BOEMRE

Bureau of Ocean Energy Management, Regulation and Enforcement

UNITED STATES DEPARTMENT OF THE INTERIOR

Well Containment Screening Tool

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Well Containment Screening Tool

- A joint industry task force was established to develop an evaluation tool to demonstrate if a well design and equipment is adequate for Well Containment.
- The WCST analyzes the well's mechanical and geologic integrity to determine which of the 3 following categories the well falls into:
  - Full mechanical and geologic integrity
  - Mechanical or geologic integrity not intact, but consequence of failure is acceptable
  - Wellbore integrity does not exist and well cannot be shut-in without hydrocarbons escaping/broaching to sea

Level 1 Screening Tool

- Level 1 is designed to expedite approval for wells that can be fully shut-in without causing underground flow using very conservative assumptions and simple calculations

- The WCST analyzes 2 load cases:
  - Collapse during uncontrolled flow to seafloor.
  - Burst after shut-in with a full hydrocarbon gradient.

BOEMRE Well Containment Screening Tool Example Well
Wellbore Schematic

18-3/4" HP housing @ 5167' RKB (12' AML)
36" LP housing @ 5170' RKB (9' AML)
Mudline @ 5179' RKB (est)

RKB: 81'
Water Depth: 5098'

Top	(angle)	Bottom	CASING Burst	CASING Collapse	MUD PP	MUD MW	MUD FG	CEMENT
			Capping Stack Rating = 15,000 psi Annular (below LMRP) = 10,000 psi BOP = 10,000 psi					
5170' TVD 5170' MD	0 degrees	5479' TVD 5479' MD	Jetted 36" 1.50" WT X80 552.69#		Seawater-Gel			Jet
5167' TVD 5167' MD	0 degrees	7880' TVD 7880' MD	26" hole 8.6 mw TOL 16" 7338' MD 8.6 pp 22" 1.25" WT X80 277.27#		Seawater-Gel 8.6-13 ppg mudline returns			TOC - Mudline 100% excess
			7950 psi	6670 psi	8.6	8.6	12.5	
7338' TVD 7338' MD	0 degrees	14400' TVD 14400' MD	16.5" x 20" hole 11.6 mw 11.2 pp 16" 0.715" WT HC N-80 118#		Synthetic			TOC - 13417' MD HID - 13909' TVD
			6260 psi	5750 psi	11.2	11.6	13.7	
5170' TVD 5170' MD	0 degrees	17438' TVD 17438' MD	14.25" x 17" hole 12.7 mw 12.4 pp 13-5/8" 0.625" WT Q125 88.20# cross over at 11500' TVD 13-3/8" 0.514" WT Q125 72.20#		Synthetic			TOC - 16672' MD HID - 17055' TVD
			10030 psi 13-5/8"	4800 psi				
			8410 psi 13-3/8"	2880 psi	12.4	12.7	14.65	
Weak Zone @ 20589' TVD/MD 17438' TVD 17438' MD	0 degrees	23790' TVD 23790' MD	12.25" hole 12.5 mw 11.1 pp Reservoir 1 - 23246' TVD Pore Pressure = 11.1 ppg Flowing = 0.280 psi/ft Static = 0.375 psi/ft		Synthetic			
					11.1	12.5		

Level 1 Acceptance Criteria

Screening tool results	
5. Shut in Pressure below formation integrity when well shut-in	PASS
6.1 Burst Integrity	PASS
6.2 Trapped annuli check	PASS
6.3 Collapse Integrity	PASS

- If a well does not pass all 4 of the above level 1 criteria than a level 2 is required for that hole interval

Level 2 Screening Tool

Level 2 WCST:

- Uses field/offset data and more advanced calculations to mitigate the probability of the failures identified in level 1.
  - Fluid gradient analysis
- If the failure cannot be mitigated/eliminated than a consequence analysis is performed to see if failure is acceptable
  - Broaching analysis

Level 2 is based on the Level 1 WCST, with the following modified/additional calculations:

- Annulus pressure buildup for trapped annuli
- Secondary string collapse and burst verification
- Formation strength verification for failed strings

Fluid Gradient Analysis

- BOEMRE's internal process for handling well specific fluid gradient requests in a level 2 WCST:
  - Company supporting documentation is sent to RE
  - RE determines the most appropriate analog well
  - RE runs nodal analysis to determine flowing and static gradients
  - RE gradient package and Operator's gradient package are reviewed by upper management
  - A decision is made based on the more conservative set of gradient numbers

Broaching analysis

- BOEMRE internal procedures for conducting broaching studies:
  - Operator submits there broaching analysis
  - RE reviews location for known natural seeps
  - RE reviews latest seismic data looking for path for hydrocarbons to take to broach to seafloor (faults, along salt face)
  - RE determines the probability of broaching

Examples of Common Mistakes on the WCST

1. Collapse/burst ratings in WCST not matching the ratings in the ewell permit

Interval Number: 4	Type: Casing	Name: Intermediate						
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth (ft)		Pore Pressure (ppg)
						MD	TVD	
1	14.000	113.0	TN-110	11000	8132	6292	6292	14.2
2	13.625	88.2	HCQ - 125	10030	6400	21515	21475	14.2

Collapse Ananlysis Component description	Collapse rating (psi)	Depth of interest (ft TVD)	Hydraulic Isolation Depth (ft-TVD)	Annulus Pressure Buildup (psi)	Setting MW, or PP (ppg)
14" 113.00 P110 TH-523 - X-Over	6400	6304	20,483	440	14.1
13-5/8" 88.20 Q125HC SLX @ Mid String	6400	13540	20,483	440	14.1
13-5/8" 88.20 Q125HC SLX @ HID	6400	20483	20,483	0	12.8
13-5/8" 88.20 Q125HC SLX @ 13-5/8"shoe	6400	21475	20,483	0	13.1

Examples of Common Mistakes on the WCST

2. Incorrect casing setting depths (mistaking MD for TVD, using old wellbore schematic)

Interval Number: 4	Type: Casing	Name: Intermediate						
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth (ft)		Pore Pressure (ppg)
						MD	TVD	
1	14.000	113.0	TN-110	11000	8132	6292	6292	14.2
2	13.625	88.2	HCQ - 125	10030	6400	21515	21475	14.2

Enter string type	String or liner lap fully cemented?	Liner lap <= 500 ft?	Setting Depth (ft-MD)	Setting Depth (ft-TVD)	Planned TOC (ft-MD)	Planned TOC (ft-TVD)	Previous Shoe Depth (ft-MD)	Max Angle above previous shoe	Idle < 1 year?	Hydraulic Isolation Depth	
										ft-MD	ft-TVD
Casing	N	N	21,475	21,575	19,450	19,450	18,800	0	Y	20,463	20,483

Examples of Common Mistakes on the WCST

3. Changing formulas in the screening tool

		Below HID	Above Hydraulic Isolation Depth				Un-trapped Annulus Calcs			
Depth of interest (ft TVD)	Hydraulic Isolation Depth (ft-TVD)	Pore Pressure @ Depth (ppg)	Previous Shoe Depth (ft-TVD)	Fracture Gradient @ Previous Shoe (ppg)	Setting Mud Weight (ppg)	Internal Pressure (psi)	External Pressure (psi)	Collapse Load (psi)	Design Factor	Comments
18250	18,250	13.4	15,500.00	16.5	14.8	5,033	=IF(C73,I+56F(C73<=D73,F73'G73'0.052+(C73-F73)'H73'0.052,C73'E73'0.052),0)			

Examples of Common Mistakes on the WCST

4. Changing fluid gradients and assumptions on level 1

HOLE SECTION:	10-5/8"		SHOE DEPTH(FT-TVD):		27,200			
	Depth (ft-TVD)	Reservoir Fluid	Reservoir Pressure or Bottom hole Flowing Pressure (ppg)	Reservoir Pressure or Bottom hole Flowing Pressure (psi)	Assumed fluid gradient for calc (psi/ft)	Mud Line Shut in Pressure (psi)	Shut in ppg @ shoe	Comments
	29,284	Oil	14.086	21,450	0.369	13,169	14.62	Justification for gradient is provided as attachment.
				-		-	-	Used average of shut-in (0.369) and flowing (0.364) gradients
				-		-	-	obtained with Prosper simulation.

Enter string type	String or liner lap fully cemented?	Liner lap <= 500 ft?	Setting Depth (ft-MD)	Setting Depth (ft-TVD)	Planned TOC (ft-MD)	Planned TOC (ft-TVD)	Previous Shoe Depth (ft-MD)	Max Angle above previous shoe	Idle < 1 year?	Hydraulic Isolation Depth ft-MD	Hydraulic Isolation Depth ft-TVD	Trapped Annulus?
Tieback	N	N	22,862	22,862	19,500	19,500	18,020	0	Y	21,181	19,000	LEVEL 2 REQUIRED
Liner	N	Y	23,993	23,993	23,200	23,200	22,862	0	Y	23,597	23,597	LEVEL 2 REQUIRED
Liner	N	Y	26,617	26,350	25,617	25,531	23,993	35	Y	26,117	25,941	NO
										-		N/A

Examples of Common Mistakes on the WCST

5. Not running APB models for tiebacks/trapped annuli

APB calculator for Untrapped Annulus	OH Weak pt (ft TVD)	Setting MW (ppg)	FG at weak pt (ppg)	Calculated APB (psi)	Level 2 Alternative APB (psi)	Comments / justification of alternative APB used	Standard A Annulus ass FG at the pr
String							
16" Liner	9,000	12.1	13.3	562			
14"/13-5/8" Casing	12,000	12.9	14.0	686	7,250	APB Pressure modeled in Wellcat	

<<Insert additional rows as necessary for other zones of interest and copy down formulas - do NOT delete this line

Collapse Analysis Component description	Collapse rating (psi)	Depth of interest (ft TVD)	Hydraulic Isolation Depth (ft-TVD)	Annulus Pressure Buildup (psi)	Setting MW, or PP (ppg)	Internal Pressure (psi)	External Pressure (psi)	Collapse Load (psi)	Design Factor	Comment
14" Casing	8,650	6,280	13,255	686	12.7	2,613	4,833	2,220	3.89	APB Pressure modeled in Wellcat
13-5/8" Casing (13,255')	5,930	13,255	13,255	686	12.7	3,659	9,440	5,780	1.02	13-5/8" Casing fails at single point (13,255')
13-5/8" Casing (6,300')	5,930	6,280	13,255	686	12.7	2,613	4,833	2,220	2.67	Entire 13-5/8" string collapses

Examples of Common Mistakes on the WCST

6. Not submitting data to justify well specific gradient

10-5/8"	SHOE DEPTH(FT-TVD):		27,200							
Depth (ft-TVD)	Reservoir Fluid	Reservoir Pressure or Bottom hole Flowing Pressure (ppg)	Reservoir Pressure or Bottom hole Flowing Pressure (psi)	Assumed fluid gradient for calc (psi/ft)	Mud Line Shut in Pressure (psi)	Shut in ppg @ shoe	Comments				
29,284	Oil	14.086	21,450	0.369	13,169	14.62	Used average of shut-in (0.369) and flowing (0.364) gradients obtained with Prosper simulation.				
			-		-	-					
			-		-	-					

Examples of Common Mistakes on the WCST

7. Incorrect mud weights used above/below the HID
   - Incorrect version (MW is used below HID)

Collapse rating (psi)	Depth of interest (ft TVD)	Hydraulic Isolation Depth (ft-TVD)	Annulus Pressure Buildup (psi)	Setting MW, or PP (ppg)	Internal Pressure (psi)	External Pressure (psi)	Collapse Load (psi)	Design Factor
8,650	6,280	13,255	686	12.7	2,613	4,833	2,220	3.89
5,930	14,000	13,255	686	12.7	3,771	9,932	6,161	0.96
5,930	6,280	13,255	686	12.7	2,613	4,833	2,220	2.67

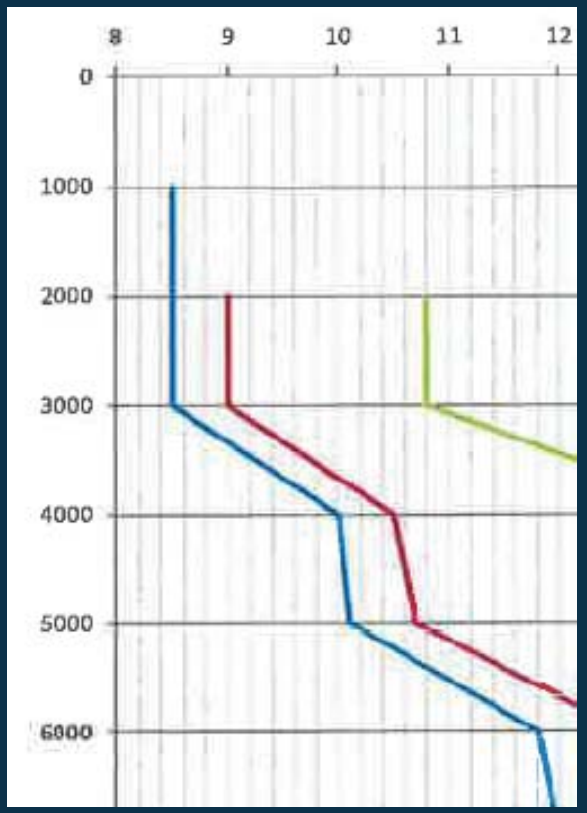
   - Correct version (PP is used below HID)

Collapse rating (psi)	Depth of interest (ft TVD)	Hydraulic Isolation Depth (ft-TVD)	Annulus Pressure Buildup (psi)	Setting MW, or PP (ppg)	Internal Pressure (psi)	External Pressure (psi)	Collapse Load (psi)	Design Factor
8,650	6,280	13,255	686	12.7	2,613	4,833	2,220	3.89
5,930	14,000	13,255	0	12.4	3,771	9,027	5,256	1.12
5,930	6,280	13,255	686	12.7	2,613	4,833	2,220	2.67

Examples of Common Mistakes on the WCST

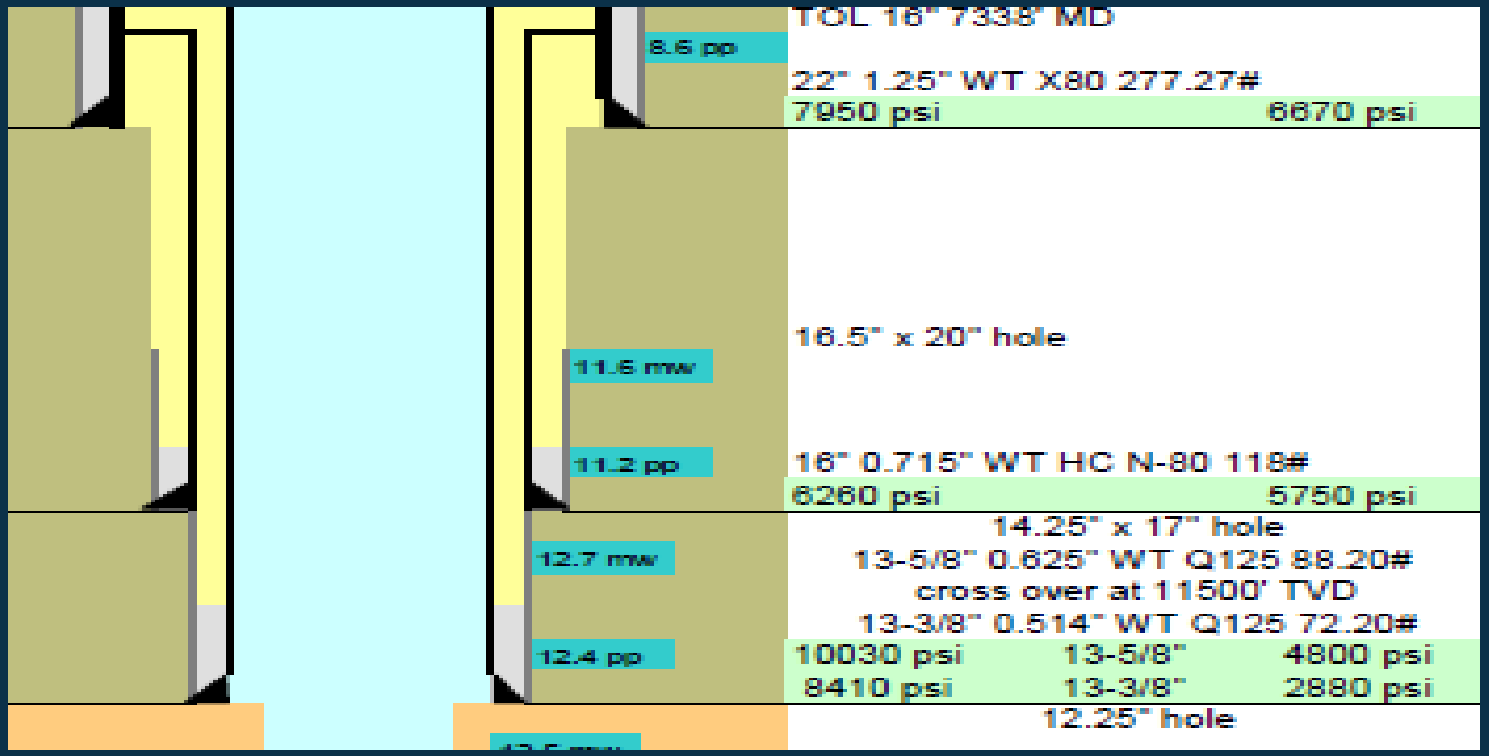
8. Pore Pressure and Fracture gradients not matching up with the Pore Pressure Plot in permit or in casing summary in eWell

Depth (ft-TVD)	Reservoir Fluid	Reservoir Pressure or Bottom hole Flowing Pressure		Assumed fluid gradient for calc (psi/ft)	Mud Line Shut in Pressure (psi)	Shut in ppg @ shoe
		(ppg)	(psi)			
3,500	Oil	10.1	1,838	0.23	2,607	5.15
			.		.	.



Examples of Common Mistakes on the WCST

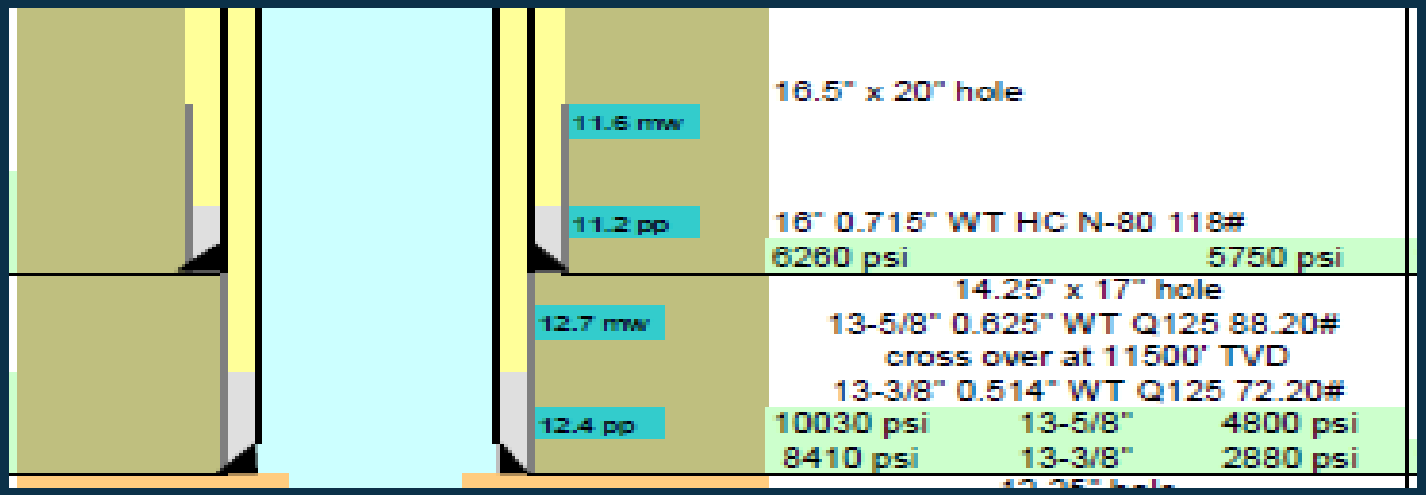
9. Burst/Collapse analysis – not analyzing at correct point of interest (HID, shoe, at casing cross-over, TOL, all points of interest, etc.)



Examples of Common Mistakes on the WCST

10. Wrong version of wellbore schematic sent with the excel file (needs to match schematic in eWell)

Interval Number:	4	Type:	Casing	Name:	Intermediate			
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth (ft) MD	Depth (ft) TVD	Pore Pressure (ppg)
1	14.000	113.0	TN-110	11000	8132	6292	6292	14.2
2	13.625	88.2	HCQ - 125	10030	6400	21515	21475	14.2



Revised Screening Tool

- The following revisions will require a revised screening tool be submitted via eWell permit
  - Changing casing setting depths by +/- 100’
  - Decrease in cement volume
  - Increase in cement volume because of need to isolate a hydrocarbon zone not previously identified
  - Increase in casing setting mud weight

Thank you