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<b>Question By</b>	Farr, Dan (Houston)			
<b>Category</b>				
<b>Investigation Title</b>	Blind Shear Ram Performance - Closed by Surface Control			
<b>Team Lead</b>	Farr, Dan (Houston)			
<b>Assigned To</b>	Florence, Even (DWH Proj)			
<b>Associated Root Cause Diagram Ref.</b>				
<b>Area of Investigation</b>	Horizon blind shear ram capabilities and function.			
<b>Investigation Actions</b>	1. Closed by surface control <ul style="list-style-type: none"> <li>o Normal control [regulated pressure]                         <ul style="list-style-type: none"> <li>■ ST Locks activated                                 <ul style="list-style-type: none"> <li>■ ST Lock System failure, hydraulic or mechanical Ref. #326</li> <li>■ insufficient pressure to shear and seal Ref. # 326</li> <li>■ exceeded design criteria</li> </ul> </li> <li>o High pressure shear activated?                                 <ul style="list-style-type: none"> <li>■ insufficient pressure to shear and seal Ref. # 326 &amp; 287</li> <li>■ mechanical failure of ram block   <ul style="list-style-type: none"> <li>■ outside/inside flow</li> </ul> </li> <li>■ Loss of surface control</li> <li>■ exceeded design criteria Ref. # 222   <ul style="list-style-type: none"> <li>■ Shearing capability Ref. # 32</li> </ul> </li> </ul> </li> <li>o External intervention [ROV]                                 <ul style="list-style-type: none"> <li>■ ROV intervention panel</li> <li>■ Autoshear trigger Ref #391</li> <li>■ hose connection by ROV</li> </ul> </li> </ul> </li> </ul>			
<b>Method of Investigation</b>	Revived available documentation/information, discussed with Transocean personnel.			
<b>Evidence / Doc. Support</b>				
<b>Documents Used</b>	API Spec 16A, 2nd edition (not attached due to copyright issues) Doc 00009945 DWH FS Assist Removal Model (1) Doc 00009490 Left BOP and LMRP SN1007042 Image. WKPROD 00000019 BOP Sub C daily log (Doc-00003667)			
<b>Summary of Investigation</b>	This issue is covered under multiple BOP tickets. 1. Closed by surface control - Most likely closed by AMF <ul style="list-style-type: none"> <li>o Normal control [regulated pressure] - Most likely closed by AMF</li> <li><input type="checkbox"/> ST Locks activated - They were found to be locked</li> <li><input type="checkbox"/> ST Lock System failure, hydraulic or mechanical Ref. #326- It appears that the locks did function. During the stack investigation at Michoud, it was originally thought that the upper shear ram would not open due to a locked and/or mechanically stuck ST Lock. The locks had been subjected to 5500 psi during the post incident work while the stack was still on bottom. This is 2500 psi above their rating working pressure and possibly damaged them. The ST Locks were later learned to be in the full unlocked position, meaning that something else kept the upper shear ram from opening (obstructions behind the rams were found to be the issue).</li> <li><input type="checkbox"/> insufficient pressure to shear and seal Ref. # 326 - The pipe was sheared but a complete seal was apparently not obtained.</li> <li><input type="checkbox"/> exceeded design criteria - The rams actually functioned within their design requirements. There are no design requirements in API Specification 16A for the shear rams to shear drill pipe with pressure inside the pipe or to close and seal under flowing well conditions. The API 16A design requirements are all in static conditions.</li> <li>o High pressure shear activated? Moot point since the rams were closed and did shear the pipe.</li> <li><input type="checkbox"/> insufficient pressure to shear and seal Ref. # 326 &amp; 287 - The pipe was sheared.</li> <li><input type="checkbox"/> mechanical failure of ram block - While there was damage to both blades visible in the bore camera videos, and later confirmed by visual inspection, it does not appear that there was a complete mechanical failure of the rams or the blades prior to them suffering pressure/flow washing. More may be learned during the forensic analysis.</li> <li><input type="checkbox"/> outside/inside flow - there was considerable release of pressure and flow from the drill pipe at the moment of shear which undoubtedly adversely effected sealing.</li> <li><input type="checkbox"/> Loss of surface control - Since the rams did close, any loss of control would have occurred later and would not be an issue here.</li> <li><input type="checkbox"/> exceeded design criteria Ref. # 222 - The rams actually functioned within their design requirements. There are no design requirements in API</li> </ul>			

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Exhibit No. \_\_\_\_\_  
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Specification 16A for the shear rams to shear drill pipe with pressure inside the pipe or to close and seal under flowing well conditions. The API 16A design requirements are all in static conditions.

□ Shearing capability Ref. # 32 – this ticket includes worst case possible shear pressures. It has now been seen that the 5-1/2" drill pipe in the wellbore had considerably cracking in the area sheared by the casing shear rams indicating that the pipe material was brittle. Brittle pipe is easier to shear than ductile pipe, therefore, the estimated shear pressures in ticket 32 could be high for this pipe.

BSR External intervention (ROV)  
 • ROV intervention panel.

The BOP ROV intervention panel combined the BSR (SHR Ram Close) and ST-Lock to lock function within a single ROV 17H female stab port as per hydraulic schematic Doc 00009945. DWH FS Assist Removal Model (1) and image Doc-00009490. This arrangement was a modification from original supplied: reference # 219 item # 20. This modification also included, combining the LPR and the ST-Lock to lock to a single ROV 17H female stab port again, reference Doc-00009945.

• Autoshear trigger Ref #391 - Autoshear trigger was cut but had no effect since the rams were probably already closed. Reference DOC-00012777.

• Hose connection by ROV

The hoses to BSR were never removed or cut during the ROV intervention. Reference WKPROD 00000019.

<b>Findings</b>	See summary of investigation
<b>Recommendations</b>	
<b>Other</b>	
<b>Percent Complete</b>	100%
<b>Investigation Complete (By Assigned To)</b>	Yes
<b>Legal Review Completed</b>	No
<b>Legal Review Completed By</b>	
<b>Investigation Completed Date</b>	
<b>Timeline Update</b>	No
<b>Timeline Updated By</b>	
<b>Team Lead Sign Off</b>	No
<b>Investigation Closed Out</b>	
<b>Completed Date/Time</b>	
<b>Attachments</b>	DOC-00009490 Left BOP and LMRP SN1007 042.JPG DOC-00009945 DWH FS Assist Removal Model (1) rev1.pdf DOC-00012777 BOP Function Timeline Rev3.doc WKPROD-00000019 BOP Sub C Daily Log (DOC-00003667).pdf

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