufactures connectors, risers and subsea blowout preventers in conformance with the relevant API standards in place at the time of the manufacture of the product. Bolting materials are supplied in accordance with these relevant and current API standards or have been or continue to be upgraded to meet API 20E BSL-3 specification.

Company provides customers with installation and maintenance procedures, including bolt torque information in conformance with applicable API standards, for all **Company** drill-thru products. This information can be found in **Company's** Operation and Maintenance Manuals, Rig Books, and/or thru distribution of our Engineering Bulletins.

Company has a failure reporting system called Field Performance Reports (FPRs). This system is used to document information associated with field incidences and their investigation, and to verify conformance with API Q1, 9th Edition requirements.

CONCLUSION:

It is our intention that this **Company** Product Advisory provides our customers and regulatory bodies with information responsive to the Safety Alert.

COMPANYCONTACTS:

For questions or comments please contact your local **Company** representative.

Connection type: **18-3/4-15M**
 Bolt part number: **10898090-001**
 Part description: **STUD, TE, 3"-8UN X 16-3/4" LG, HI STRGTH, ZINC-NICKEL**
 Bolt material/yield: **NS43/130Ksi**
 Bolt pattern/hex size: **20 bolt / 4-5/8" hex**
 Lubricant to be used/coefficient of friction: **Moly 503/0.067**

Ensure correct lubricant stated above is applied to both the bolt thread, and the mating face of the nut, prior to assembly.

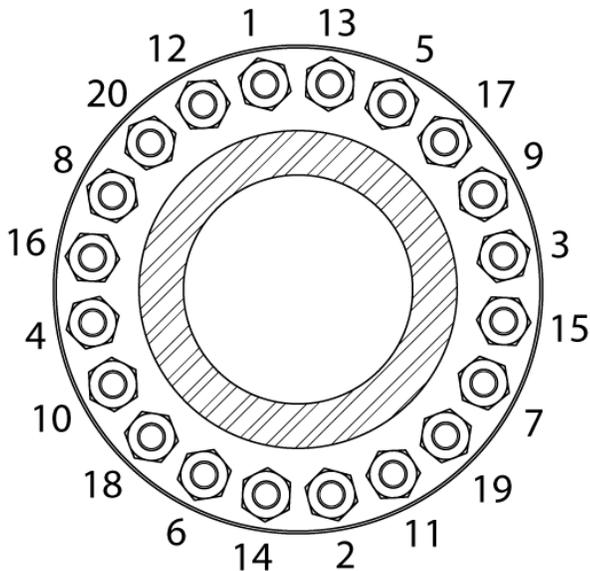
In any bolted assembly, the bolts must never be torqued to full torque on the first time through the torque sequence. This is even more important for raised face flanges where the bolts are outside the contact surface. The procedure below highlights the steps required to torque large flanges with high bolt torque values.

After flange assembly and all nuts have been run down by hand, start wrench tightening following the sequence of the numbers indicated (marking the number on the flange aids in keeping track of the tightening process).

Confirm that the hydraulic power unit for the torque wrench has valid gauge calibration in effect and monitor the pressure reading throughout the process to ensure correct torque is applied.

Assign one person as a task monitor to ensure make-up procedure is followed correctly.

During all of the following steps, keep any gap between flanges even all around the circumference, and nuts made up approximately the same amount on each end of the bolt.



- First time around just snug the nuts with a hand wrench.
- Second time around tighten the nuts firmly with the same wrench.
- Third time around apply **2404ft/lbs** (approximately 25% recommended torque).
- Fourth time apply **7212ft/lbs** (approximately 75% of recommended torque).
- Fifth time around, apply **9616ft/lbs** (100% of recommended torque). During the 100% torque sequence EVERY nut must move. If not, loosen the nut 1/4 turn and re-torque.
- Continue tightening nuts in the tightening sequence until nuts do not move under 100% recommended torque.

If possible, re-torque after 24 hours or after the first pressure test. Most of any bolt preload loss occurs within 24 hours or after the first pressure test.

Referenced document: AX050091RevF.

PRODUCT INFORMATION

Product Bulletin No.: D4516596732-PIB-001

Rev 01

Bolting Hardness

Date: March 03, 2016

Subject: Bolt failures

Product: Subsea BOPs, Annular BOPs and BOP stacks

Affected

Assemblies: Annular BOPs, Ram BOPs and BOP stack structures used subsea

Objective: To advise customers to replace certain bolts on Subsea BOPs, Annular BOPs and BOP stacks that may be susceptible to hydrogen embrittlement.

Issue: In the past 4 years the industry has experienced bolt failures related to hydrogen embrittlement that could affect the safe operation of subsea equipment. **COMPANY** has reviewed the current material industry standards and has identified bolts manufactured to certain material specifications that may be manufactured from harder materials that may be more susceptible to hydrogen embrittlement. The current material industry standards that **COMPANY** has reviewed are:

ASTM A574

ASTM A354

ASTM A540

SAE J429 (Grade 8 only)

Bolts manufactured from AISI 4340 or 8630 that exceed 35 HRC

Solution: **COMPANY** has reviewed each Subsea stack, annular BOP, and Ram BOP to identify bolting material that may be manufactured from harder materials that may be more susceptible to hydrogen embrittlement. As a precautionary measure **COMPANY** recommends that the identified bolting material be replaced. Contact BoltingReplacementInfo@Company.com for the list of bolts that need to be replaced

for your stack. Parts (but not installation) will be supplied by **COMPANY** Incoterms FCA, for all equipment defined by **COMPANY** to be affected by the above described issue for one year from the date of this revision of this bulletin.

Drill through flange bolts, closure bolts and choke and kill line and valve flange bolts are not manufactured to any of the above specifications and therefore are not affected by this bulletin.

Pressure containing and pressure retaining fasteners including included API flange bolting, BOP side outlet bolting, door or bonnet bolting and connector body bolts have already been addressed in previous bulletins.

Bolting affected by this bulletin is not classified as critical bolting and is classified as utility bolting. Critical bolting is bolting that the failure of which would result in the loss of containment of wellbore fluids to the environment. Examples include API drill through flange bolts, BOP side outlet API flange bolts, bonnet or door bolts, wellhead and LMRP connector primary load path bolts, blind shear ram primary load path bolting, and riser primary load path bolting. Utility bolting is all other bolting that is not critical bolting.

Failure to follow the recommendations and/or guidance in *COMPANY* Manuals and Product Bulletins may result in death, bodily injury or property damage.

Operators should also refer to previous **COMPANY** Product Information Bulletins and Safety Alerts for additional information related to this issue and information regarding safe operation, maintenance, and inspection criteria by signing in to your MY**COMPANY** account at <https://portal.myCompany.com> and then searching with the Product Bulletin Search available below the heading 'Application Groups'. For information on registering, please visit <https://www.Company.com/Search/register.aspx>.

Please contact your local **COMPANY** Service Center if you have any questions regarding this bulletin.

Revision History:

Rev	Date (mm/dd/yyyy)	Change Description
01	03/03/2016	Initial Release

CALIBRATION DATA SHEET

Inspection Report Number

SPR0000664-UT-003

INSPECTOR INFORMATION

Inspector Name	Dakota Kirby	Date	10/7/2016
Certification	Level II	Location	Pacific Santa Anna

INSTRUMENT INFORMATION

PAUT Instrument Name	Omniscan MX	Serial Number	OMNI-1998/2854
Probe	5L32-A32	Serial Number	P4270
Wedge	None	Serial Number	N/A

CALIBRATION DATA

Cal Stud No	012555			
Cal Stud Size	3.0 in		in	Image
Calibration Gain	15 dB	Notch 1 Depth	5.01	Attached
Sweep Angle Range	-30° to 30°	Notch 2 Depth	6.11	Attached
Focal Depth	200 mm	Notch 3 Depth	14.54	Attached

COMMENTS

BOP Stack SN: 20090012-2
Upper Triple To Spool
No recordable Indications

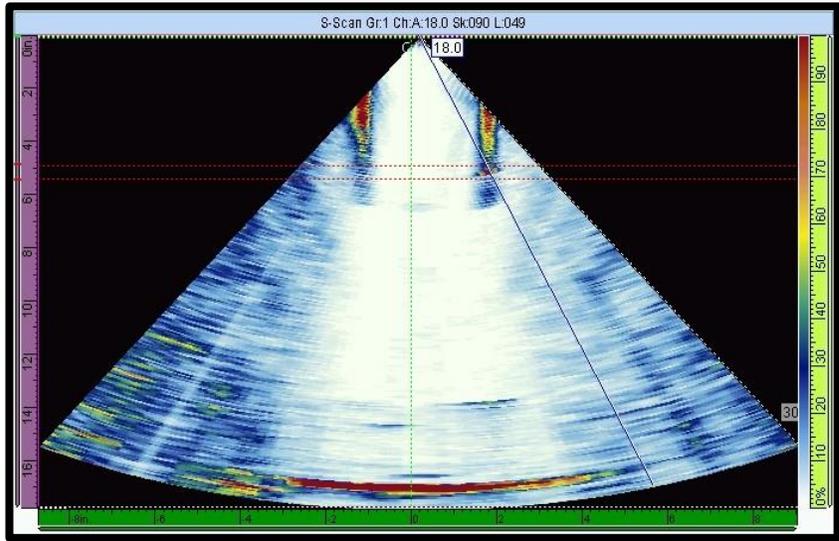
Inspector Signature

Level III Review

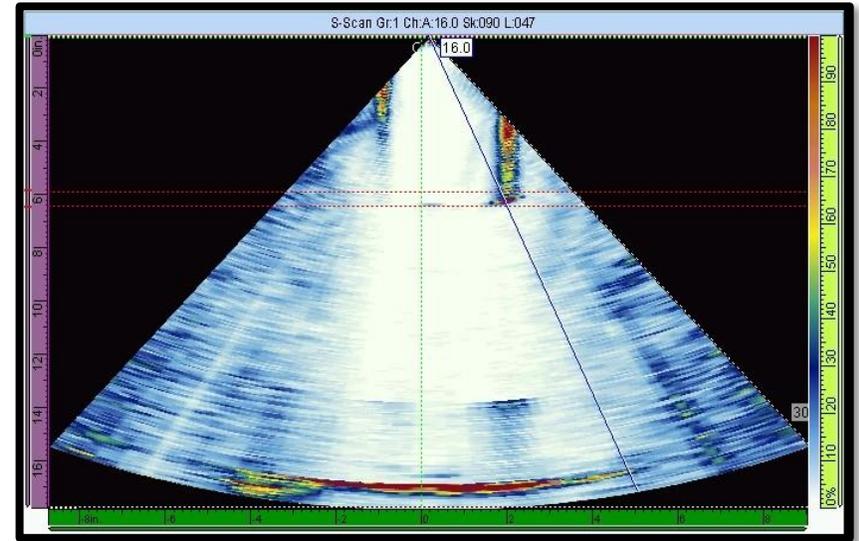
Witness

Inspection Result Data Sheet

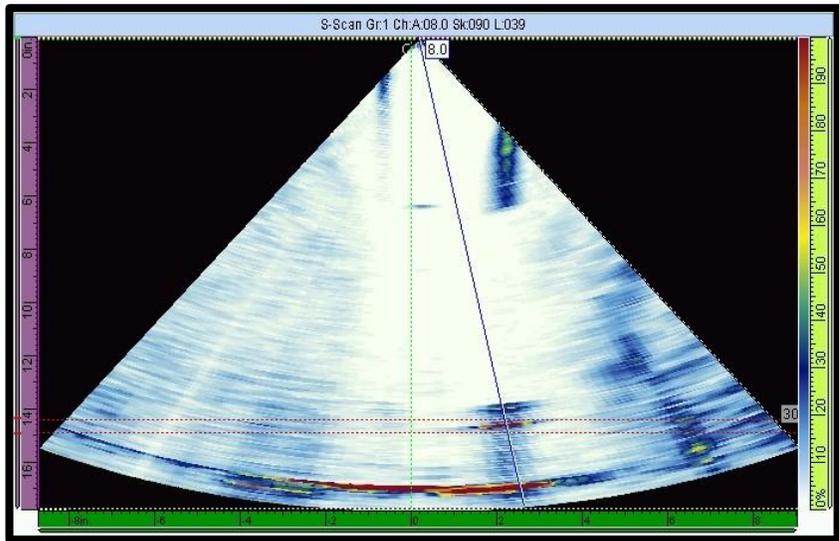
Stud Location	Stud Number	Serial Number	Indication Location	Images
Upper Triple To Spool	A1	None	Accept	Attached
Upper Triple To Spool	A2	None	Accept	Attached
Upper Triple To Spool	A3	None	Accept	Attached
Upper Triple To Spool	A4	None	Accept	Attached
Upper Triple To Spool	A5	None	Accept	Attached
Upper Triple To Spool	A6	None	Accept	Attached
Upper Triple To Spool	A7	None	Accept	Attached
Upper Triple To Spool	A8	None	Accept	Attached
Upper Triple To Spool	A9	None	Accept	Attached
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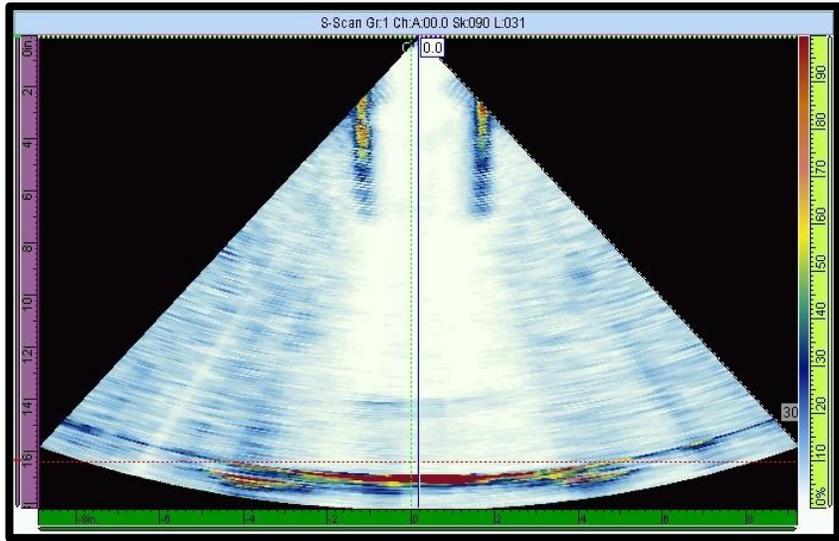
Cal In Notch_1



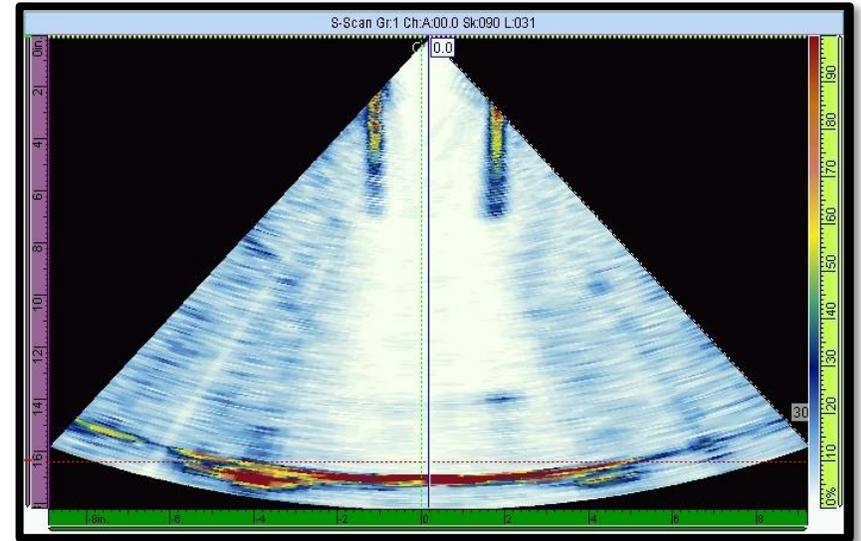
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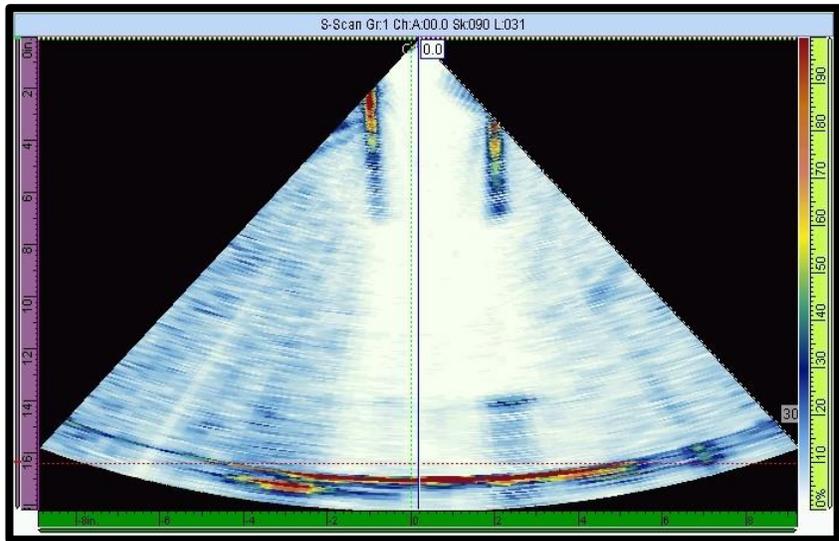
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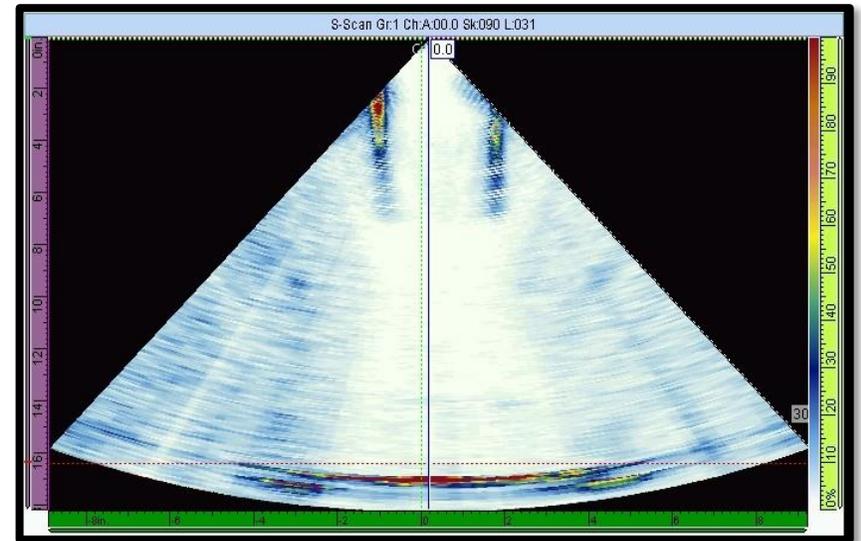
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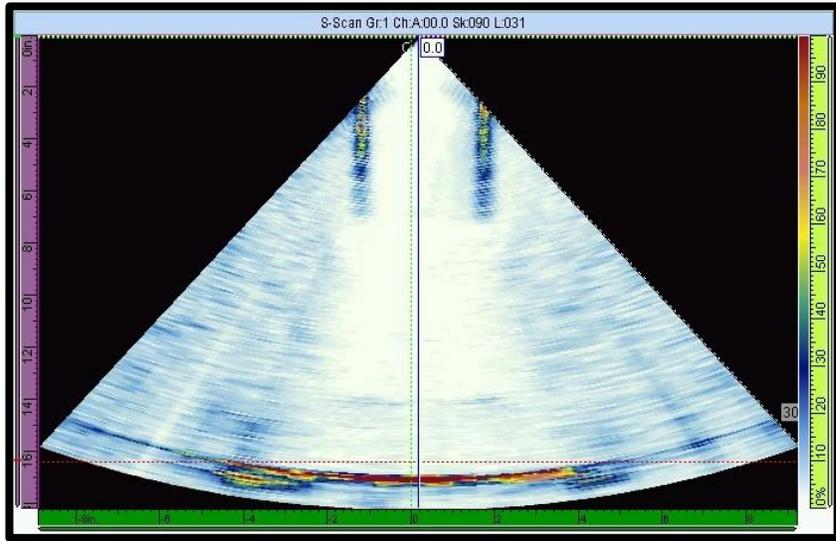
Upper Triple to Spool Bolt A1 45°



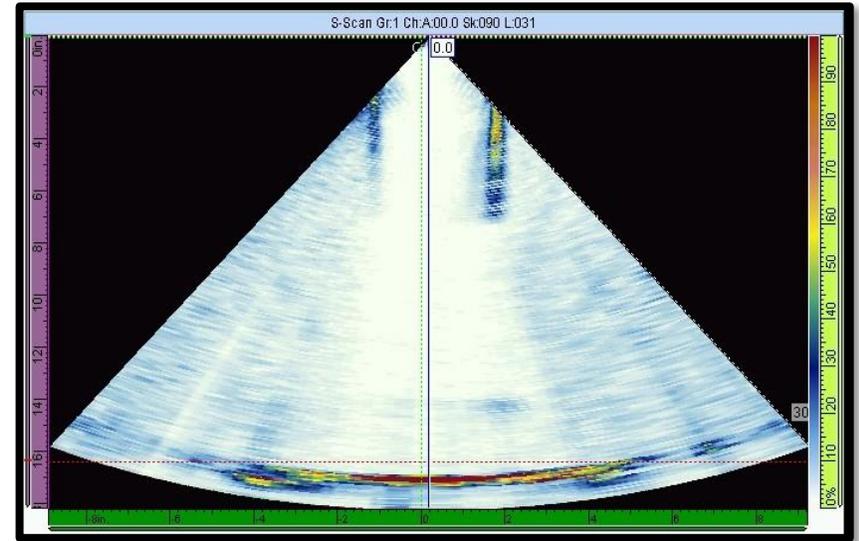
Upper Triple to Spool Bolt A1 90°



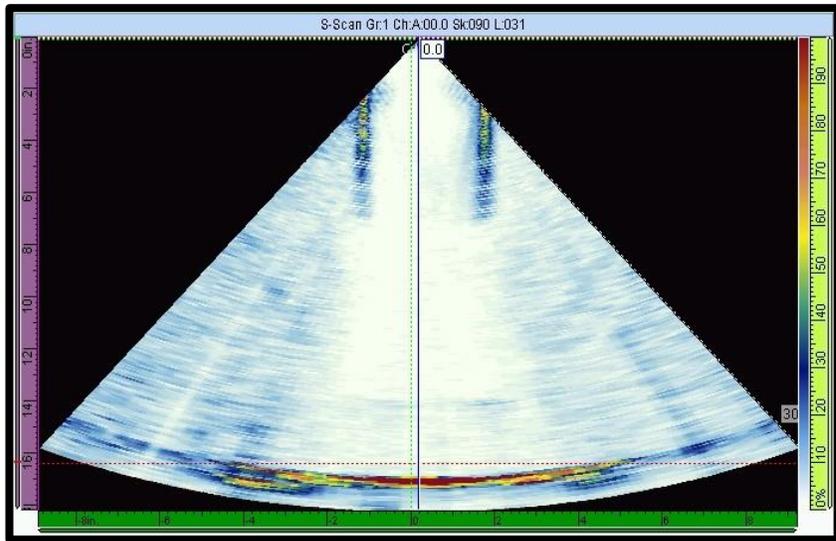
Upper Triple to Spool Bolt A1 135°



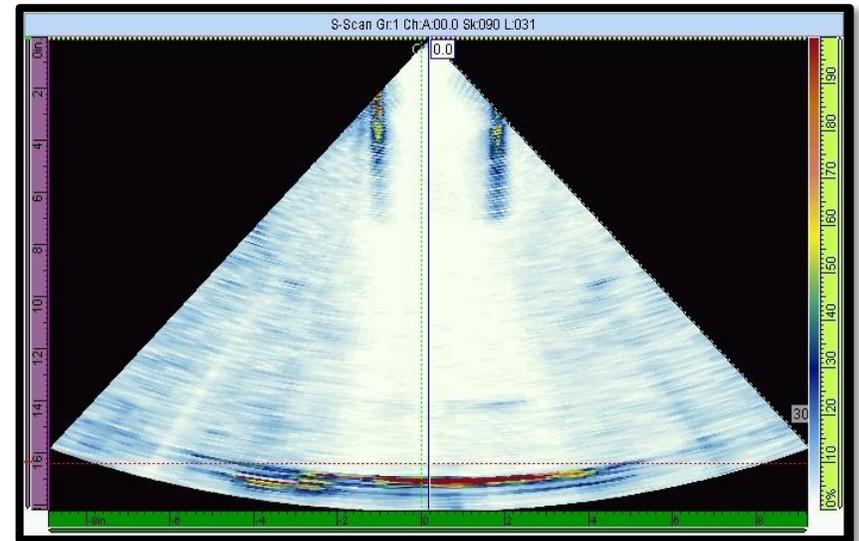
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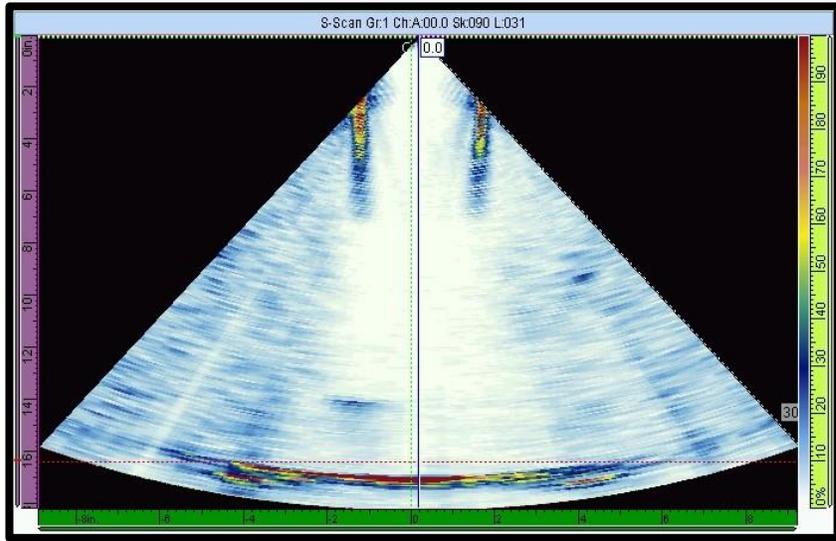
Upper Triple to Spool Bolt A2 45°



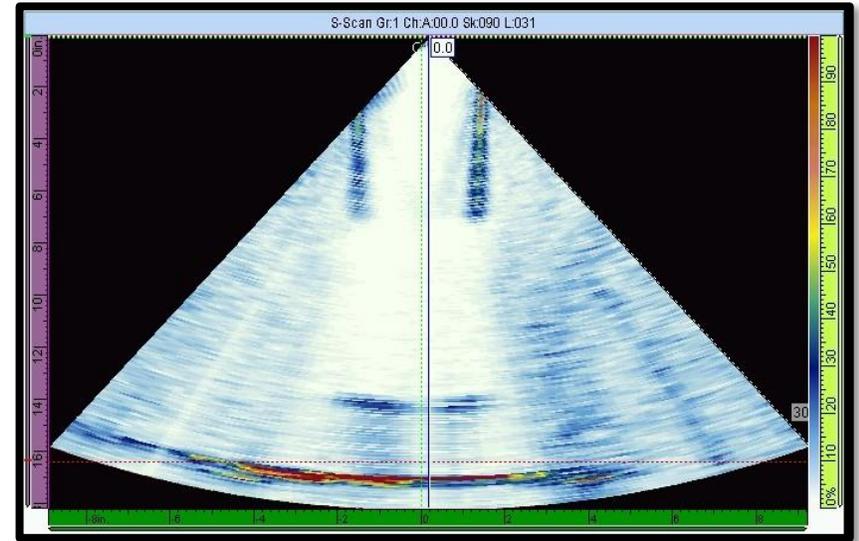
Upper Triple to Spool Bolt A2 90°



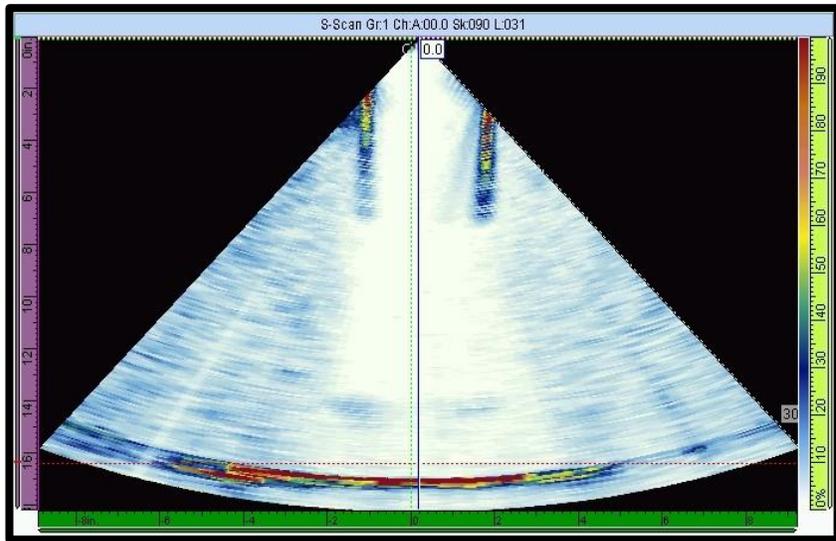
Upper Triple to Spool Bolt A2 135°



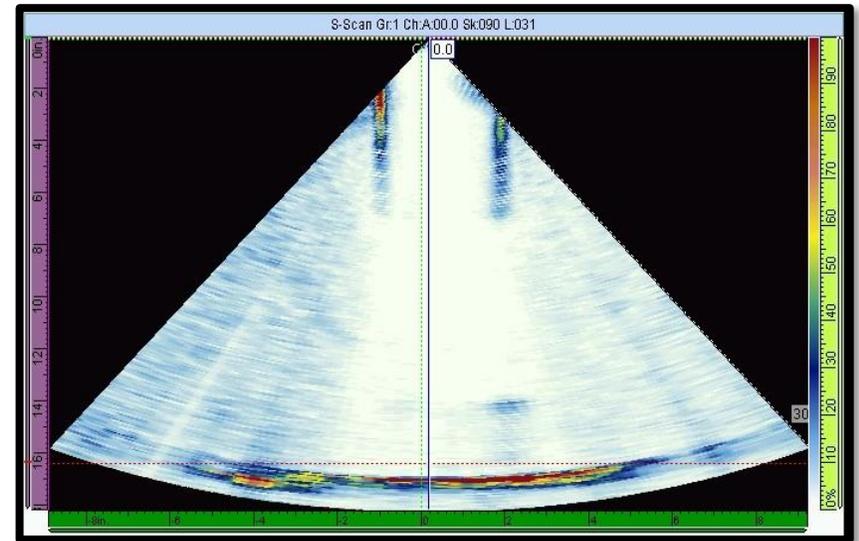
Upper Triple to Spool Bolt A3 0°



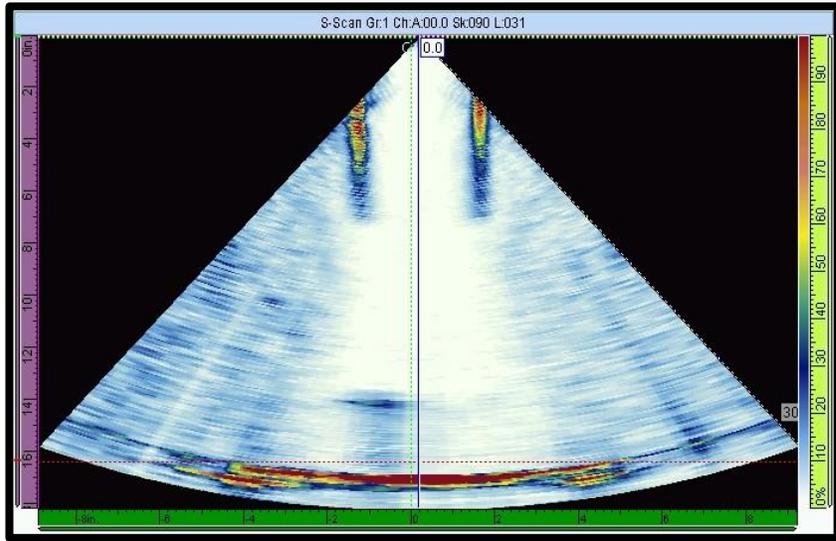
Upper Triple to Spool Bolt A3 45°



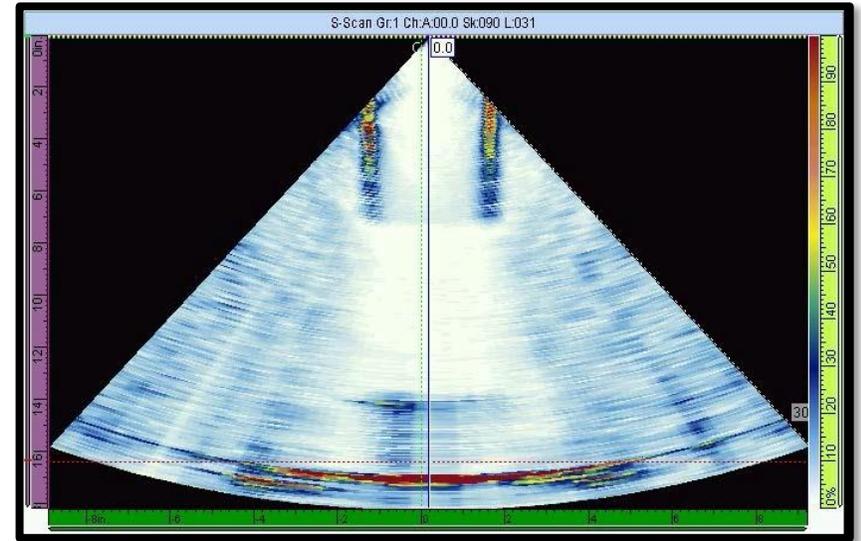
Upper Triple to Spool Bolt A3 90°



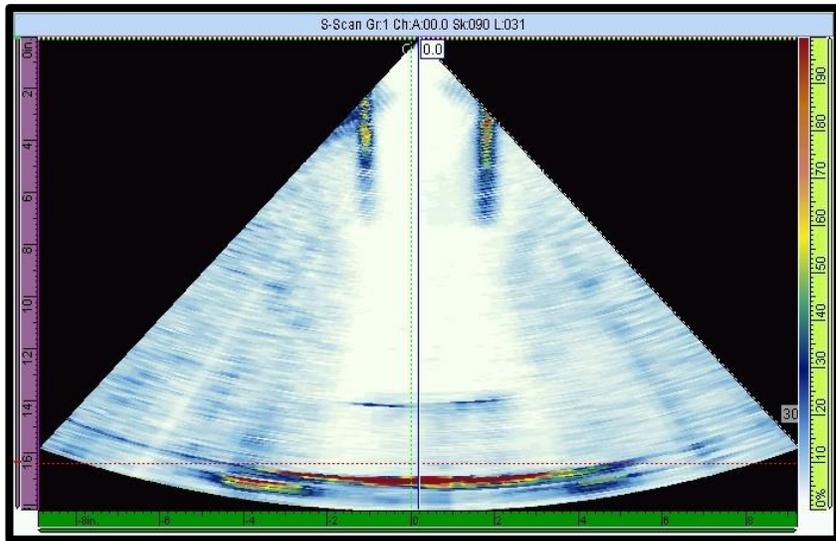
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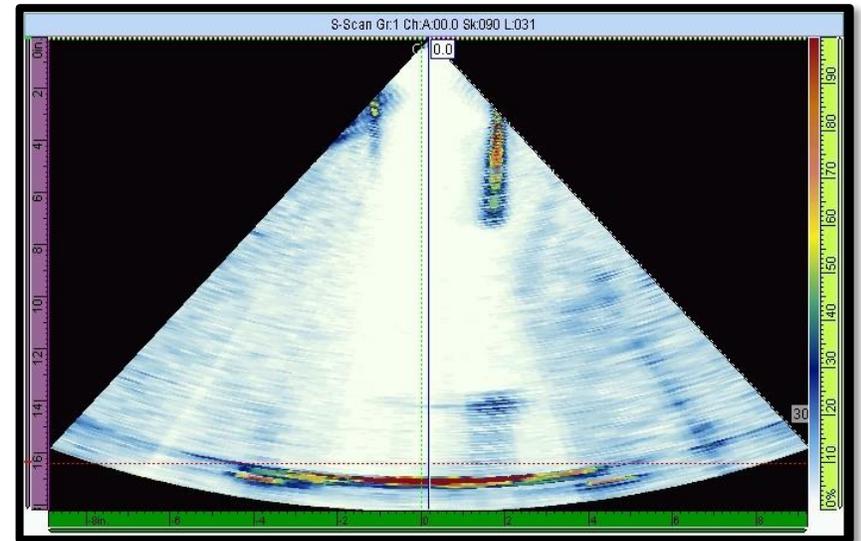
Upper Triple to Spool Bolt A4 0°



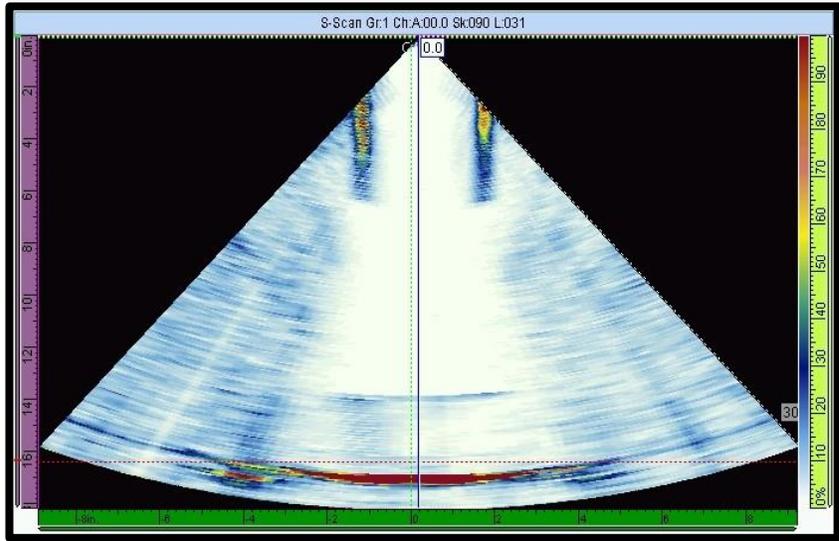
Upper Triple to Spool Bolt A4 45°



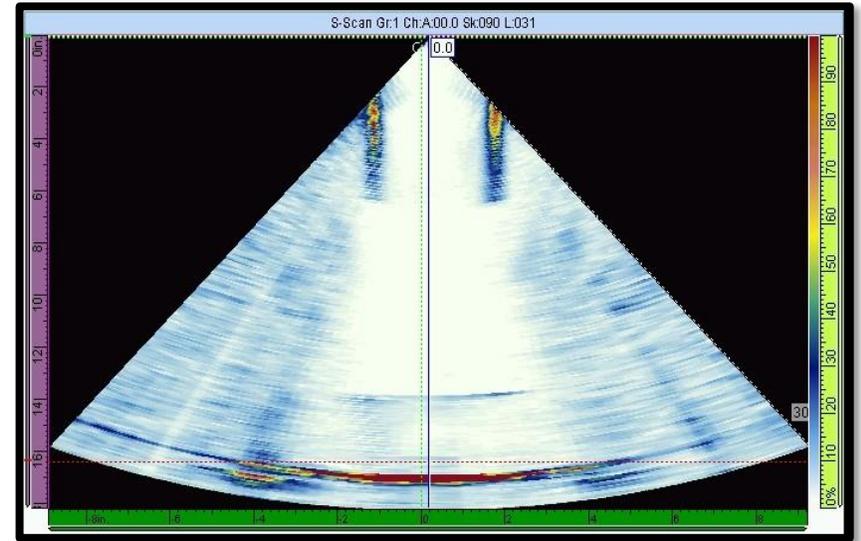
Upper Triple to Spool Bolt A4 90°



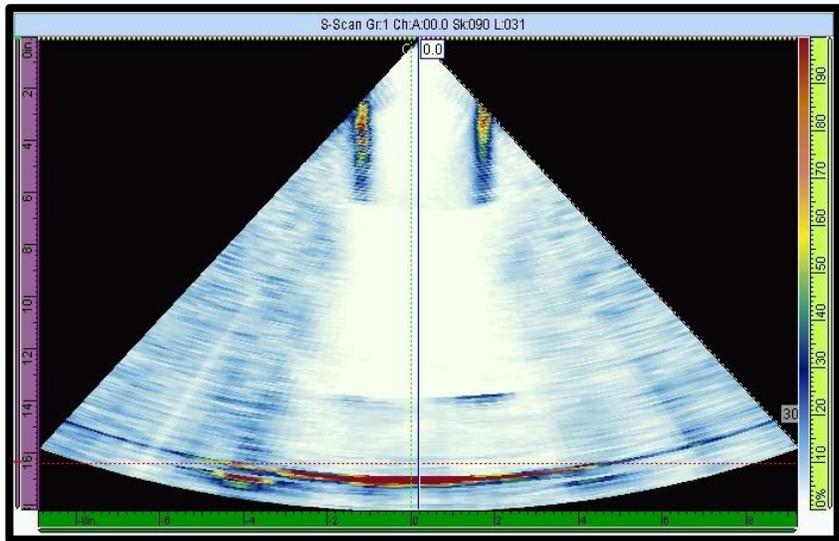
Upper Triple to Spool Bolt A4 135°



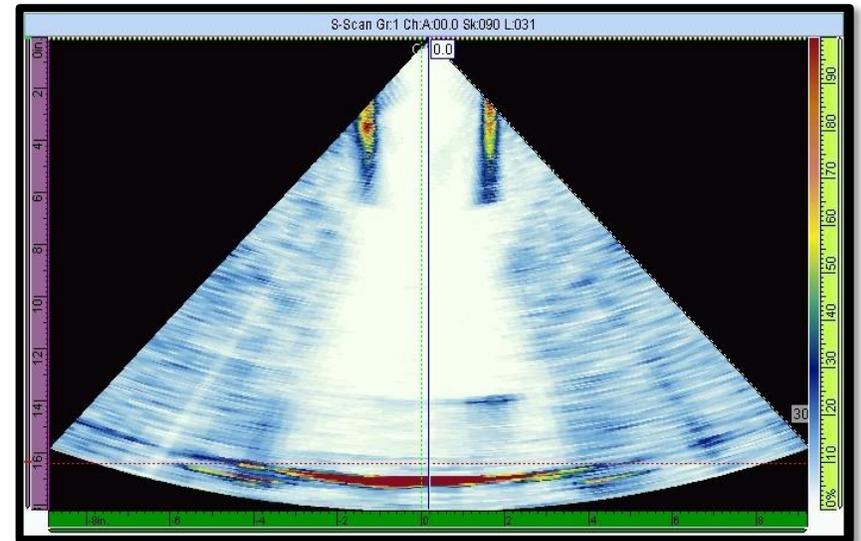
Upper Triple to Spool Bolt A5 0°



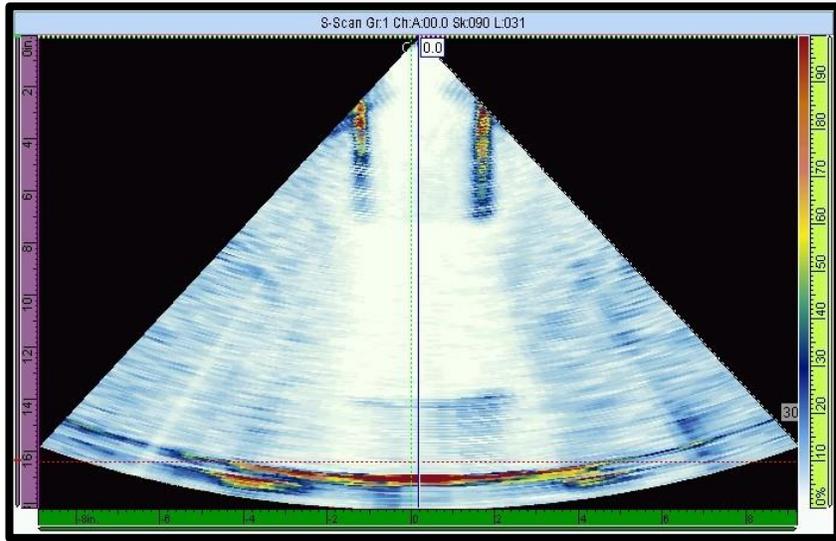
Upper Triple to Spool Bolt A5 45°



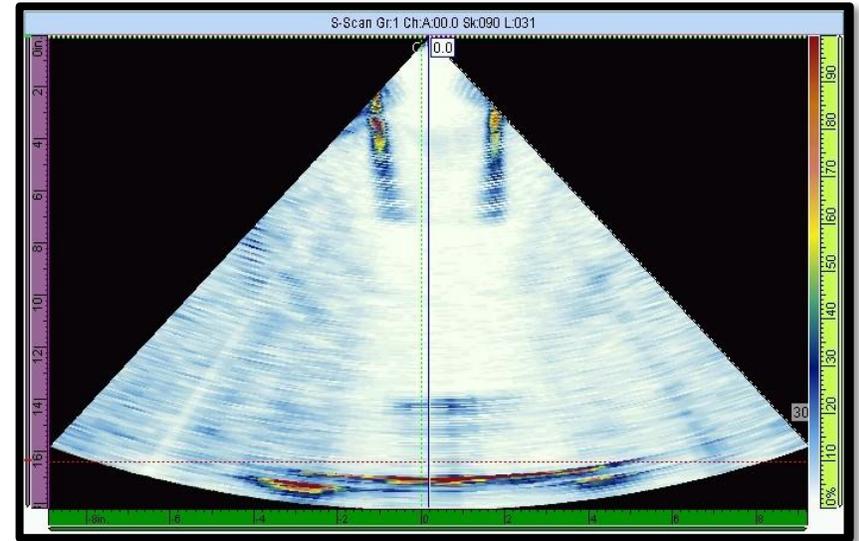
Upper Triple to Spool Bolt A5 90°



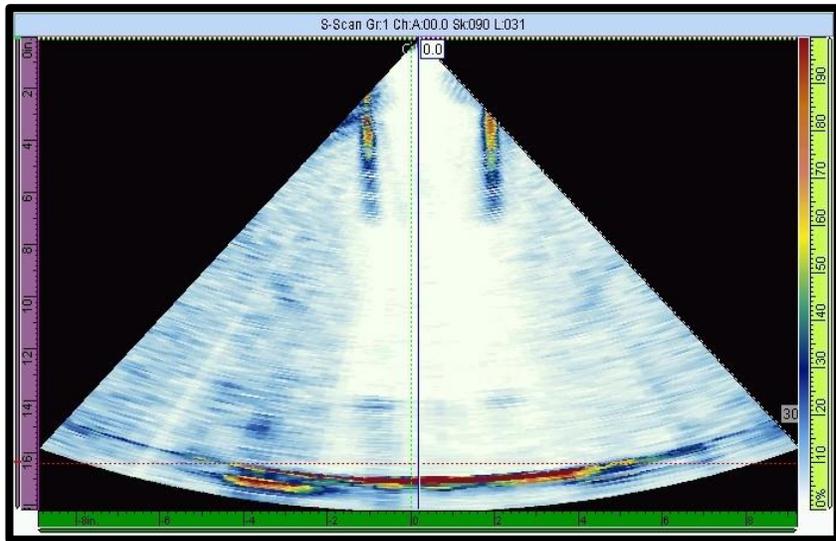
Upper Triple to Spool Bolt A5 135°



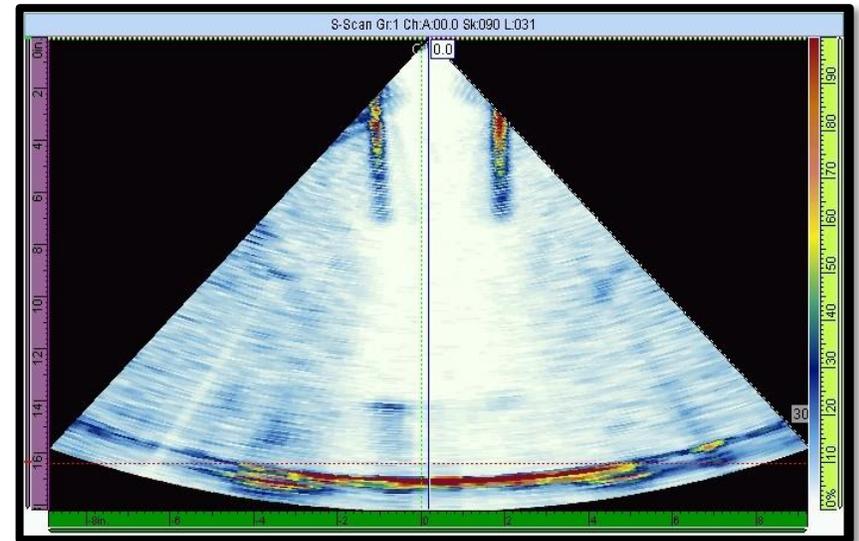
Upper Triple to Spool Bolt A6 0°



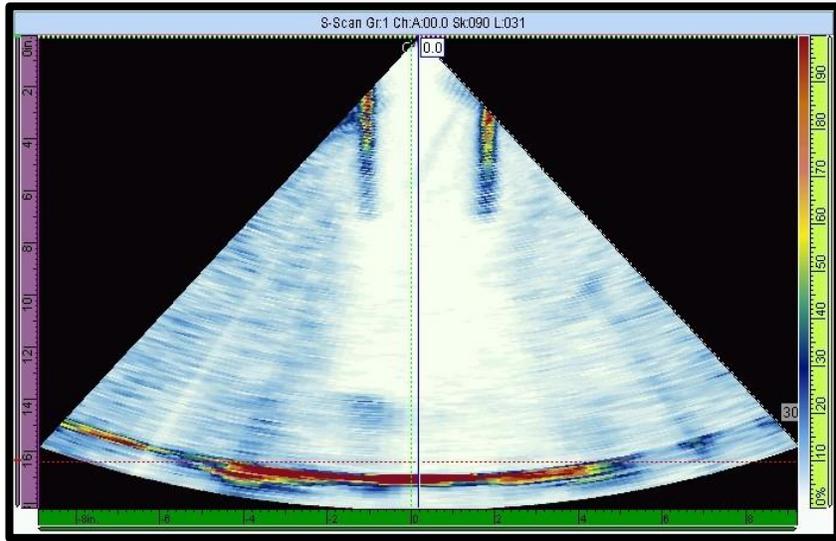
Upper Triple to Spool Bolt A6 45°



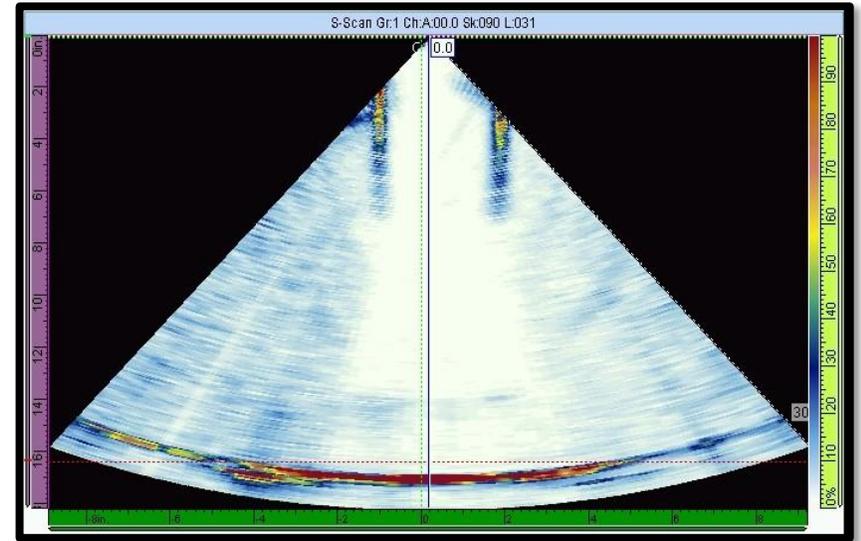
Upper Triple to Spool Bolt A6 90°



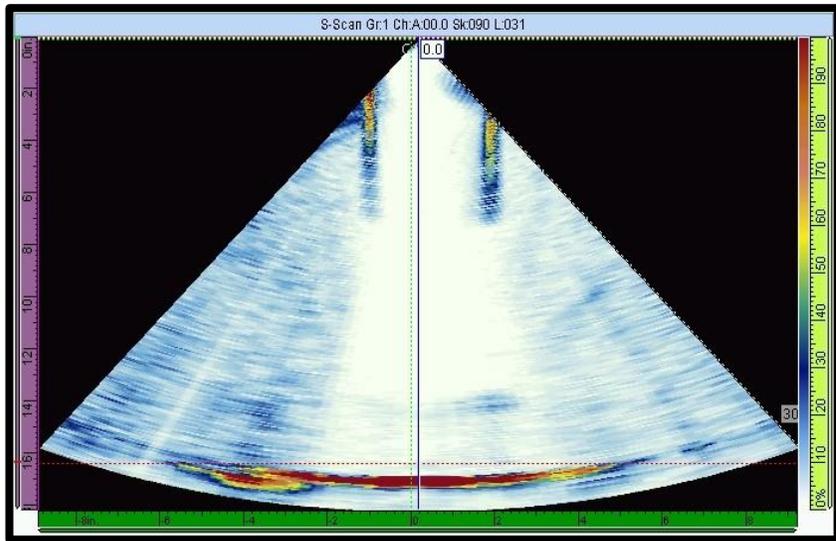
Upper Triple to Spool Bolt A6 135°



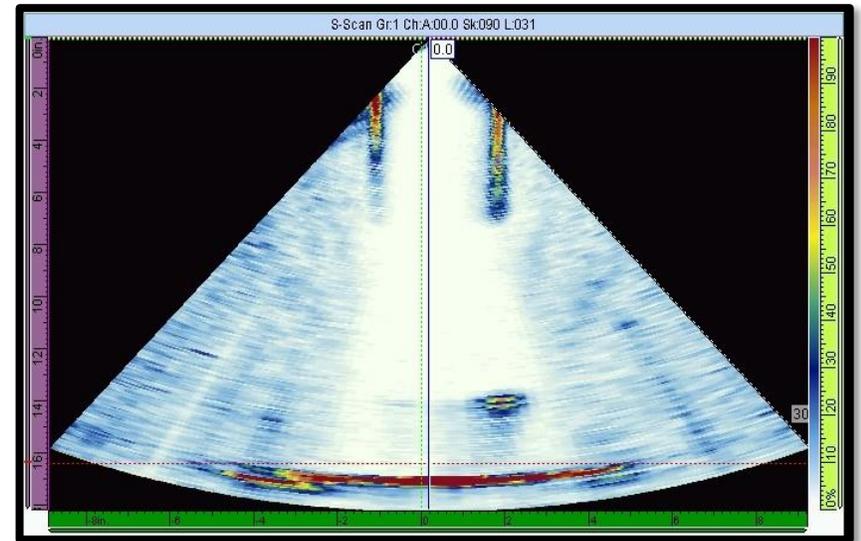
Upper Triple to Spool Bolt A7 0°



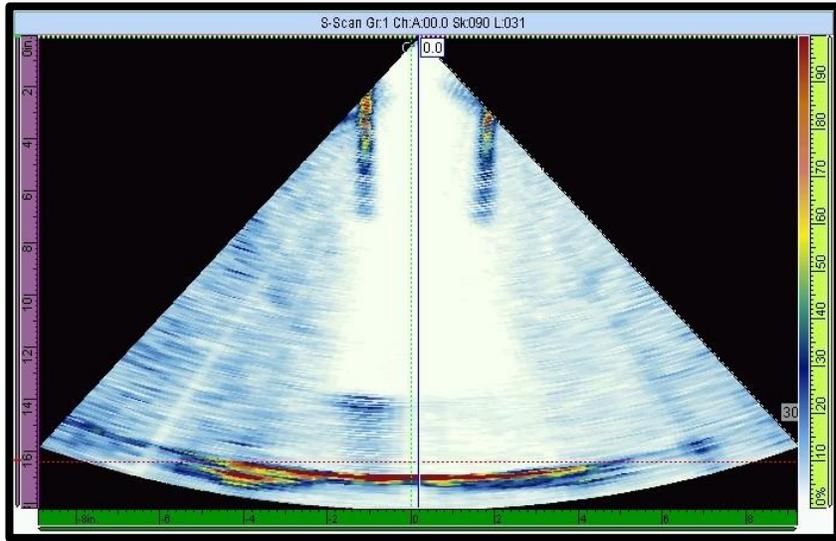
Upper Triple to Spool Bolt A7 45°



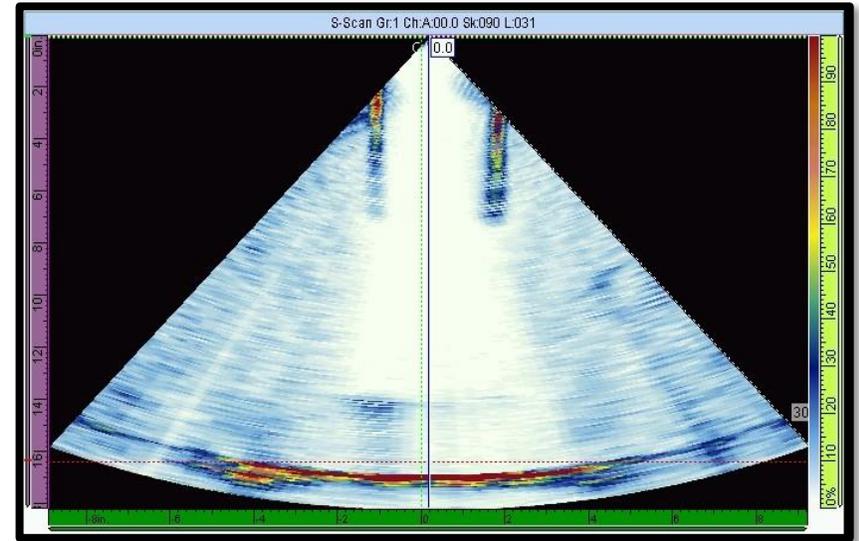
Upper Triple to Spool Bolt A7 90°



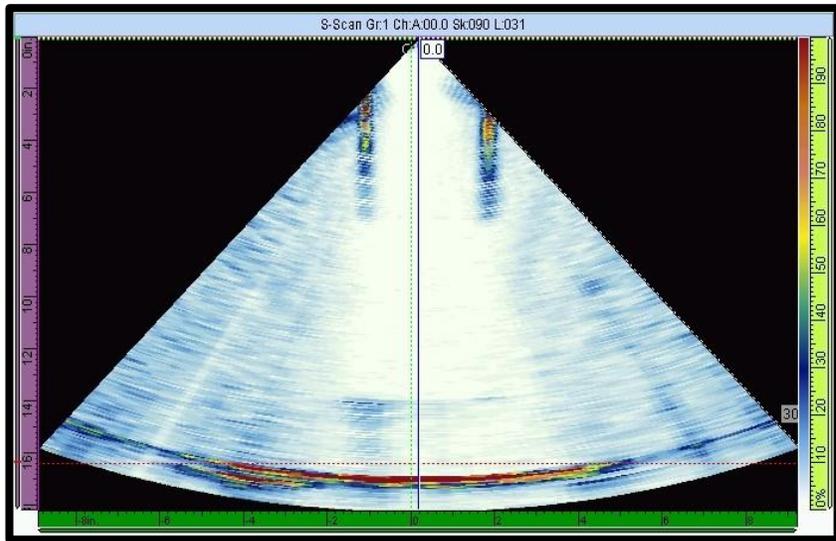
Upper Triple to Spool Bolt A7 135°



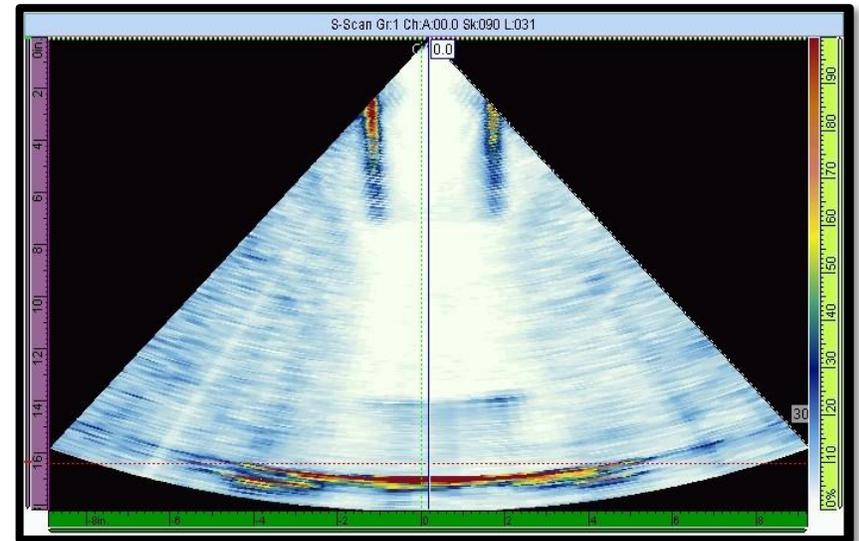
Upper Triple to Spool Bolt A8 0°



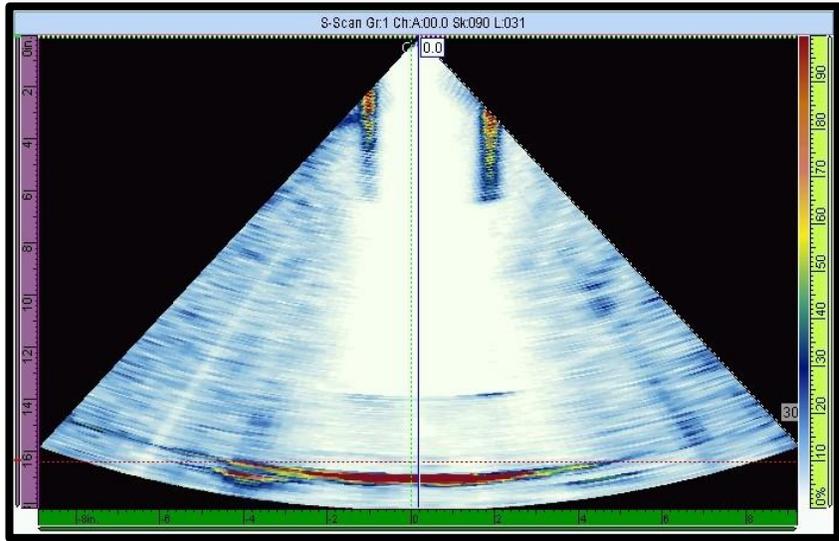
Upper Triple to Spool Bolt A8 45°



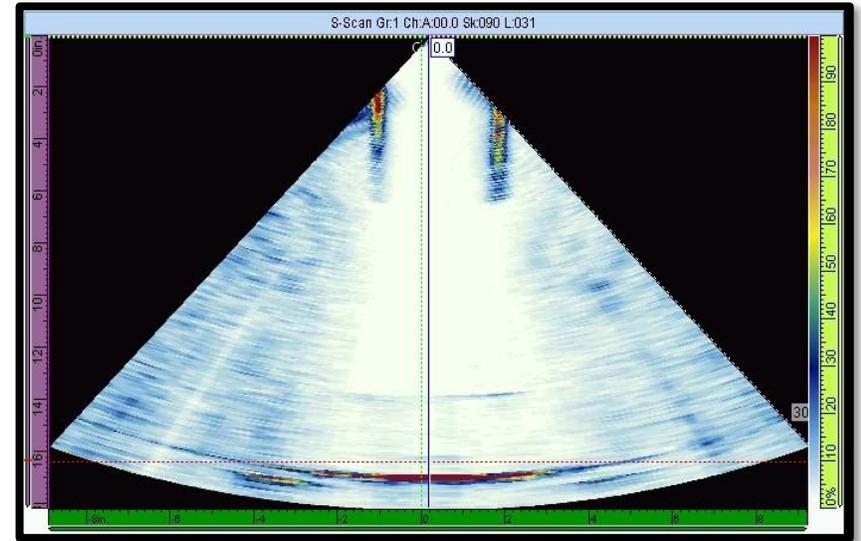
Upper Triple to Spool Bolt A8 90°



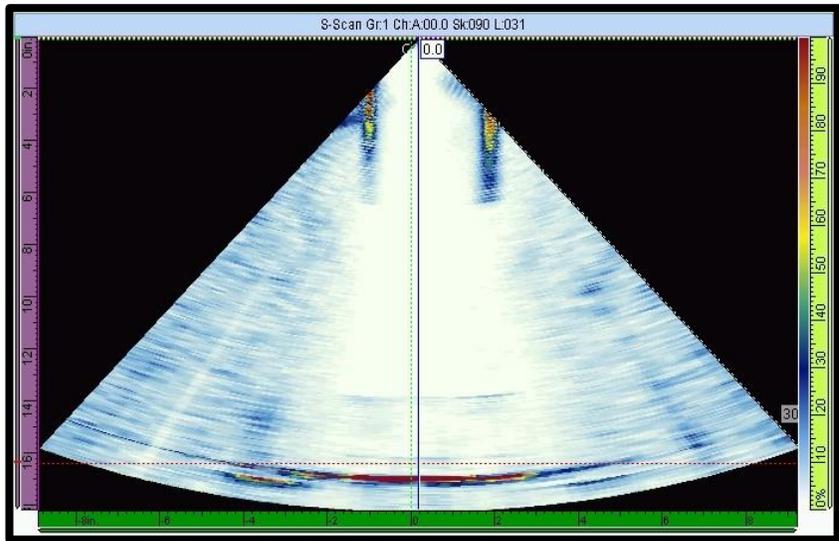
Upper Triple to Spool Bolt A8 135°



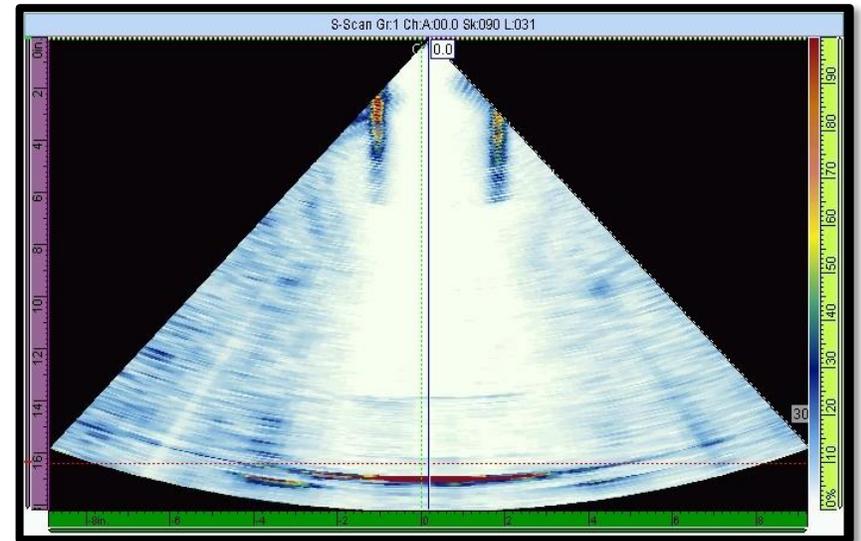
Upper Triple to Spool Bolt A9 0°



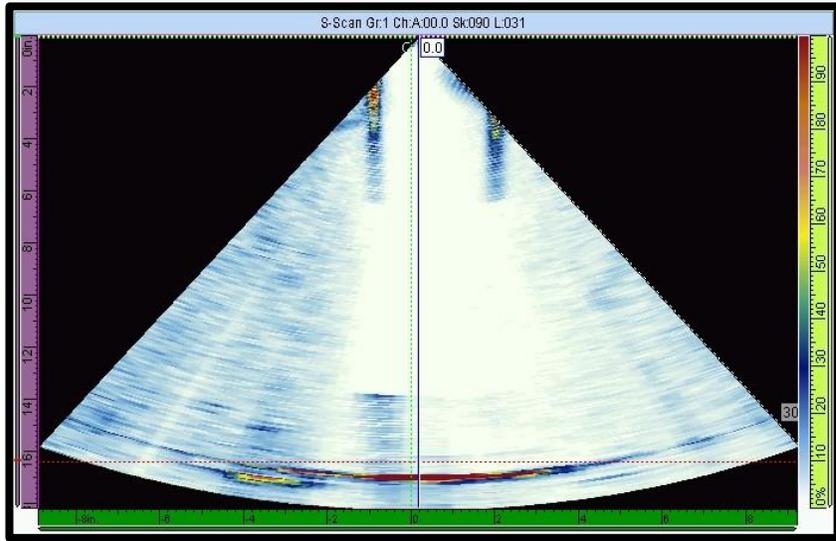
Upper Triple to Spool Bolt A9 45°



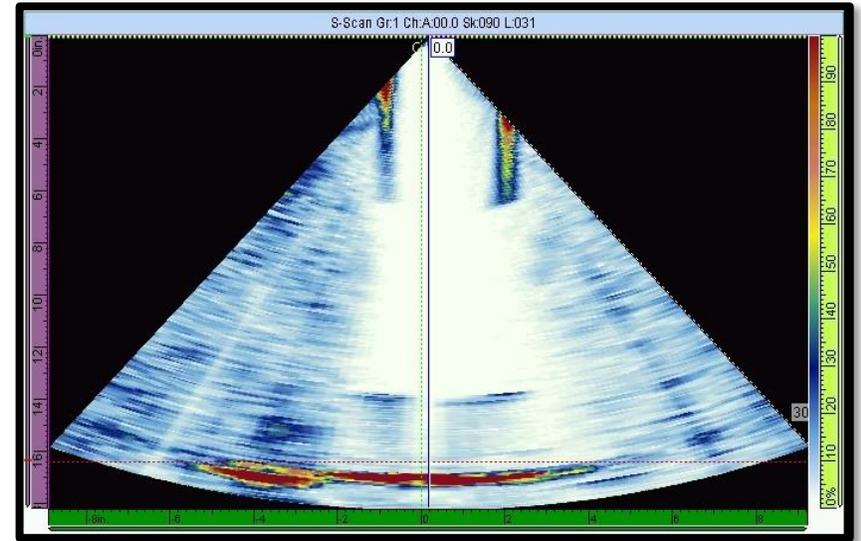
Upper Triple to Spool Bolt A9 90°



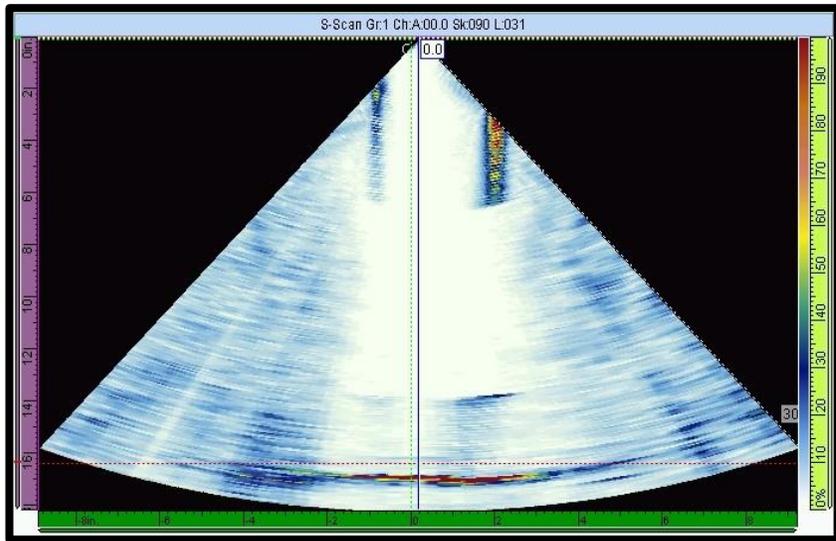
Upper Triple to Spool Bolt A9 135°



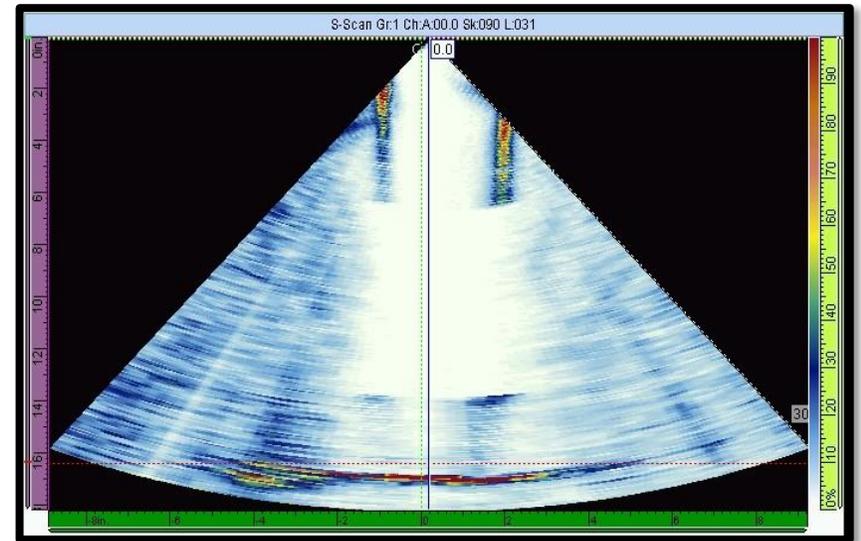
Upper Triple to Spool Bolt A10 0°



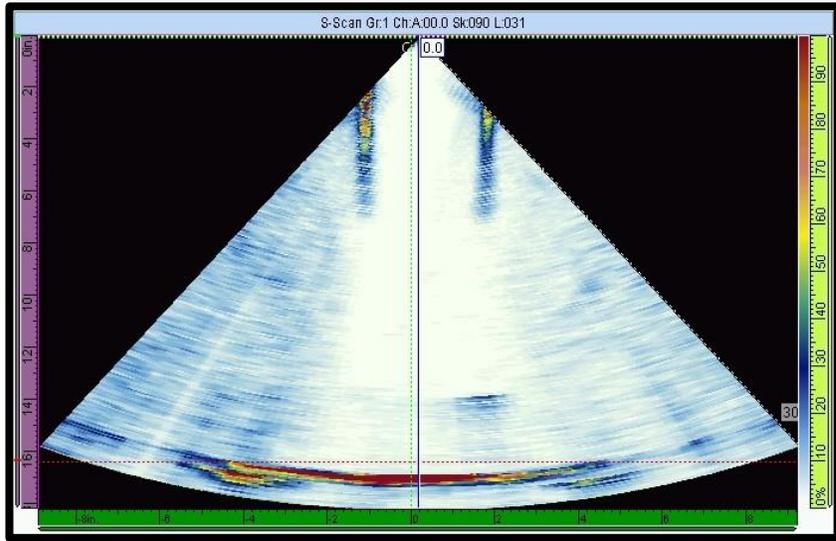
Upper Triple to Spool Bolt A10 45°



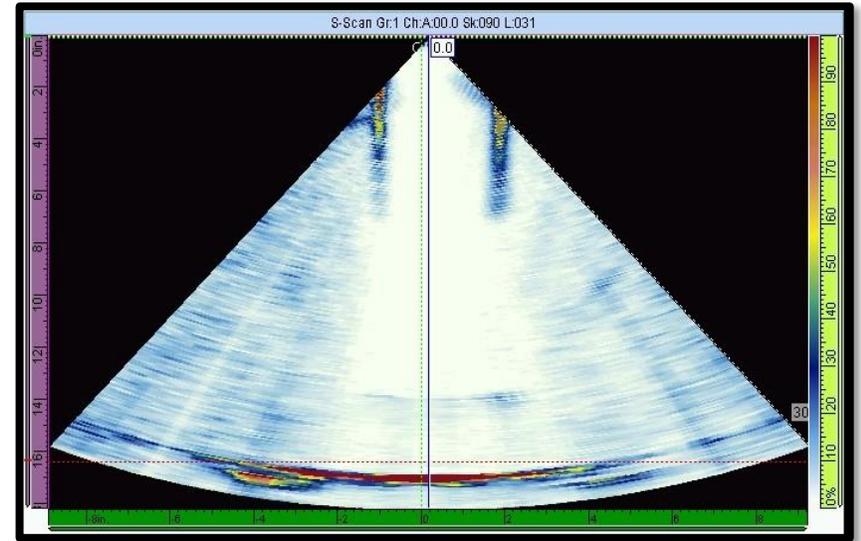
Upper Triple to Spool Bolt A10 90°



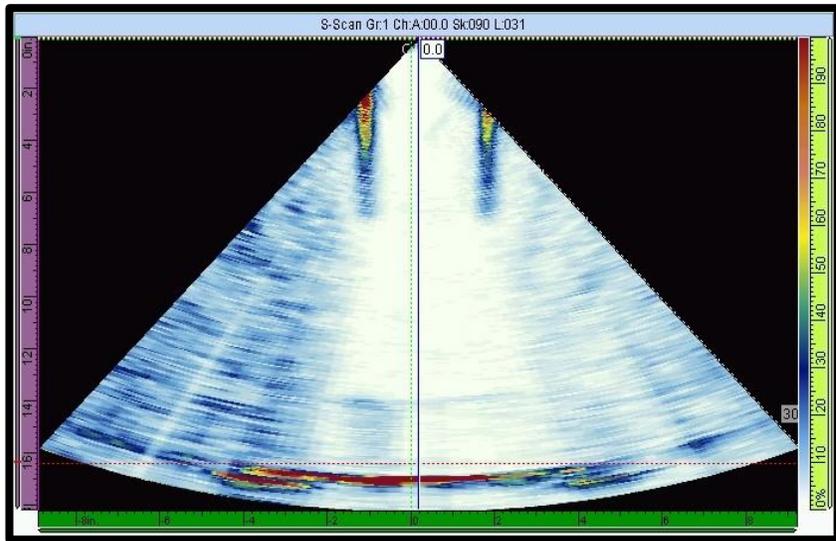
Upper Triple to Spool Bolt A10 135°



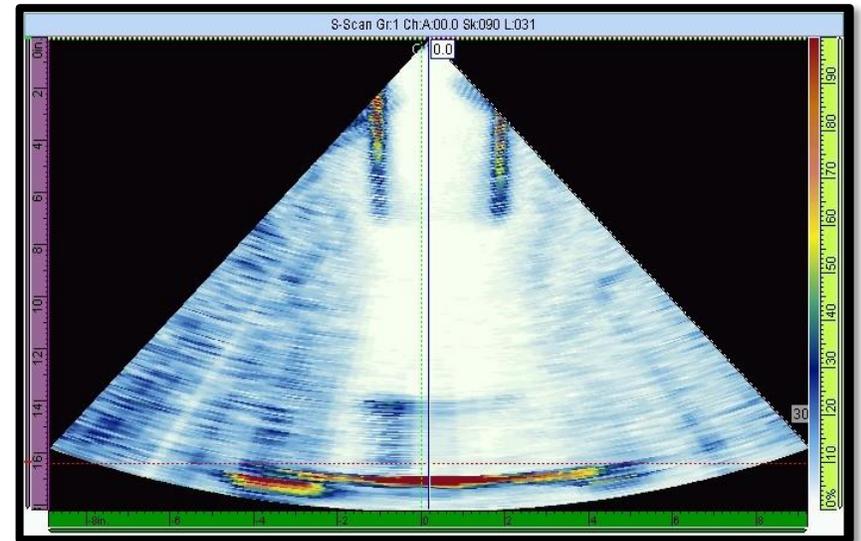
Upper Triple to Spool Bolt A11 0°



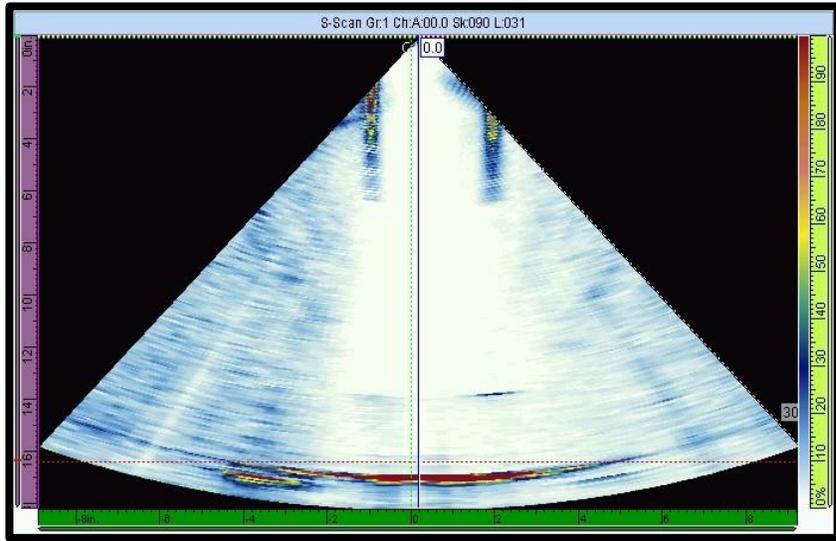
Upper Triple to Spool Bolt A11 45°



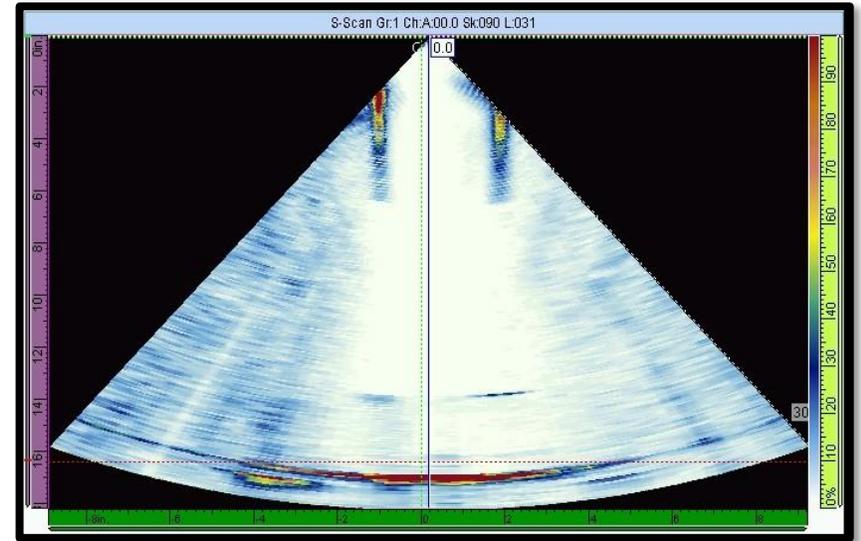
Upper Triple to Spool Bolt A11 90°



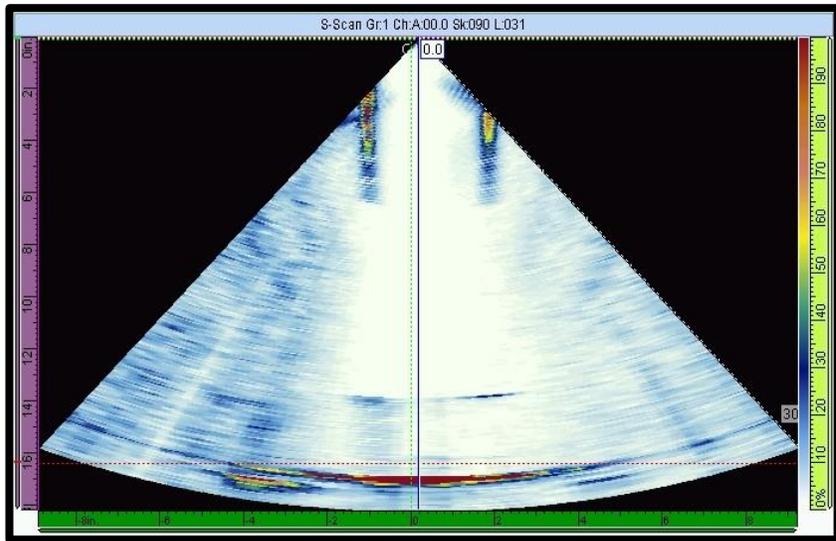
Upper Triple to Spool Bolt A11 135°



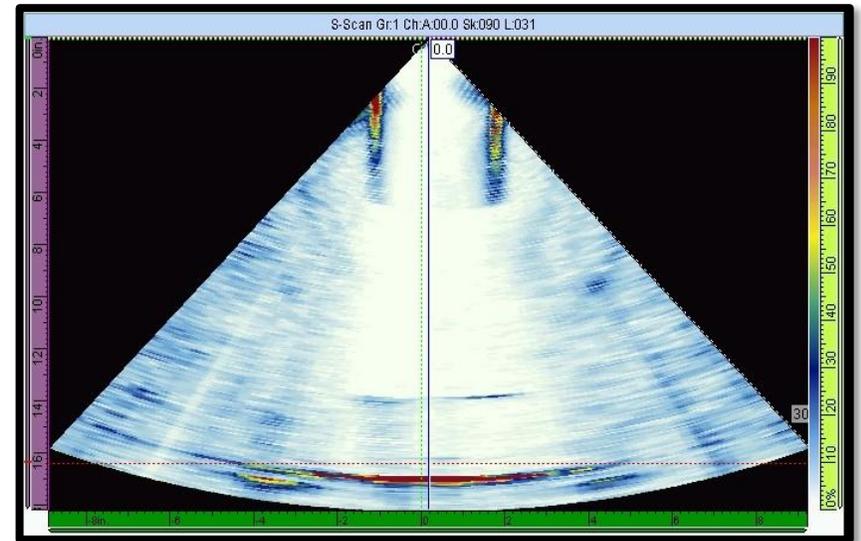
Upper Triple to Spool Bolt A12 0°



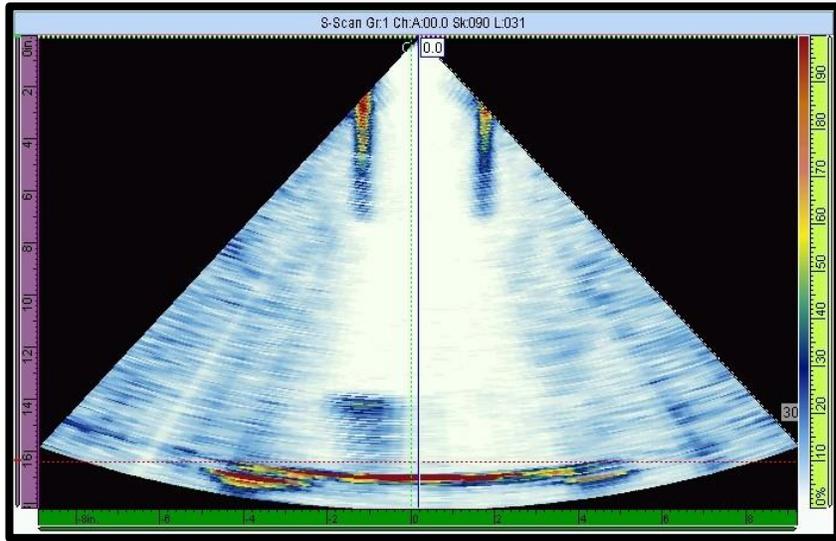
Upper Triple to Spool Bolt A12 45°



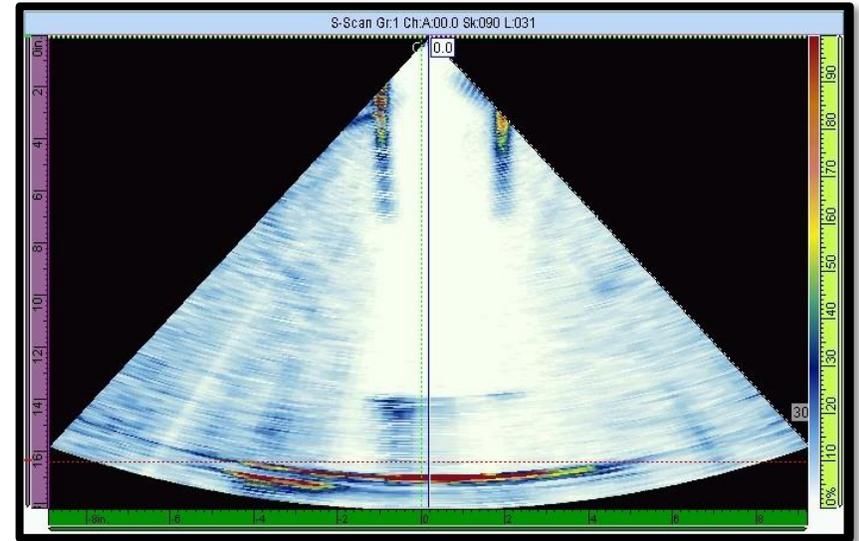
Upper Triple to Spool Bolt A12 90°



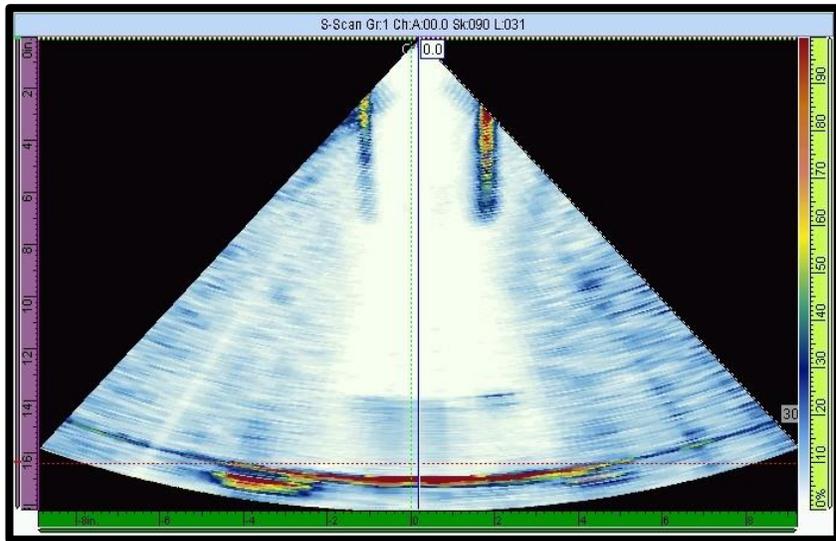
Upper Triple to Spool Bolt A12 135°



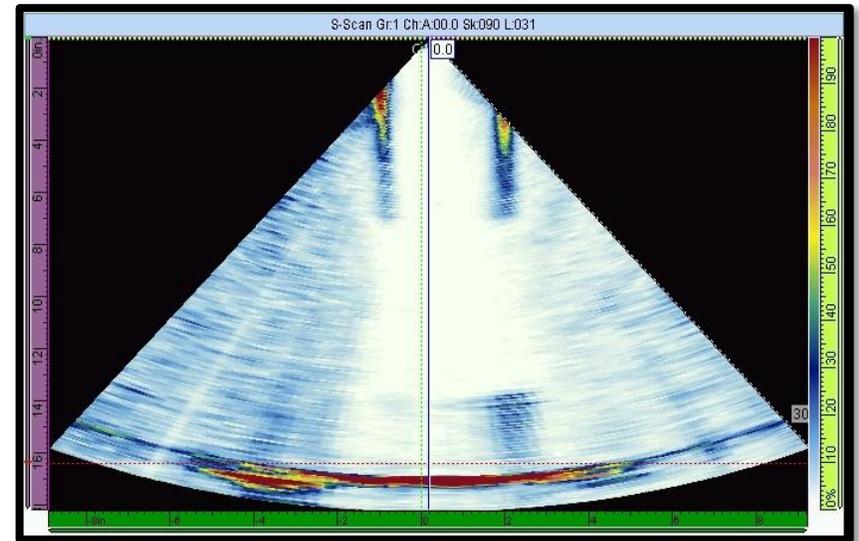
Upper Triple to Spool Bolt A13 0°



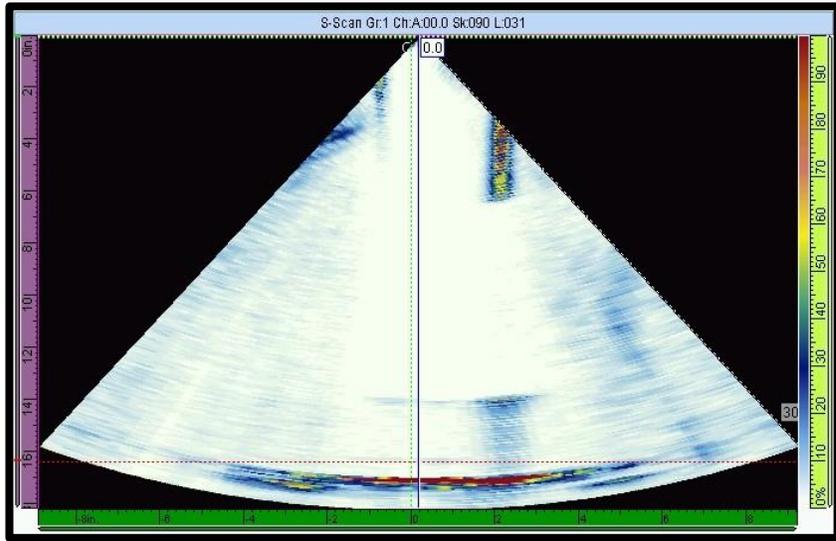
Upper Triple to Spool Bolt A13 45°



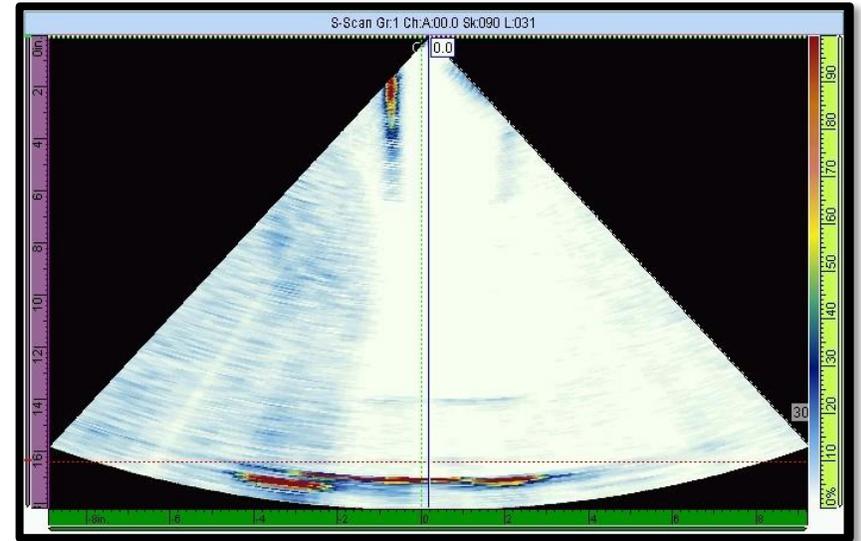
Upper Triple to Spool Bolt A13 90°



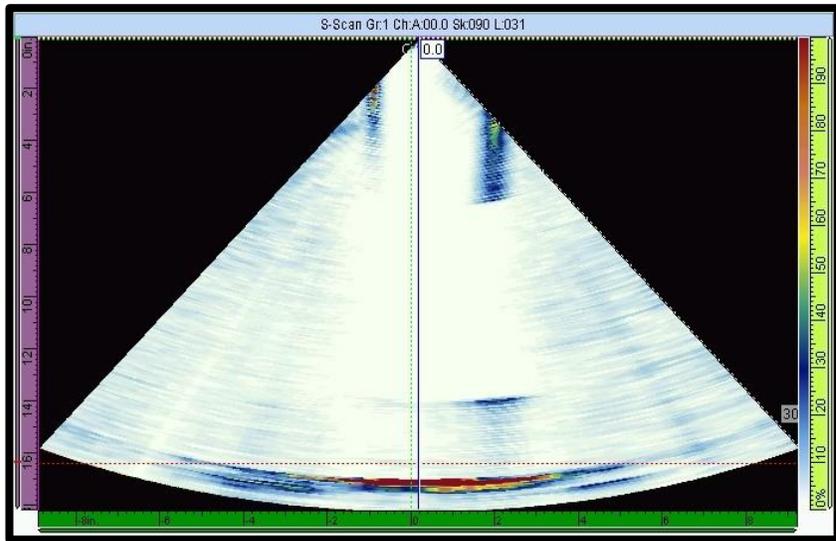
Upper Triple to Spool Bolt A13 135°



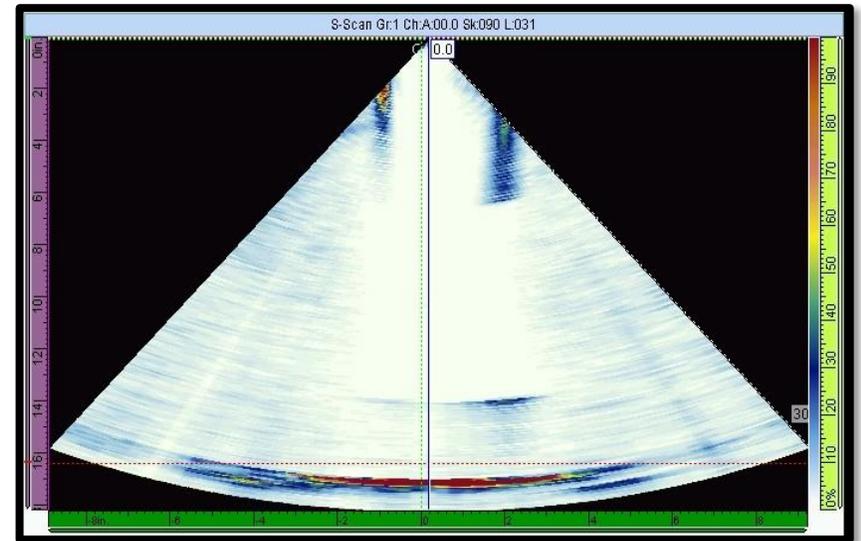
Upper Triple to Spool Bolt A14 0°



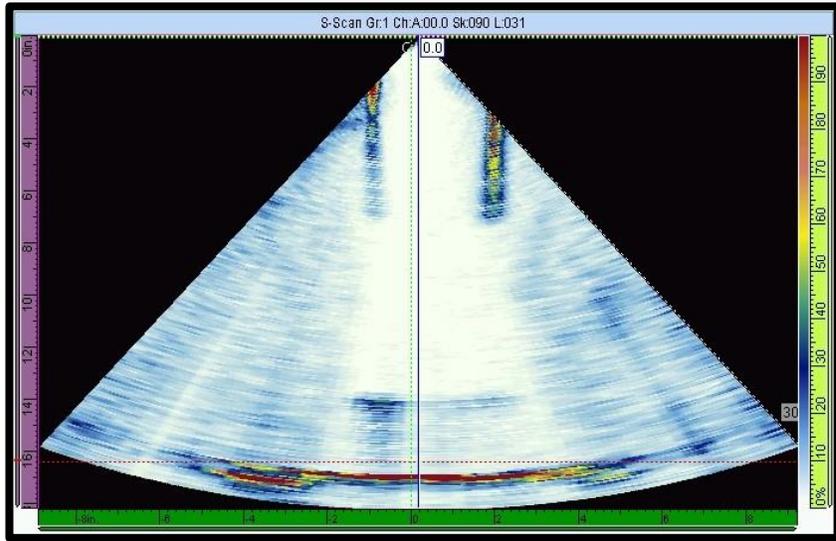
Upper Triple to Spool Bolt A14 45°



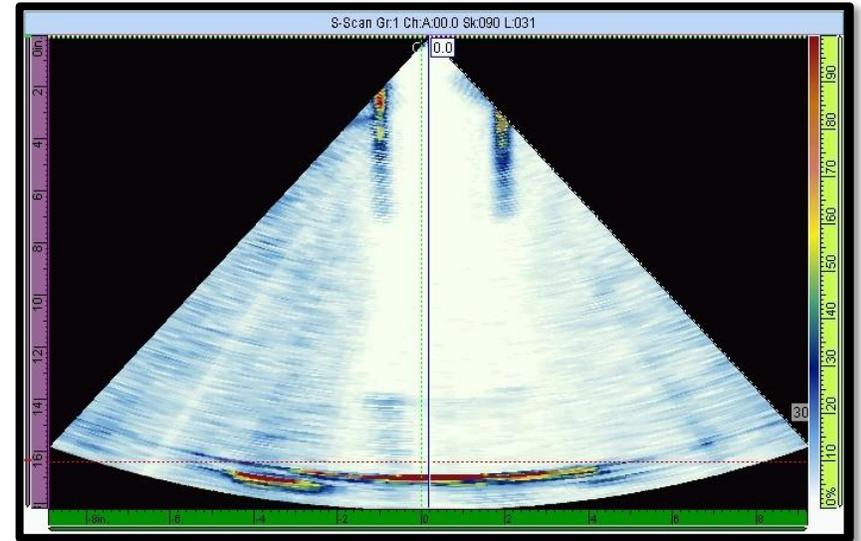
Upper Triple to Spool Bolt A14 90°



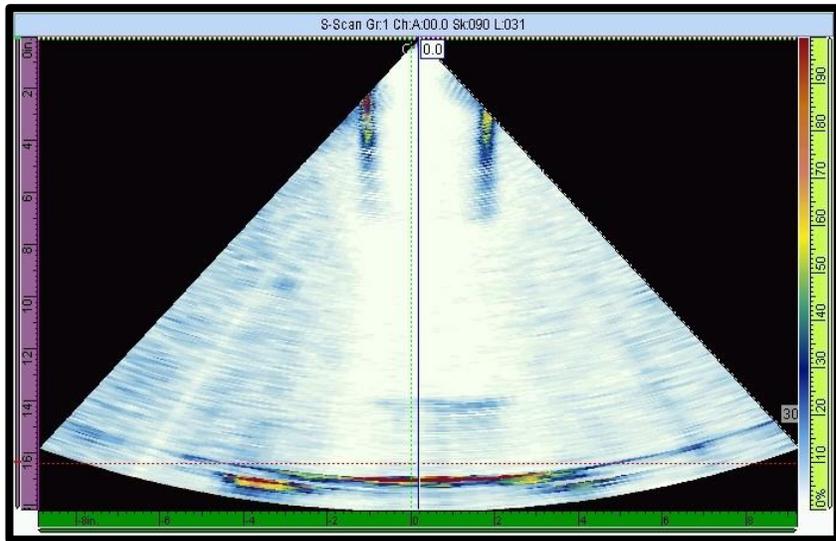
Upper Triple to Spool Bolt A14 135°



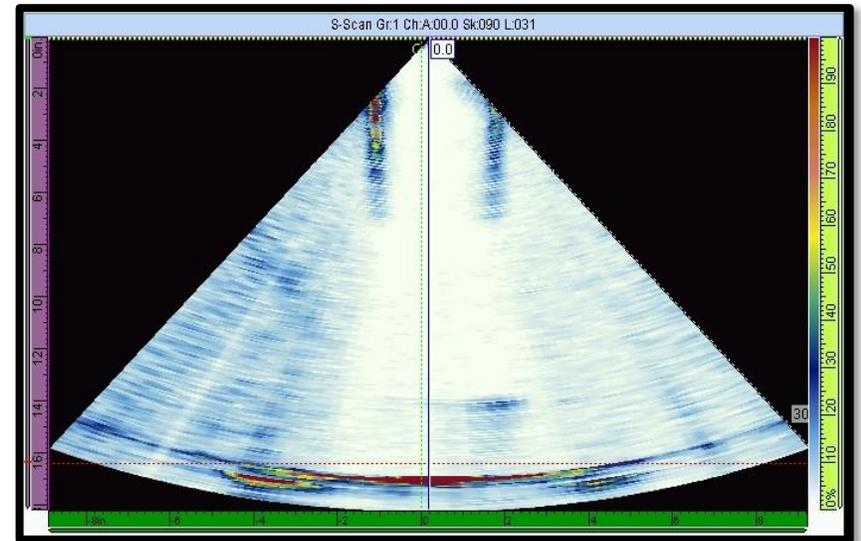
Upper Triple to Spool Bolt A15 0°



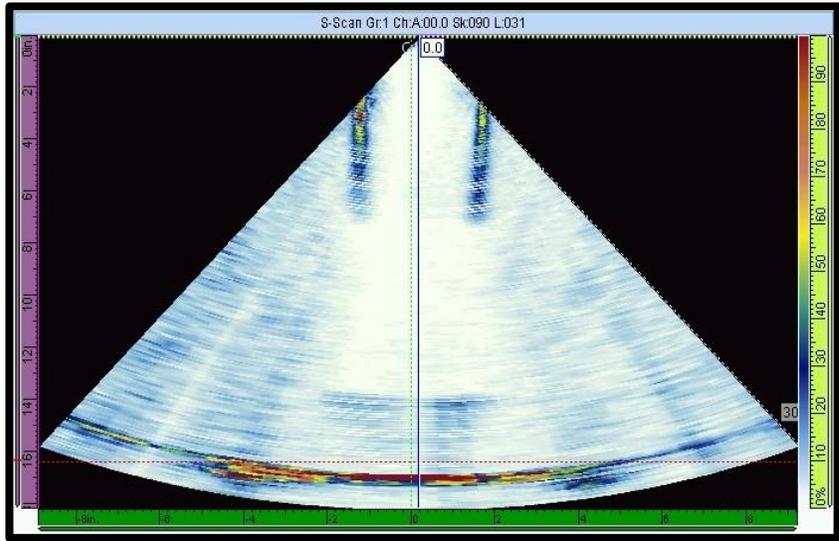
Upper Triple to Spool Bolt A15 45°



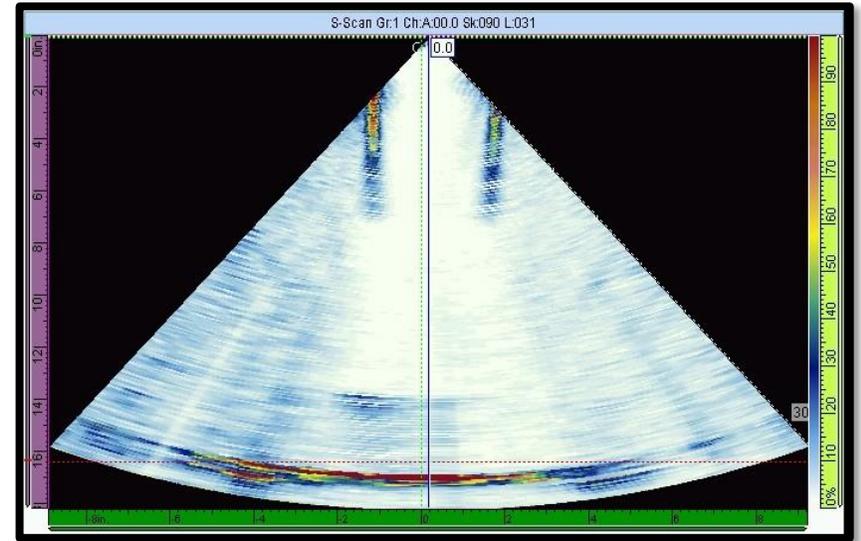
Upper Triple to Spool Bolt A15 90°



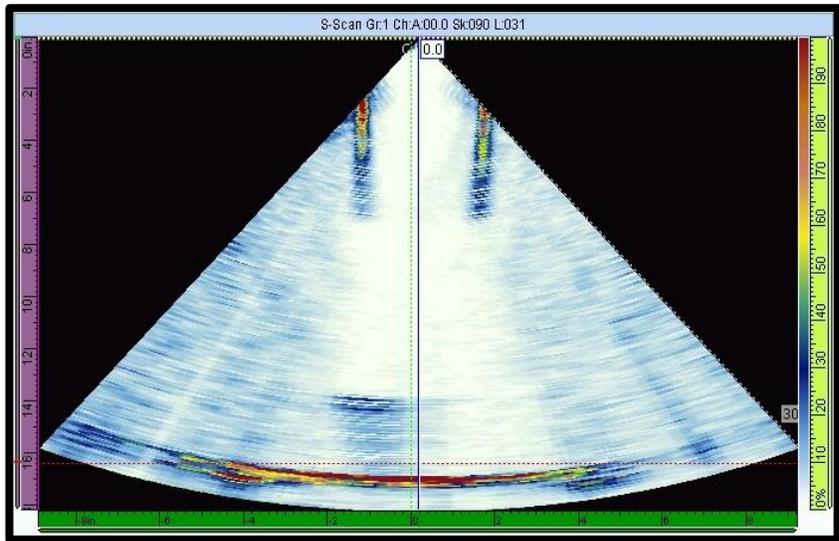
Upper Triple to Spool Bolt A15 135°



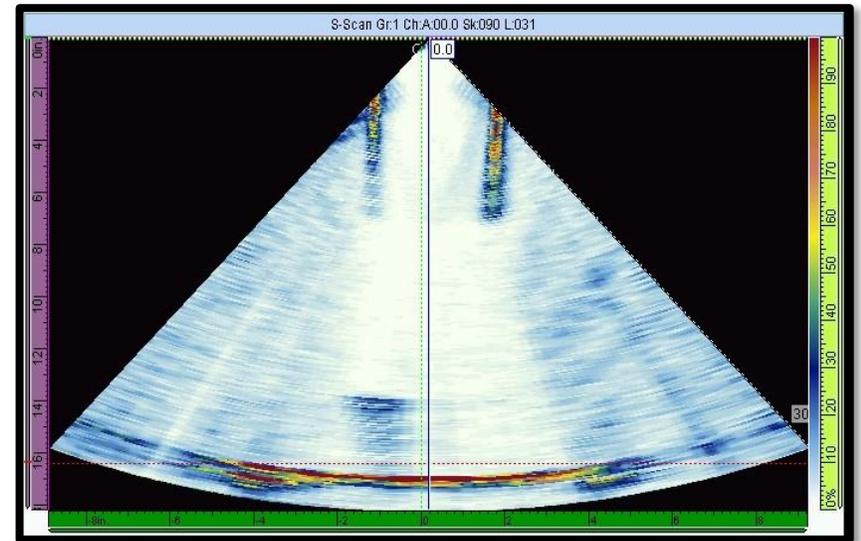
Upper Triple to Spool Bolt A16 0°



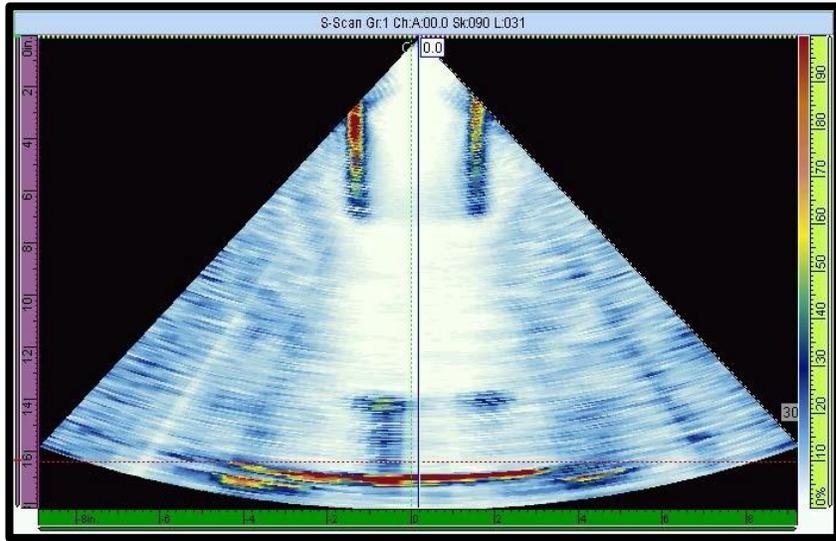
Upper Triple to Spool Bolt A16 45°



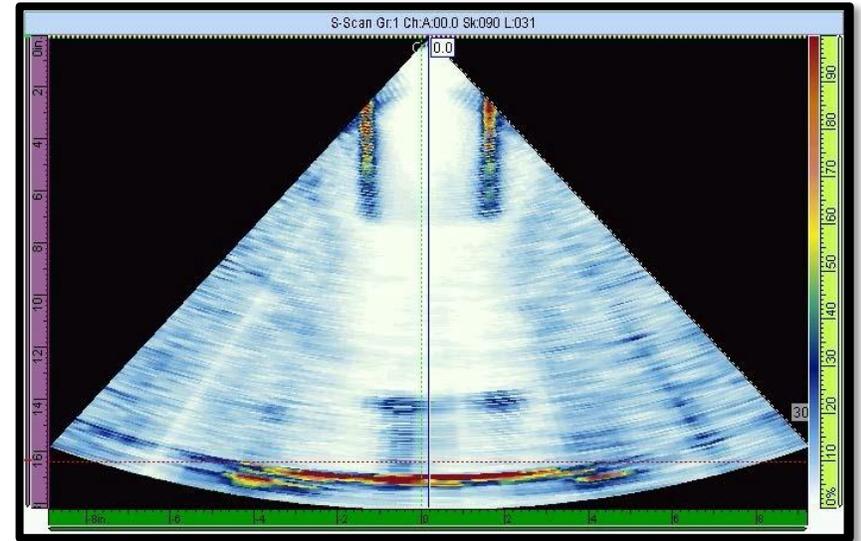
Upper Triple to Spool Bolt A16 90°



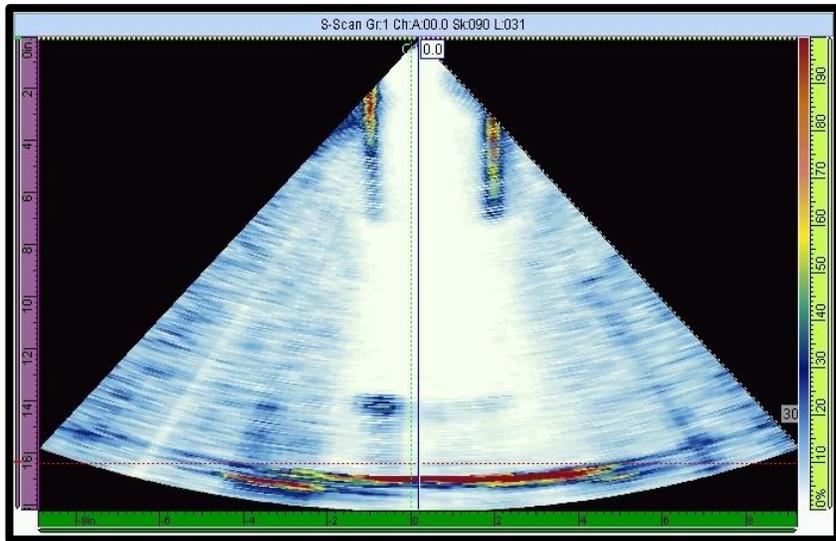
Upper Triple to Spool Bolt A16 135°



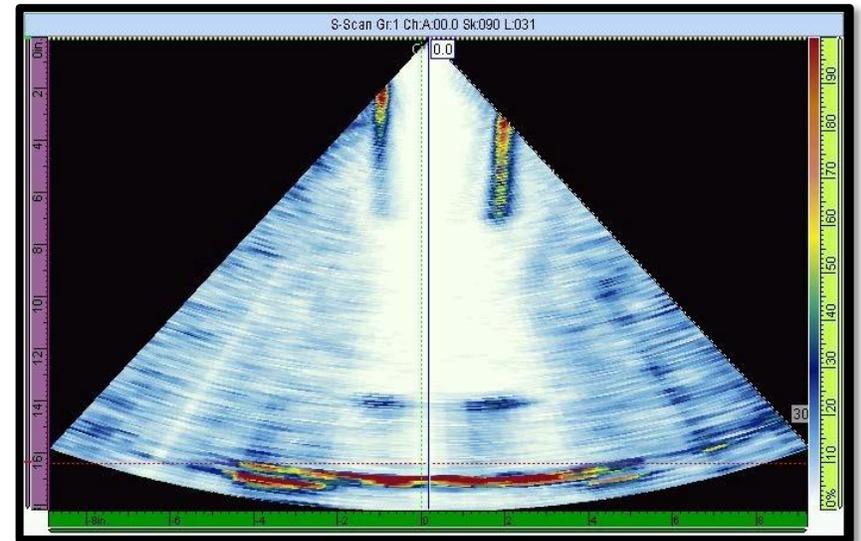
Upper Triple to Spool Bolt A17 0°



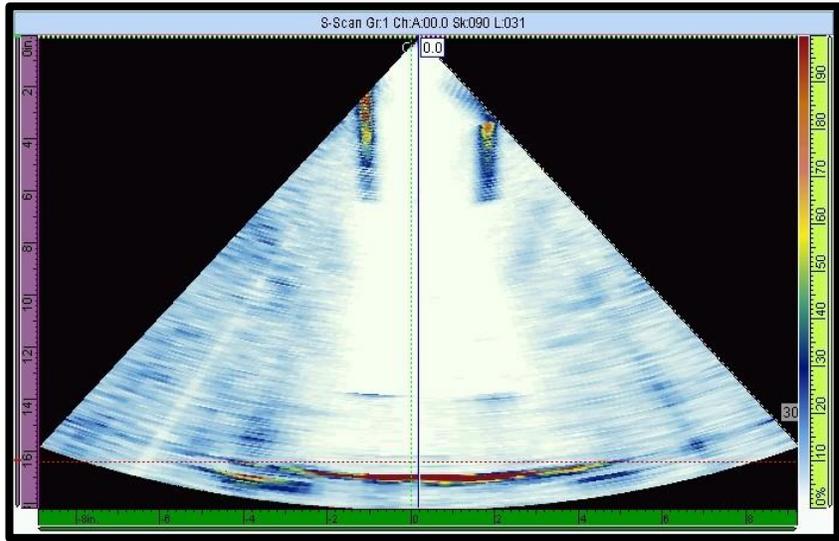
Upper Triple to Spool Bolt A17 45°



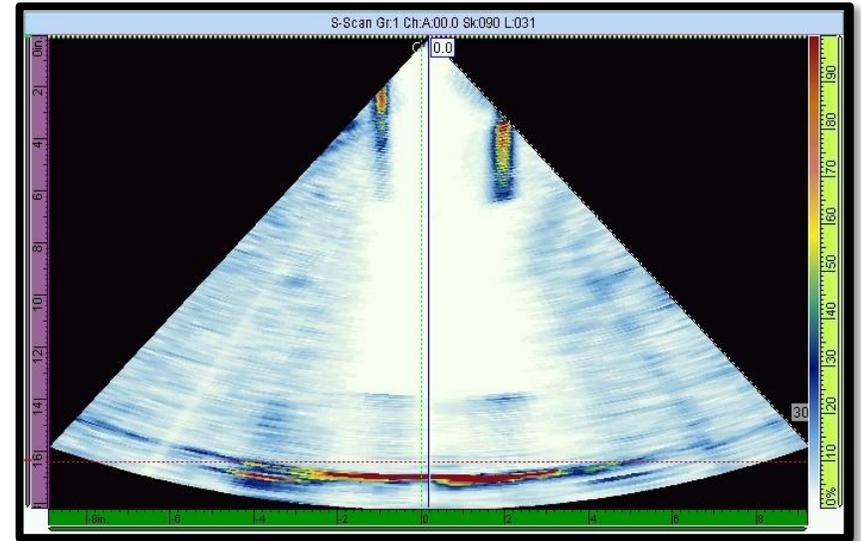
Upper Triple to Spool Bolt A17 90°



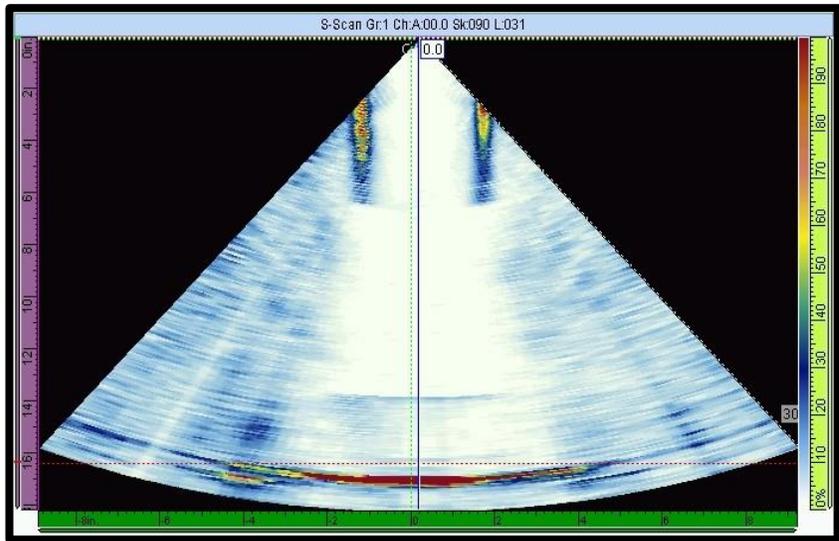
Upper Triple to Spool Bolt A17 135°



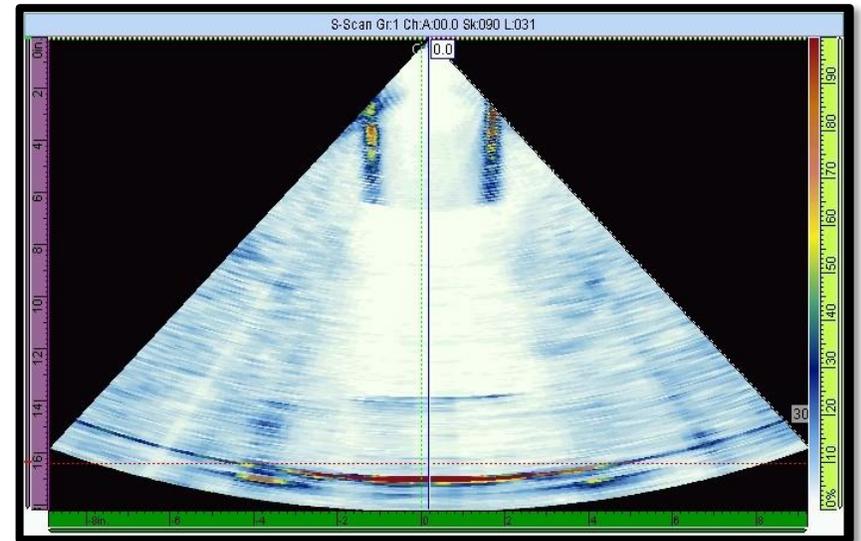
Upper Triple to Spool Bolt A18 0°



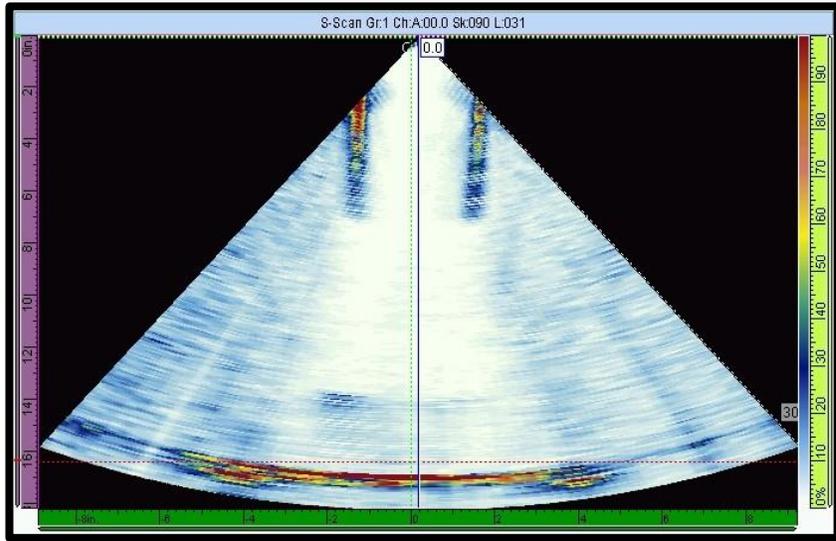
Upper Triple to Spool Bolt A18 45°



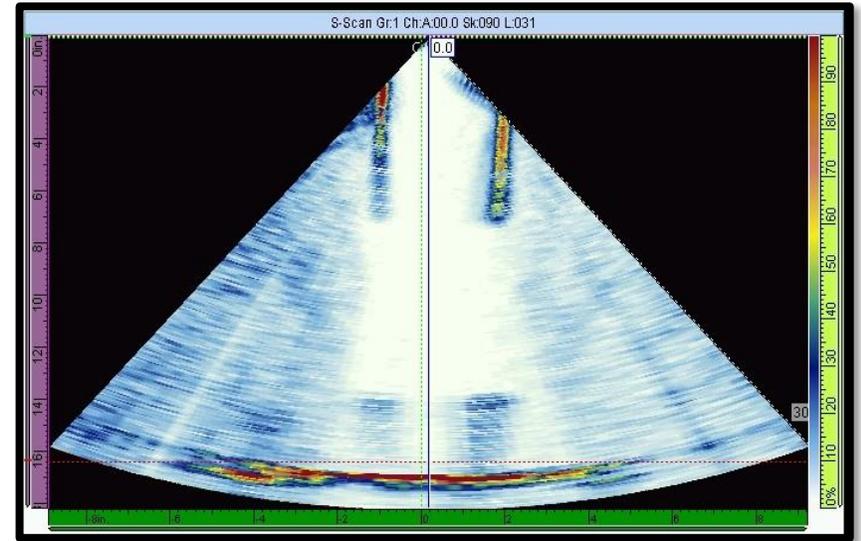
Upper Triple to Spool Bolt A18 90°



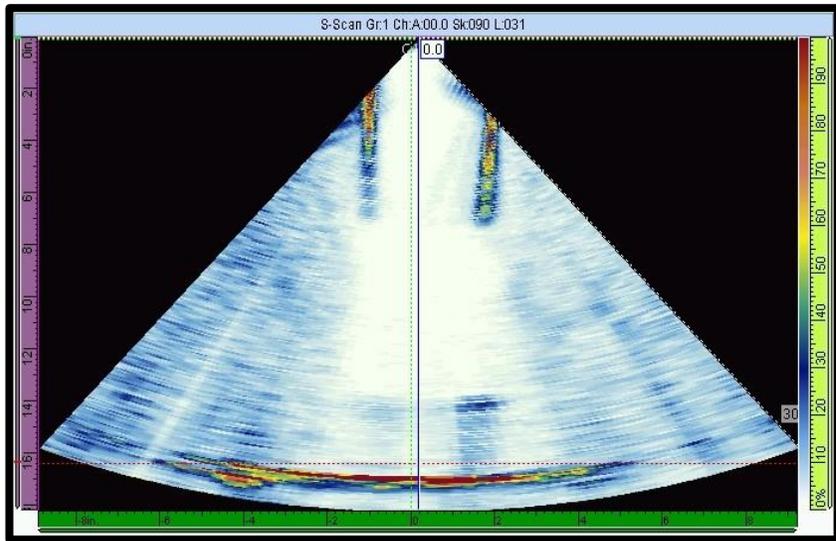
Upper Triple to Spool Bolt A18 135°



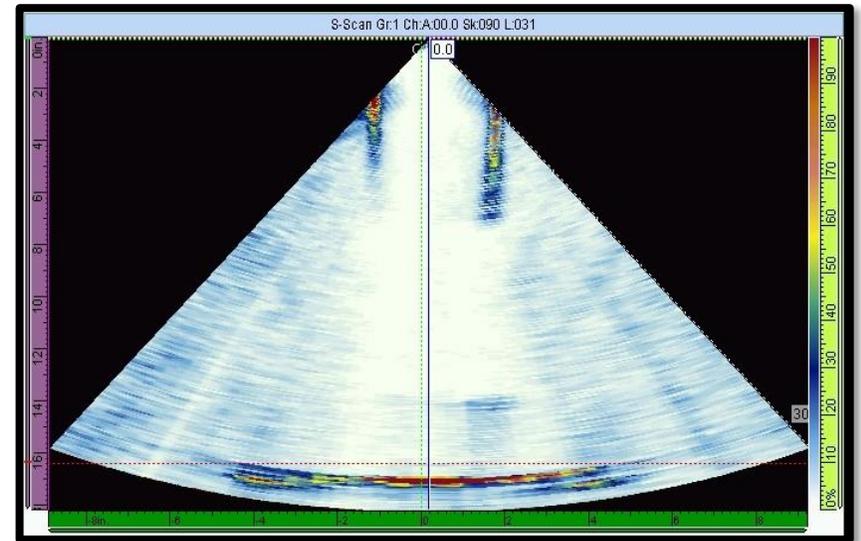
Upper Triple to Spool Bolt A19 0°



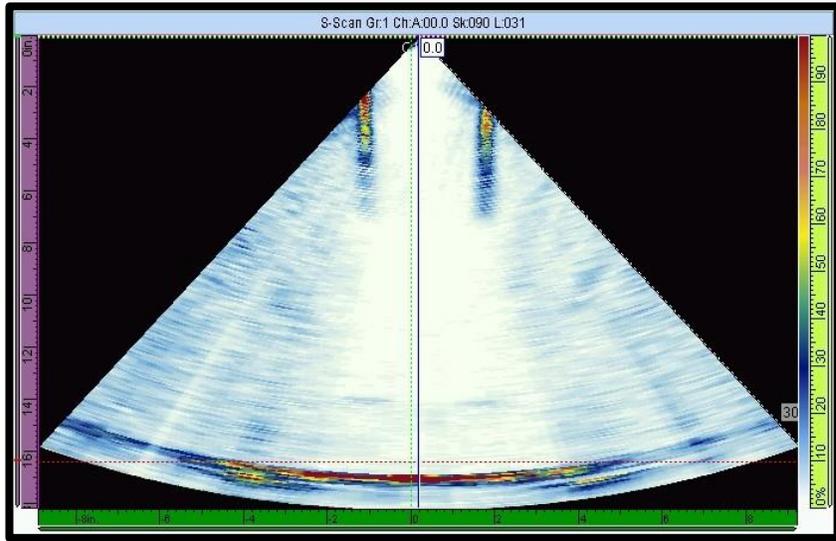
Upper Triple to Spool Bolt A19 45°



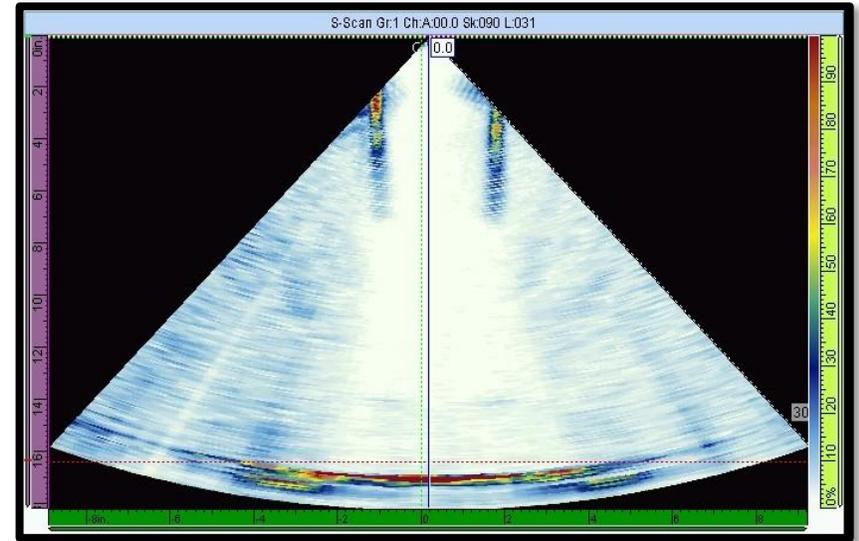
Upper Triple to Spool Bolt A19 90°



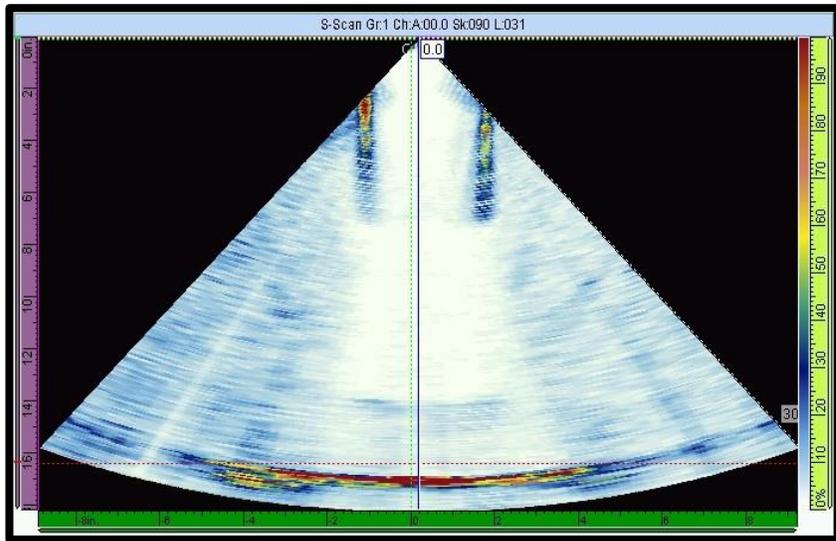
Upper Triple to Spool Bolt A19 135°



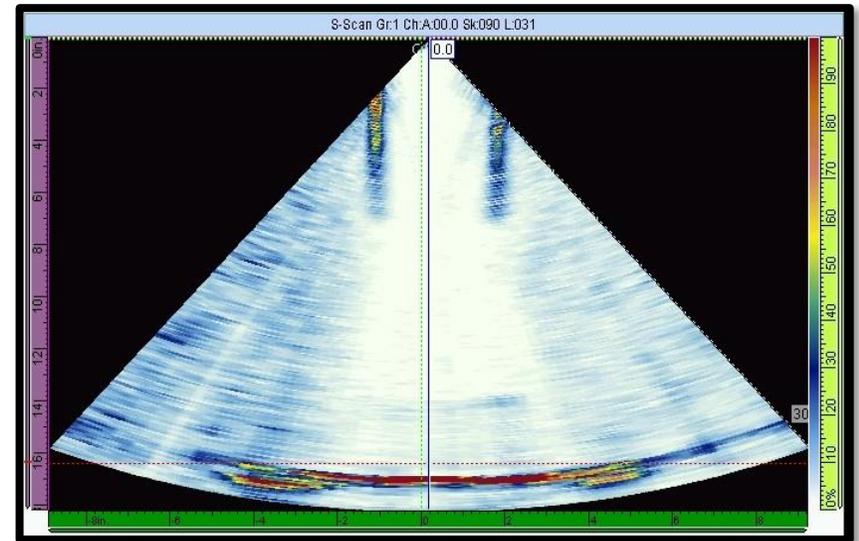
Upper Triple to Spool Bolt A20 0°



Upper Triple to Spool Bolt A20 45°



Upper Triple to Spool Bolt A20 90°



Upper Triple to Spool Bolt A20 135°