WCST Overview

Prepared for BOEMRE Industry Permitting Workshop
Held August 30, 2011 in Metairie, La

Background on WCST – 1

- **BOEMRE issued NTL 10 Nov 8, 2010**
  - —The title of NTL 10 is —"Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources"
  - —Although not explicitly stated in the NTL 10 notice, the BOEMRE requires that the operator demonstrates in the APD that the well design is adequate to contain an uncontrolled flow.
- **JIFT established to address Well Design to demonstrate compliance with NTL 10**
  - —Level 1 Screening tool version 1.17 issued Feb 15, 2011. Simplistic , conservative analysis endorsed by BOEMRE.
- **JIFT continued with development of Level 2 analysis methodology to address wells which were beyond the scope of a Level 1 WCST analysis**
  - —Level 1 and Level 2 WCST version 1.18 issued April 14, 2011. Version 1.18 included a 55 page detailed instruction manual.

Background on WCST – 2

- **JIFT began work on WCST version 1.19**
  - —Met with BOEMRE May 24, 2011 to understand issues BOEMRE identified from early submissions.
  - —JITF solicited issues with current WCST 1.18 from industry though Helix and MWCC members. Replies received by July 14, 2011 (three relies in total) . Issues noted were:
    - —Amend flowing gradient assumption in Level 2 to exclude SI gradient
    - —Add Level 3 analysis methodology for cap and flow.
    - — Request to challenge Level 1 assumptions
      - —Oil gradient assumption of .23 psi/ft
      - —Trapped annulus for inclinations greater than 30 deg.
      - —Use of HID in collapse analysis for fully cemented liners
      - —What is the basis assumption on HID

Level 1 –
•Screening based on simplifying assumes
•Four screening criteria
•Goal is to let "simple wells" pass screening.
•Spreadsheet is structured to do "simple math"

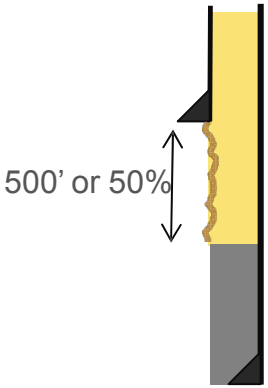
Screening tool results	
5. Shut in Pressure below formation integrity when well shut-in	PASS
6.1 Burst Integrity	PASS
6.2 Trapped annuli check	PASS
6.3 Collapse Integrity	PASS

Figure 1: Screening Tool Results

Level 2 –
•For wells that don't pass level 1 (do to loads, capacities or criteria)
•Well Engineer has freedom to change assumptions (e.g.; gradients, UGV'g, primary string failure, cap and flow, ratings, TAP/AFE, HID etc)
•Spreadsheet is structured to do "simple math". However logic is more complex.

WCD Collapse Loads:
Annulus Plugging – Level 1 screening criteria

Parameter	Criteria
Liners	If liner lap < 500' and criteria a and b below are met, then considered the annulus un-trapped for screening purposes. If liner lap is <500', then criteria a, b, & c must be met to pass the Level 1 trapped annulus screening .
Tiebacks & Scab Liners	Do not meet the requirements for a Level 1 screening
Casing Strings	Must meet criteria a, b & c below to pass the Level 1 screening.
CRITERIA	
a) Hole Angle	less than 30º
b) Time	1 year
c) Distance between TOC and previous shoe	Cement channeling – annulus cement volume is 50% by volume or less of the gauge hole volume or is a minimum of 500 feet from the shoe in gauge hole



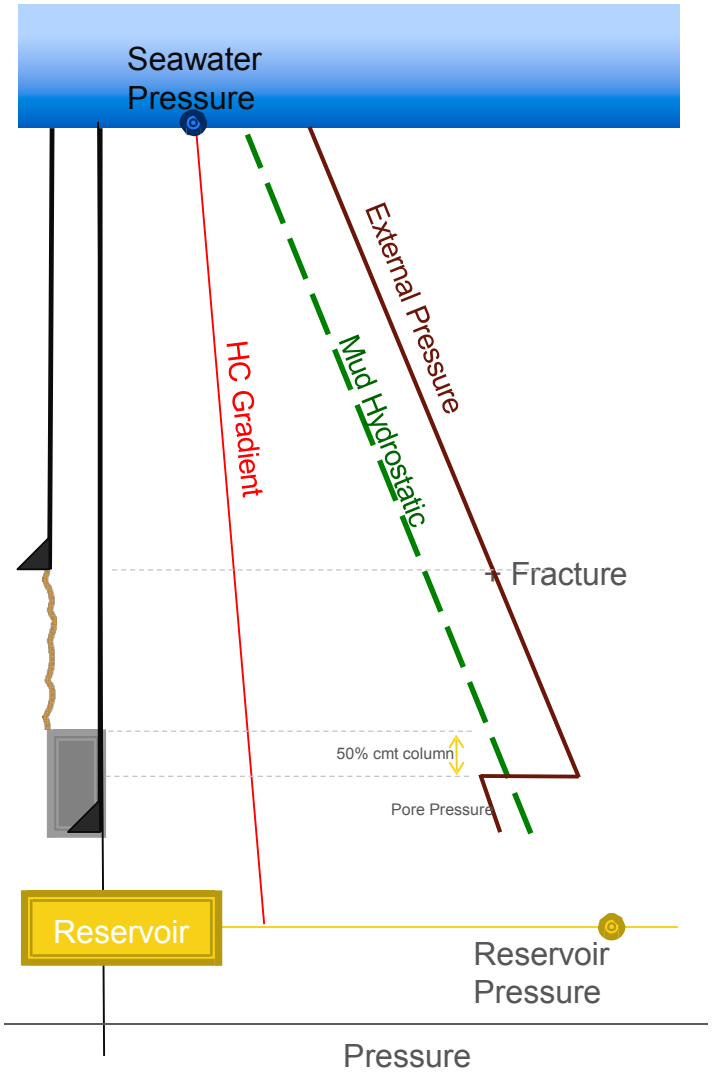
If does not meet above screening criteria, need Level 2 consideration such as :
-Pipe rating is sufficient to withstand APB during WCD event
-APB mitigation to prevent collapse or other mitigations
-Total solids volume

Level 1 Survival Well Loads – WCD Collapse Loads

- Collapse Case for WCD to Sea Floor (Casing Annulus open to bleed APB to formation)
  - —Internal Pressure
    - Mudline = SW Pressure
    - TD = extrapolate to the deepest shoe using HC Gradient
  - —External Pressure Profile
    - Above HID: Fracture pressure at previous shoe or weak formation in open hole above HID; project to other depths using as mud weight casing was run in.
    - Below HID: Local Pore Pressure

Assumptions:

- HID = Shoe depth minus 50% of planned cement height
- Collapse Rating in the Level One Screening is API or manufacturer rating meeting API 5C3.
- HC gradient for gas <= 9,000', use 0.1 psi/ft. 9,000' to 11,000' linearly increase to 0.15 psi/ft. HC gradient for oil or mixed oil/gas/water use 0.23 psi/ft.
- Annular Pressure Buildup limited by Fracture Gradient at the previous shoe (unsealed case)
- Fracture gradient (including salt) based on PPFG submitted in APD



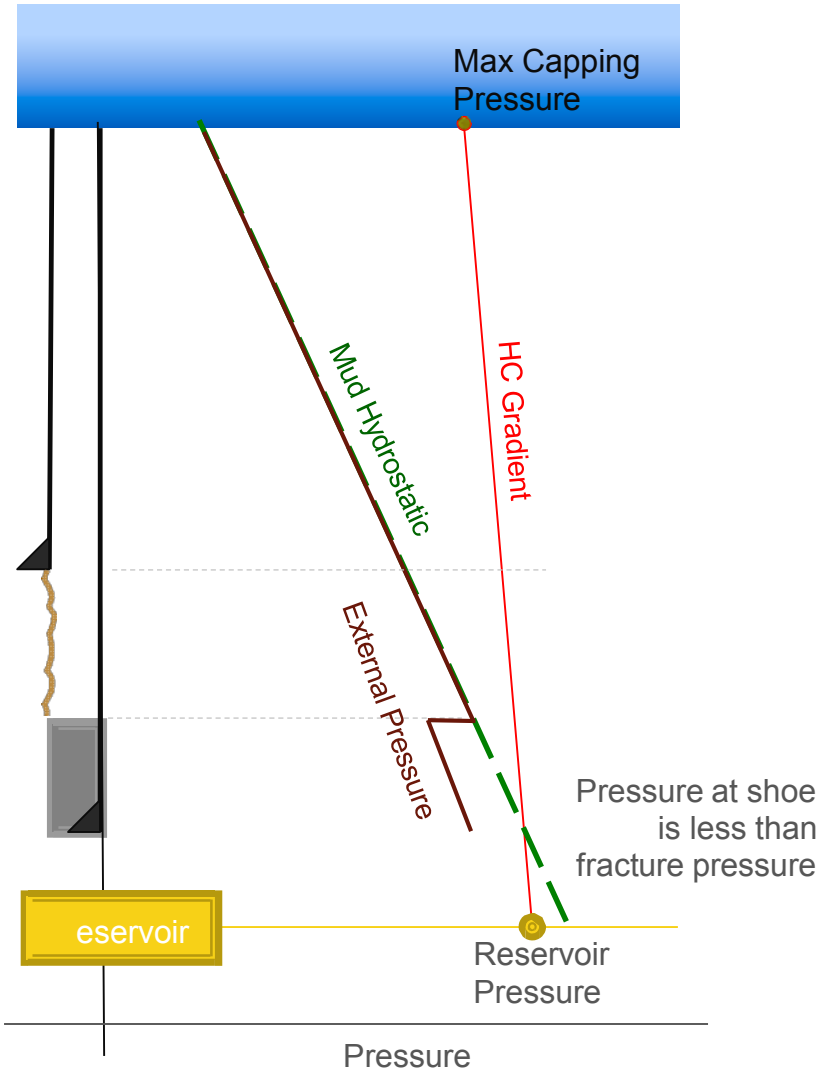
Screening based on Design Factor >= 1

Level 1 Survival DW Well Loads – Cap and Shut In

- Burst Case: Cap and Long Term Shut-In (Casing Annulus open to bleed APB to formation)
  - —Internal Pressure
    - Reservoir Depth = Reservoir Pressure
    - ML = Res Pressure – HC Grad
  - —External
    - ML to TOC = Mud Weight Casing was set in
    - OH below top of cement = Pore Pressure

Assumptions

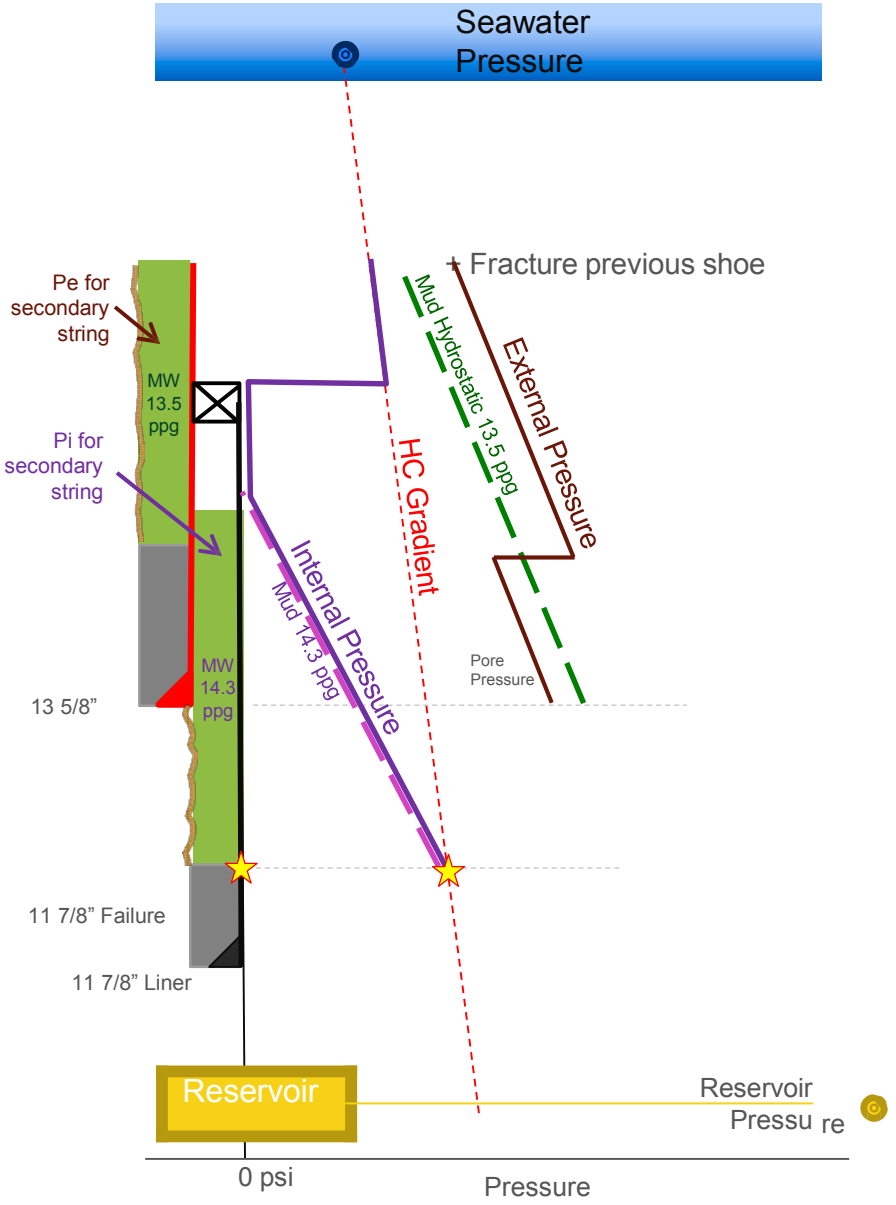
- Burst Rating in the Level One Screening is API Burst or manufacturer rating meeting API 5C3.
- The pressure calculated at the deepest exposed shoe does not exceed fracture gradient.
- HC gradient for gas <= 9,000', use 0.1 psi/ft. 9,000' to 11,000' linearly increase to 0.15 psi/ft. HC gradient for oil or mixed oil/gas/water use 0.23 psi/ft.
- External pressure assumes trapped pressure resulting from mud column hydrostatic when the seal was set.



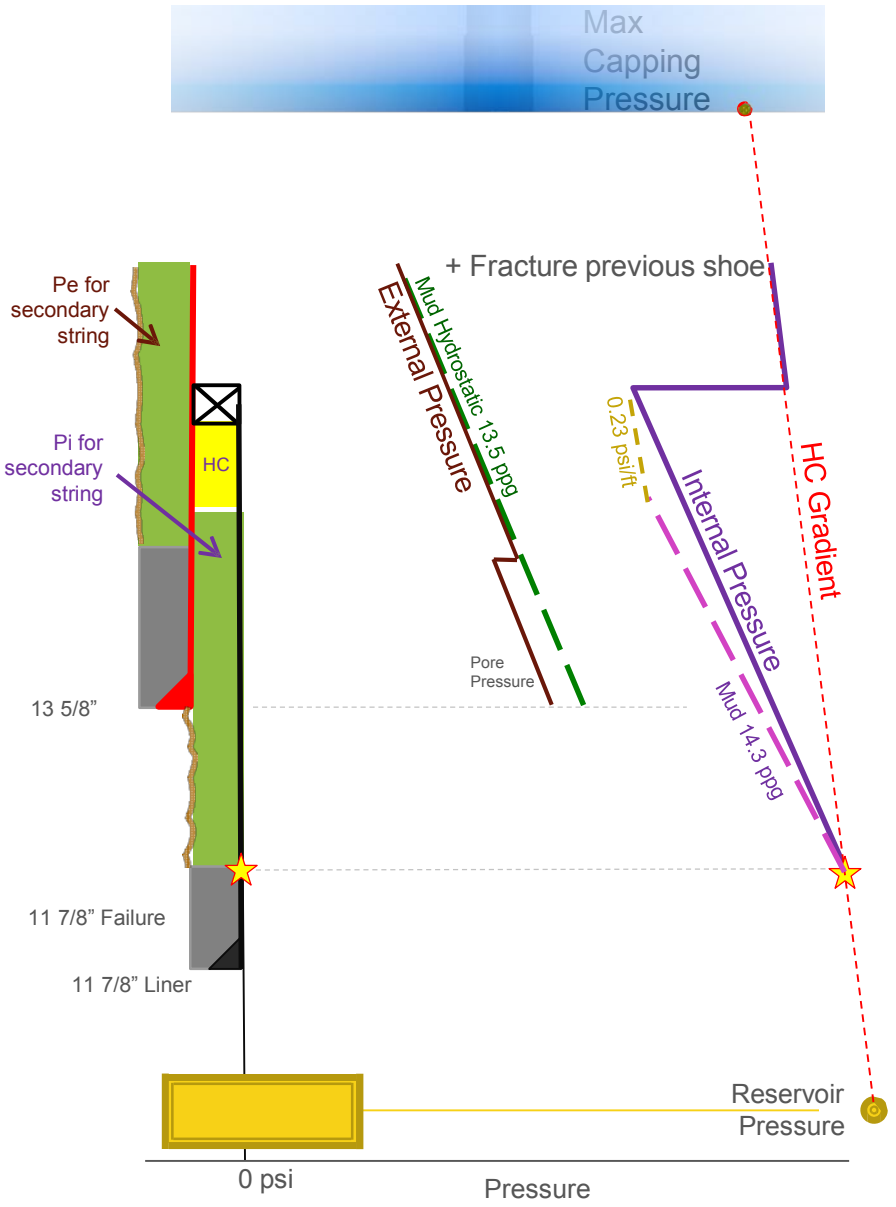
Screening based on Design Factor >= 1

Level 2 Secondary String – WCD Collapse Loads (Outer Csg – in RED)

- Collapse Case for an outer string which is exposed to flowing pressure following loss of integrity of the primary string.
  - —Internal Pressure
    - Mudline = SW Pressure
    - Connect HC flowing pressure @ collapse depth with original mud gradient inside outer casing to a minimum of zero psi.
      Above this, revert back to HC flowing pressure (anchored by Psw at mudline)
  - —External Pressure Profile
    - ML = Frac at Previous Shoe – MW when current casing is set
    - HID = Frac at Previous Shoe + Mud Grad when current casing is set
    - OH/Cmt = Pore Pressure



- Burst Case for an outer string which is exposed to capping pressure following loss of integrity of the primary string.
  - —Internal Pressure
    - Connect HC shut in pressure at collapse point with the pressure at the top of a mud and HC column as depicted.
      Above TOL, connect back to HC shut in pressure (anchored by Pres)
    - Reservoir Depth = Reservoir Pressure
    - ML = Res Pressure – HC Grad
  - —External
    - ML to TOC = Mud Weight Casing was set in
    - OH below top of cement = Pore Pressure



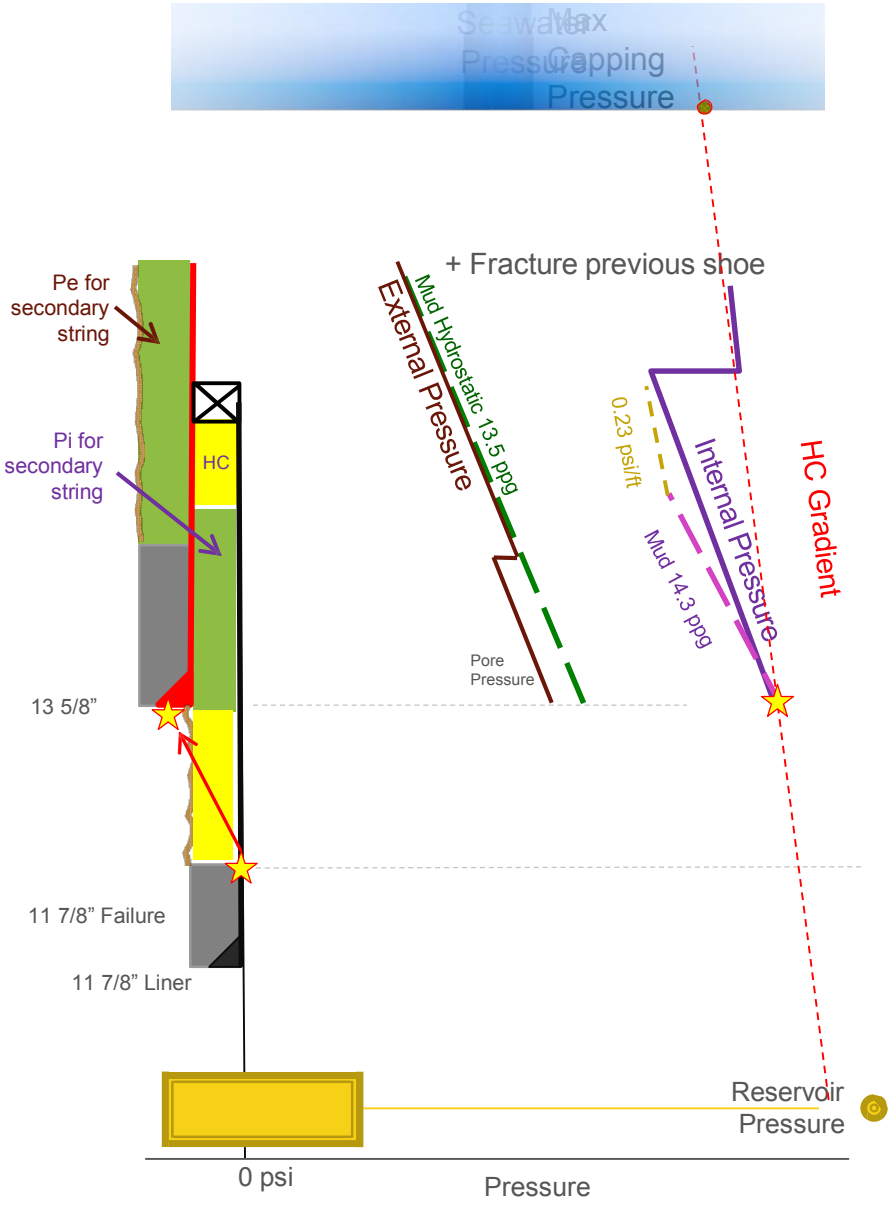
- Burst Case for an outer string which is exposed to capping pressure following loss of integrity of the primary string & UGV/Loss Zone behind primary string.

—Internal Pressure

  - Connect HC shut in pressure at Loss Zone with the pressure at the top of a mud and HC column as depicted.
    Above TOL, connect back to HC shut in pressure (anchored by Pres)
  - Control Point = UGV Pressure
  - ML = UGV Pressure – HC Grad

—External

  - ML to TOC = Mud Weight Casing was set in
  - OH below top of cement = Pore Pressure



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