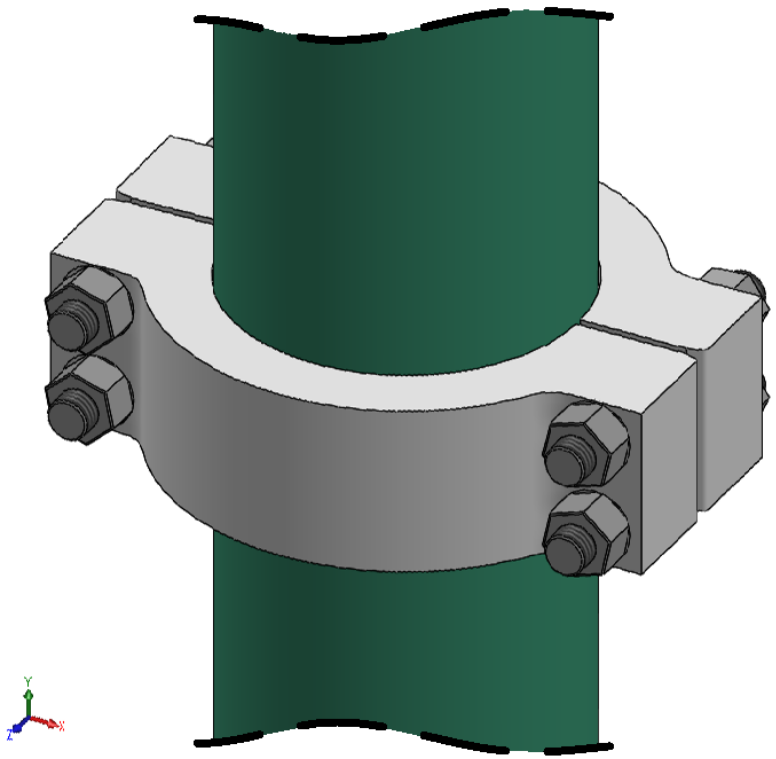
STUDY CASE:

BX-160 RING GASKET ON 13-5/8” 5M API 16A HUB CONNECTION BY USING ABAQUS 6.10-1



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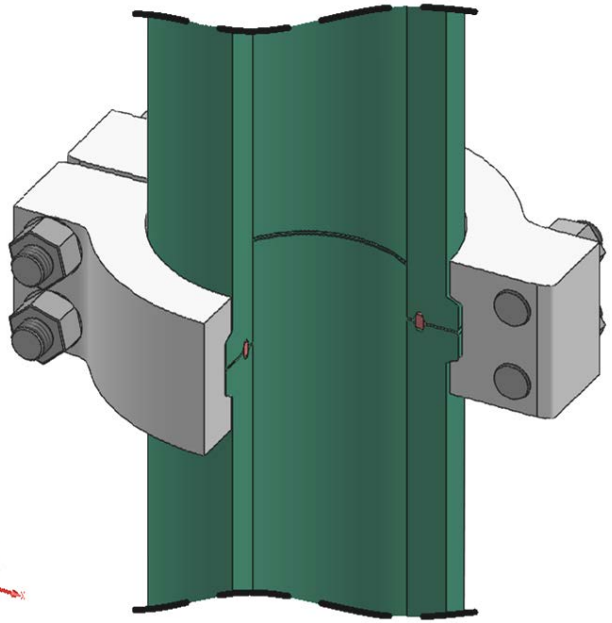
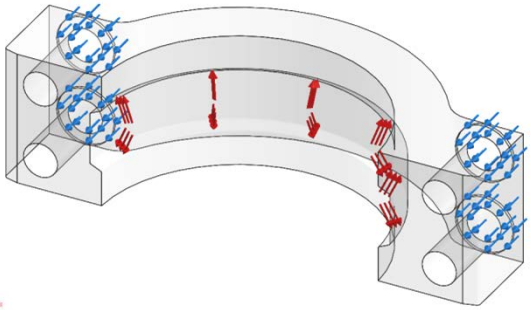
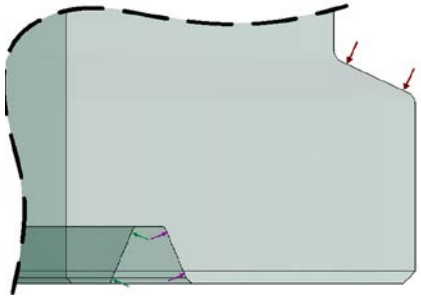
BACKGROUND

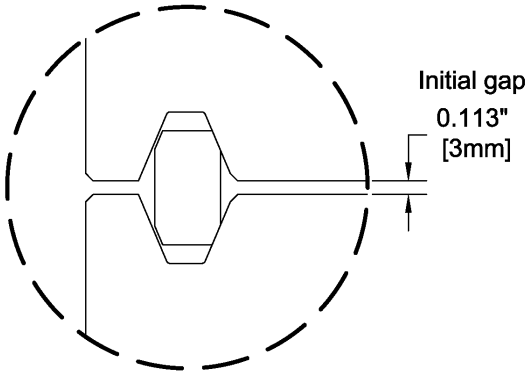
- It was known that 6BX flange / 16BX hub has a face-to-face connection which (intuitively) leaves no visible gap. However, API 6A mention “face-to-face contact is not necessary for proper function of type 6BX flanges” [4] Clause 10.1.2.3.1
- The simulation was done on hub instead of flange connection to verify if the same idea are applicable on hub connection.
- Hub connection make-up process shall be simulated by using finite element software Abaqus/CAE 6.10-1 to see if there’s any gap left after make-up connection.
- The simulation study shall cover:
    1. Sealing capability assurance that was formed after ring gasket compressed.
    2. Validation of any gap between hub bodies once all studs being torque as per recommended value.

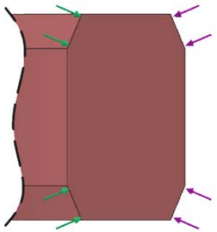
TRANSFER LOAD











4 (four) pieces of Ø2-1/4” stud nut being torque up in accordance with API 6A 20th Edition standard.

All tension load on stud shall be fully transferred through a series of clamp-hub in order to compress the ring gasket.

Initial gap between hub bodies was measured 113mil [3mm] based on layout prior make-up.

INPUT & CONSTRAINT

- The model being generate by using axi-symmetric feature.
- 3 (three) bodies were to simulate the make-up process:

a. 13-5/8” 5M Hub Top Body

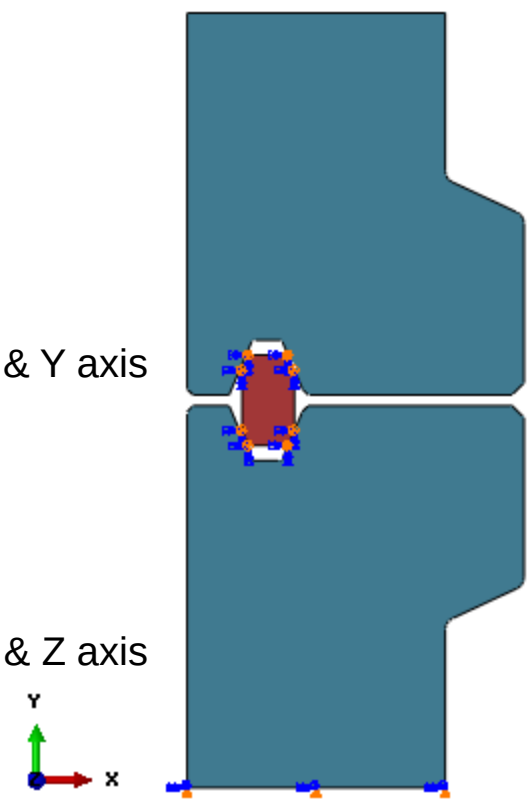
Material : Low Alloy Steel 4130 75k yield
Constraint : -
Connection : contact with gasket taper OD side in initial
Load : Pressure at hub OD taper surface

b. BX-160 Ring Gasket

Material : Austenitic Stainless Steel 316 36k yield
Constraint : restrained at Z axis with no rotation against X & Y axis
Connection : contact at gasket taper OD side
with both hub taper groove profile in initial

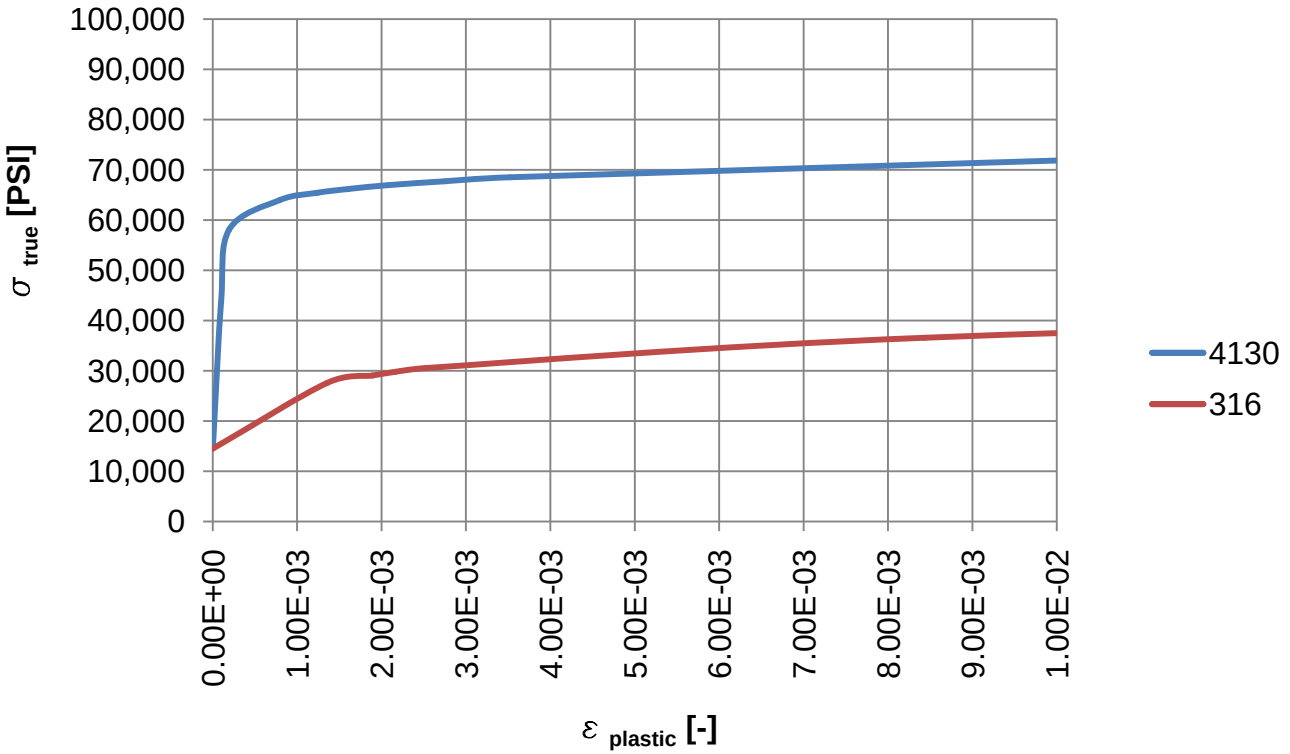
c. 13-5/8” 5M Hub Bottom Body

Material : Low Alloy Steel 4130 75k yield
Constraint : restrained at Y axis with no rotation against X & Z axis
Connection : contact with gasket in initial
Load : Pressure at hub OD taper surface



MATERIAL

- Both material being given plastic parameter instead of elastic to accommodate plastic deformation possibility during simulation.
- Plastic parameter data on each material (true stress vs plastic strain) was generated in accordance with ASME method [1].



LOADING

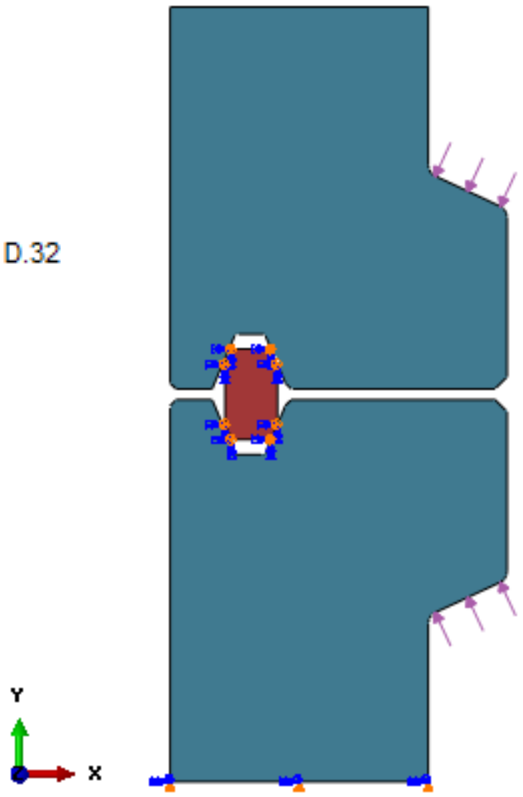
- Loading shall be given in terms of pressure at the hub taper profile. Pressure load was given with consideration all tension load from stud nut shall be fully transferred through clamp up to the hub taper profile.

Input Parameter

Stud tension	[lbf]	186,758	___[4] Annex D Table D.32
Stud quantity	[-]	4	
Hub taper area	[in^2]	46.38	

Pressure load = (186,758 x 4) / (46.38 x 2)

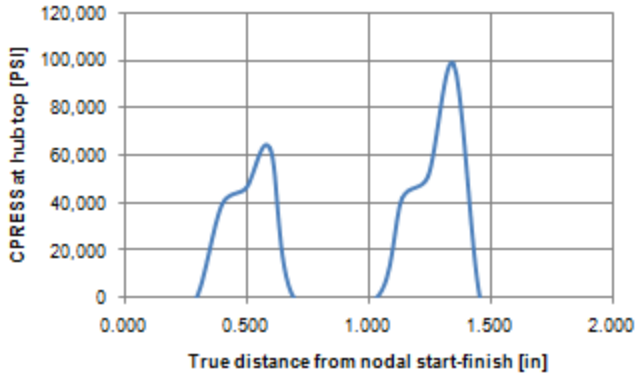
≈ 8,000 [PSI]

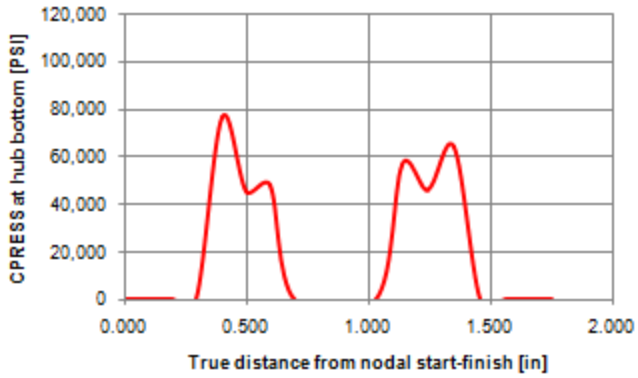


CONTACT PRESSURE

- Sealing capability assurance being verified through contact pressure that formed due to ring gasket compression. The sealing situation is occur when the contact pressure formed is minimum 3 times of the test / working pressure [3].

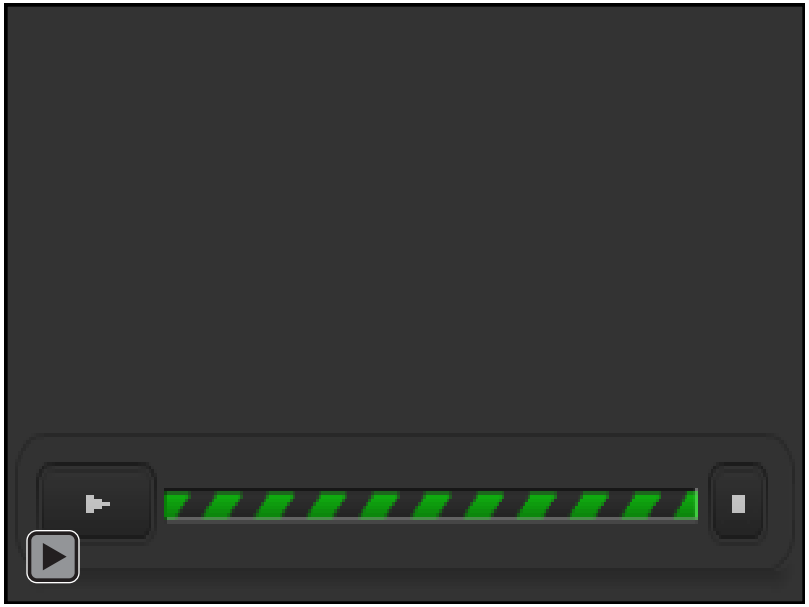
Zoom for better visual



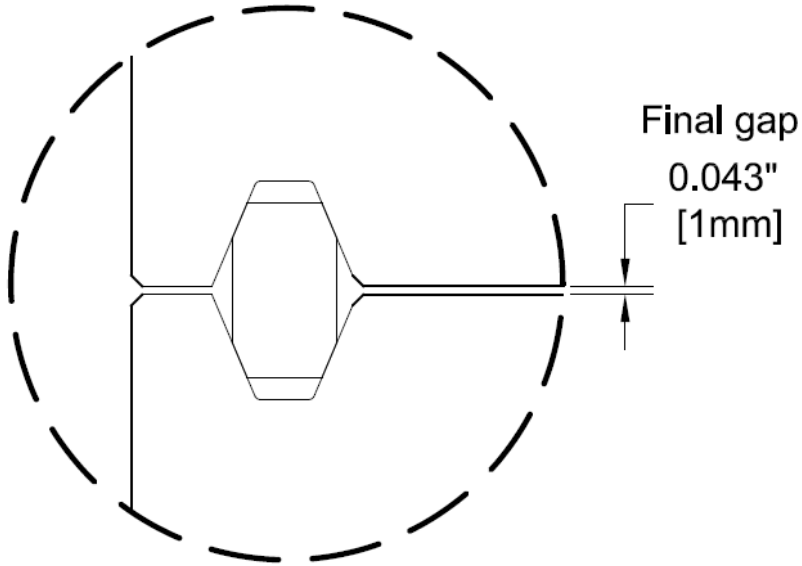


DISPLACEMENT

- Visible gap being verified from magnitude of displacement at the top hub body to how far it will go once gasket being compressed.
- It was found the hub top body travel maximum 70mil against initial position which indicate the initial gap (113mil) was not closed even when gasket has been compressed.

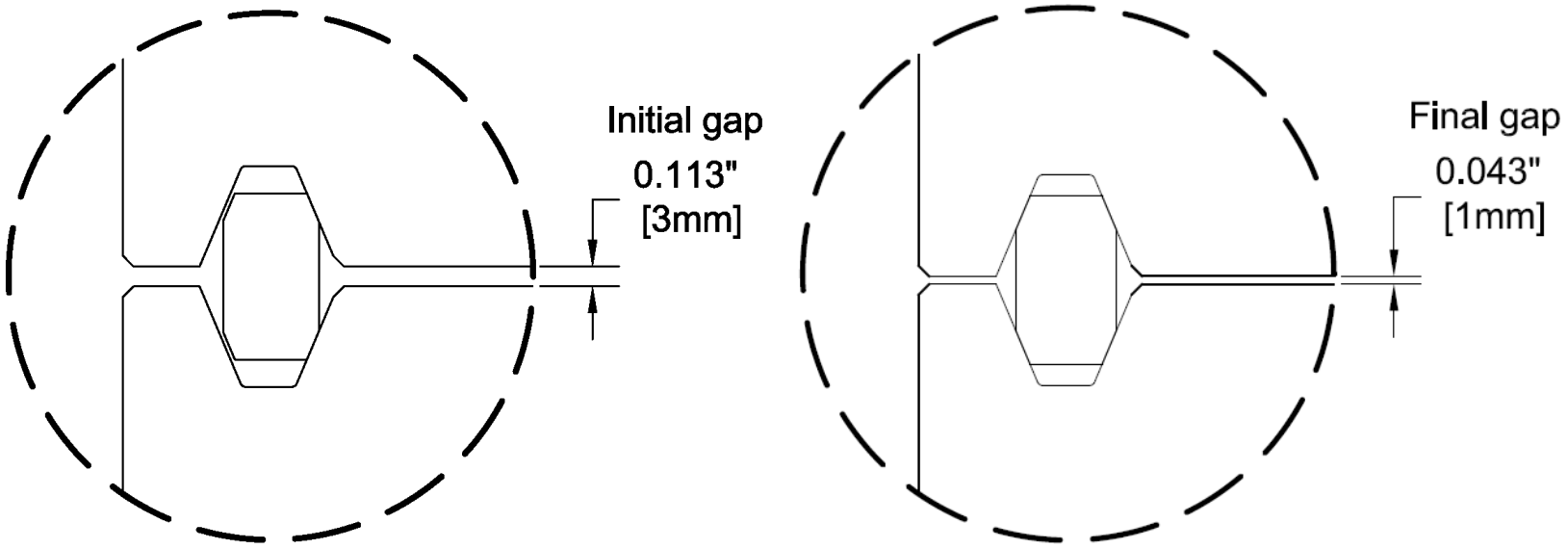


Zoom for better visual



CONCLUSION

- Based on simulation, 16BX hub still leaves visible gap though it is set with recommended torque value.
- Similar idea with 6BX flange connection also applicable where “face-to-face contact is not necessary for proper functioning of type 16BX hub”.
- This idea might reflect the real situation where 16BX hub / 6BX flange connections were installed with brand new ring gasket .



REFERENCE

1. ASME BPVC Section VIII, Division 2, 2013 Edition, Annex 3D
2. Boyer, E. Howard. *Atlas of Stress-Strain Curve*, 2nd Edition. ASM International, 2002.
3. Milberger, L.J.; A. Radl; *"Evolution of Metal Seal Principles and Their Application in Subsea Drilling and Production"*, OTC 6994, presented at the 24th Annual OTC in Houston, Texas, May 4-7, 1992.
4. API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*, 20th Edition, October 2010.
5. API Specification 16A, *Specification for Drill-through Equipment*, 3rd Edition, June 2004.
6. www.azom.com