
Preparing for the Unexpected: Lessons Learned from GoM Shelf Decommissioning

**AADE Deepwater and Emerging Technology
Study Group Meeting
October 24, 2019**

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Introduction

- **Amoco, BP, Apache – GoM Shelf**
- **Over 250 Platform Removal and Reefing Projects to Date (7 ft to 700 ft)**
- **Over 1200 GoM Shelf Well P&As to Date**
 - (Vert, Dev, Horiz, HPHT, H2S, Virgin, Depleted, Subsea)
 - 400 Wells Were Good Practice
 - 600 Wells Had Minor Problems
 - 180 Wells Had Major Problems
 - **20 Wells Tried to Ruin My Career, But I Learned the Most from Those**

Motivation for This Presentation

- **P&A “Cost Saving” Ideas Showing Up Around the World That Don’t Reflect What We Have Already Learned in the GoM Shelf**
 - Minimizing the Number of Plugs in a P&A to Minimize Costs (Calculations vs. Cement)
 - Eliminating the Formation Squeeze
 - Perf and Circulate Techniques Through Multiple Casing Strings vs. Cutting Casing & Setting CIBPs
 - Intervention Equipment Designs Not Capable of Handling Surprise “B” or “C” Annulus Pressures

Wisdom vs. Knowledge

- **Knowledge Is What They Teach in School**
- **Wisdom Comes One of Two Ways**
 - Learning from Someone Else's Mistakes
 - Learning from Our Own Mistakes
 - Easy Way or Hard Way, **the Choice Is Ours**

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- **Don't Assume That the Well Is Going to Behave as You Expect It To**

Agenda

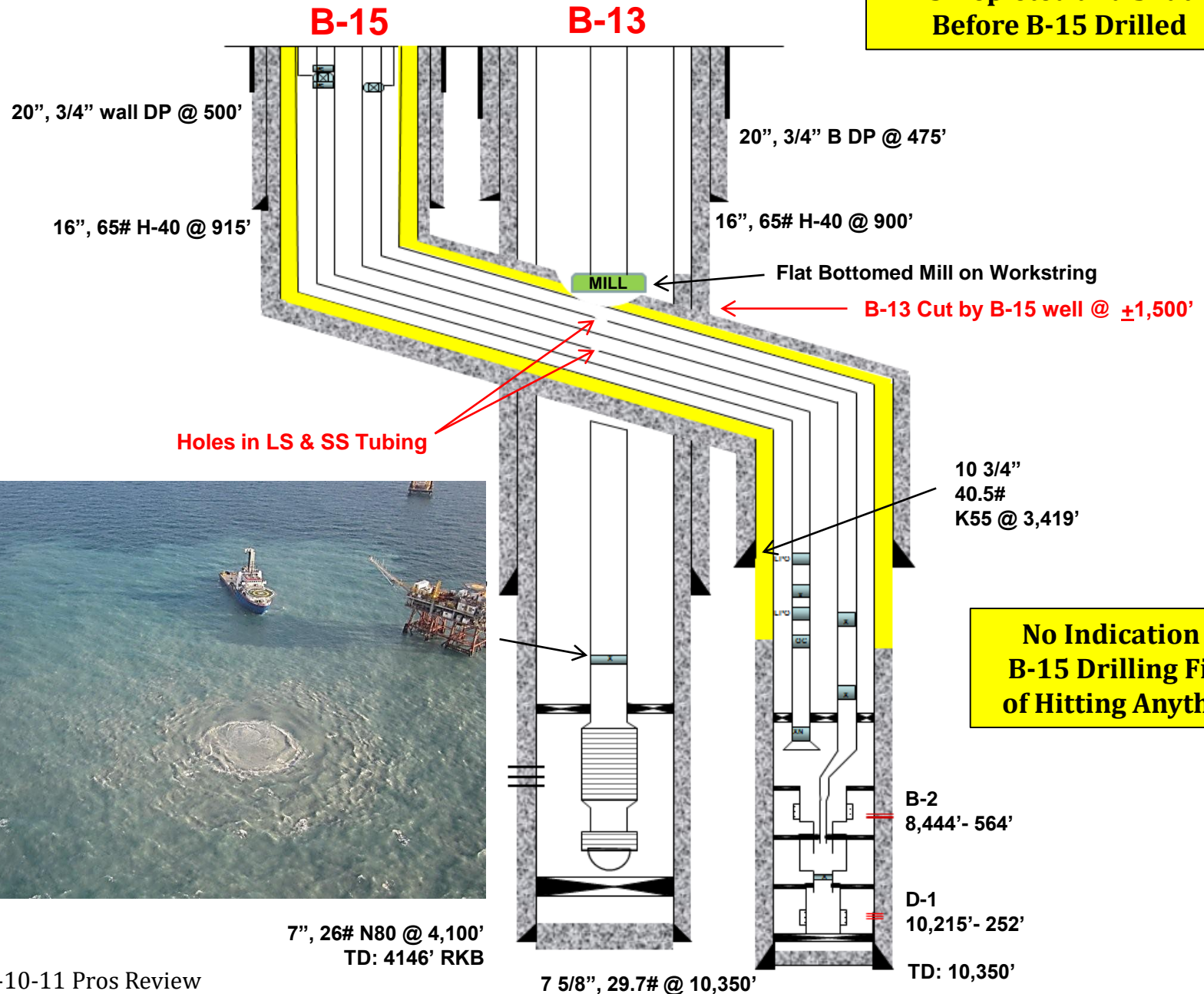
- **Example Decommissioning “Surprises”**
- **Getting Prepared for the Unexpected**
 - *Soft Skills Section Greatly Minimized for the Available Time Slot*
- **Technical Recommendations on P&As to Prevent Future Problems**

Examples of Surprises

Technical Surprises

- **East Cameron Intersected Wells**
 - Working on Well B-13
 - Encountered Tubing Obstruction
 - Needed to Mill Out Obstruction
 - Set Up BOPs, Milled 6 Inches, Hit Pressure
 - Stopped the Job to Figure Out What Was Going On
 - **The Critical Question That Richard Asked**
 - Found Matching Pressure on B-15 Casing
 - Watch for Bubbles Guys !

**B-13 Depleted and Shut-In
Before B-15 Drilled**



Technical Surprises

- **Vermillion Well Re-Pressuring**
 - Depleted Gas Well with 115 ft of Perfs at 14,860 ft
 - Well Was So Old There Were **No SCSSVs** in the “Production String” and “Kill String” in This Dual Tubing Well
 - Already **Had a Rig** on Location for This Problem Well
 - Scale and Electric Line Completely Blocking One Tubing String

Technical Surprises

- **Vermillion Well Re-Pressuring**
 - Maximum Anticipated Surface Pressure from the “Depleted” Reservoir Was 1500 psi
 - Pulled Plug and Encountered 9800 psi at Surface
 - **15K Wellhead Started Seeping Gas**
 - **“I Suggest You Call Boots & Coots”**
 - Well Plugged 120 Days and Over \$ XX MM Later

Technical Surprises

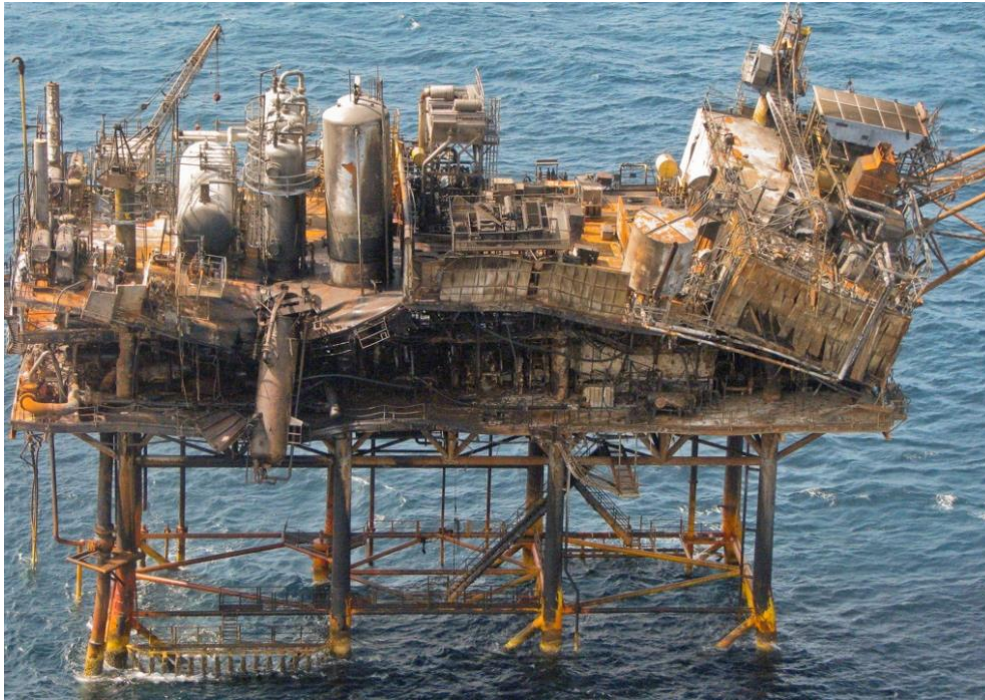
- **High Island P&A'd Well Blow Out**
 - Wednesday Night Before Thanksgiving Holiday
 - **“Mr. Hunger This is the MMS. You have a blowout in the GoM in Block XX.”**
 - “But sir, we don’t even have an operation ongoing in that block.”

Technical Surprises

- **High Island P&A'd Well Blow Out**
 - Turnkey Drilled Well
 - “Dry Hole” High Pressure Non-Commercial Gas
 - Original Producer Took Charge of P&A
 - **Original P&A Was a “Perf and Circulate” Design**
 - Production and Intermediate Casing Was Not Pulled
 - Replacement P&A Design Recovered Prod. and Int. Casings and Set CIBPs and Cement Plugs Above the Casing Stubs
 - Over \$ XX MM Intervention to Re-P&A

Natural Disasters

- **Apache Eugene Island Burned Platform**
 - Hurricane Ike 2008



Getting Prepared for The Unexpected

Beyond Just Pre-Job Planning & HAZIDs

Mindset

- **“If It Ain’t Broke, It Ain’t Ours”** Terry Costlow
- **“You Don’t Know What You Don’t Know”**
Donald Rumsfeld 2002
- **“Plan Your Work and Work Your Plan”**
– But Expect Surprises
- **Avoid the Mentality of**
“We Are Going to Save Money
No Matter How Much It Costs.”
- **“Know When to Say When”** Budweiser

Mindset

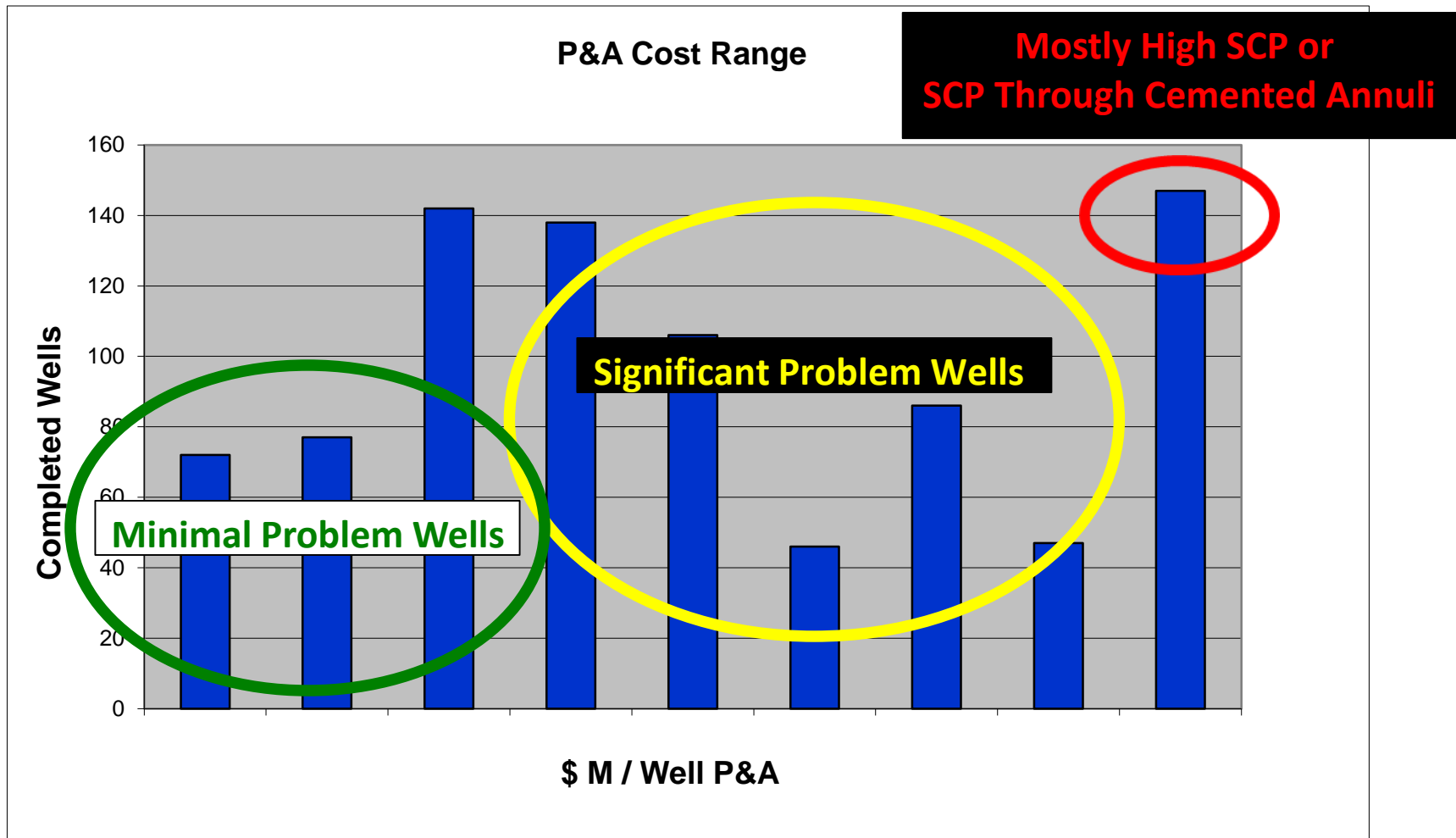
- **Don't Assume That the Responsible Parties Really Know Their Business**
 - Coiled Tubing “Expert” Consultants
- From Tom Straub
 - **What Do You Know?**
 - **How Do You Know?**
 - **Show Me?**

Technical Recommendations

Technical Recommendations on P&As

- **Predicting Problem P&As**
 - **Sustained Casing Pressure Above Cemented Annuli**
 - **Shallow Mechanical Obstructions**
 - Fish (Plugs/WL/CT), Crimps, Holes in Tubing, Parted Tubing, Collapsed Tubing or Casing
 - **Wells that Have Subsided Differentially to the Wells and Platform Around Them**
 - **Hidden Internal Corrosion Just Below the Wellhead**

Per Well P&A Cost – Actual Spread



5 Years of Data – 861 Wells Total

Technical Recommendations on P&As

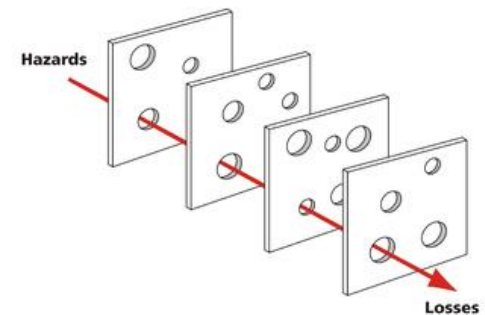
- **Don't Ever Reduce the Number of Plugs to Reduce the Well P&A Cost**

- **Two Plug P&As?**

Remember the Swiss Cheese Model

- **Always Keep in Mind the Hazards & Costs of a Failed P&A Re-Entry**

- **Over 5 Times the Cost with Platform Still There**
- **Over 20 Times the Cost if the Platform Is Gone**
- **What Would Be The Cost to Address a Leaking P&A in the North Sea or GoM Deepwater?**
- **And How Long Would It Take to Respond?**



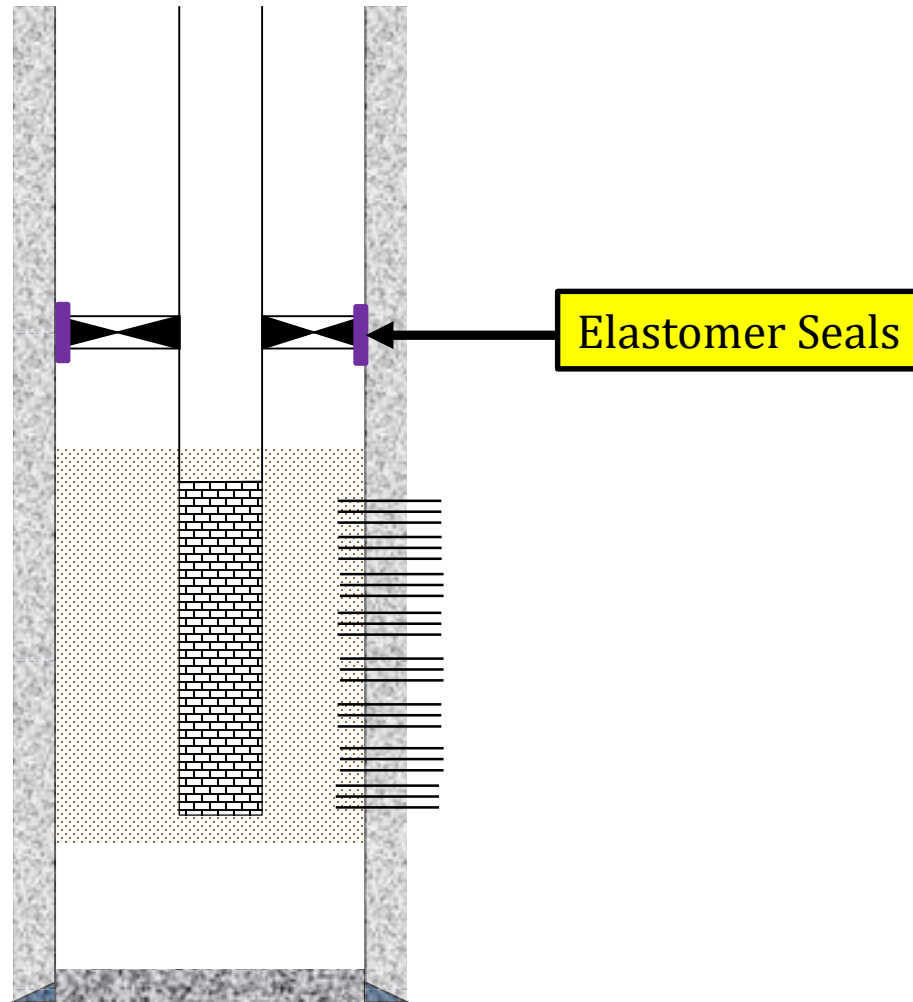
Technical Recommendations on P&As

- **Don't Skip the Formation Squeeze**
 - If Hydrocarbons Are in Your P&A'd Wellbore, They Are Going to Spend **Eternity** Trying to Get to the Surface
- **Common Statement**
 - “The Well Won't *Flow* Because the Hydrostatic Is Greater Than the Reservoir Pressure.”
 - **Pressure Does Not Overcome Bubbles**
 - Consider the Bubbles in Your Coca-Cola Bottle. They May Be Under Pressure, But They Still Float to the Top
 - **Think of a Bubbling P&Ad Well as Taking a Very Slow Kick**

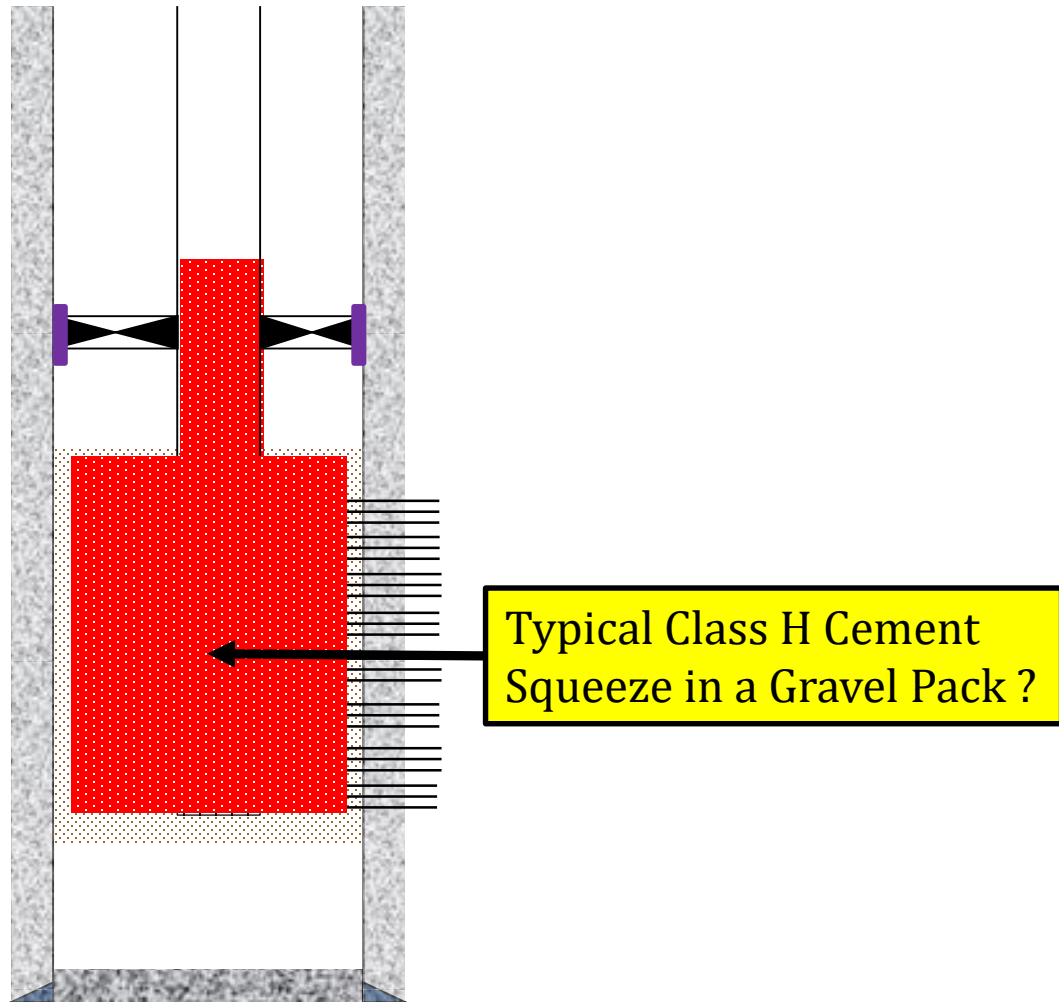
Technical Recommendations on P&As

- **The Cement Plug Immediately Above the Production Packer Is the Most Important**
- **Why ?**
 - Because if the Squeeze of the Perfs and/or Gravel Pack Isn't Perfect, Hydrocarbons Will Eventually Get Past the Packer and Migrate Uphole
 - Elastomer Packer Seals Are Not Going to Last for __ Yrs
 - **Because I've Had to Re-Enter a Significant Number of Leaking P&As** (by other operators)
Where Some Cheap __ e__ Skipped This Plug.
 - The Original P&A Typically Didn't Last a Year.

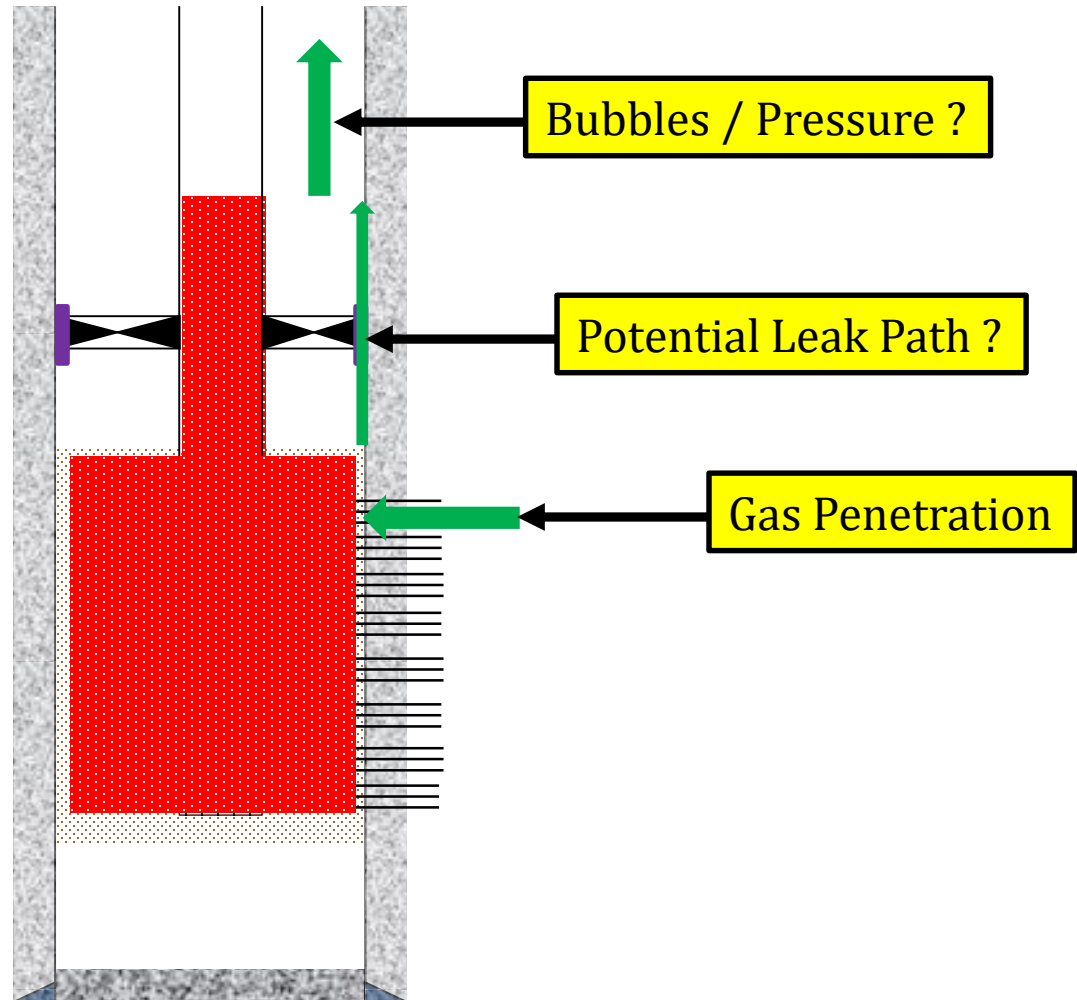
The Critical Packer Plug



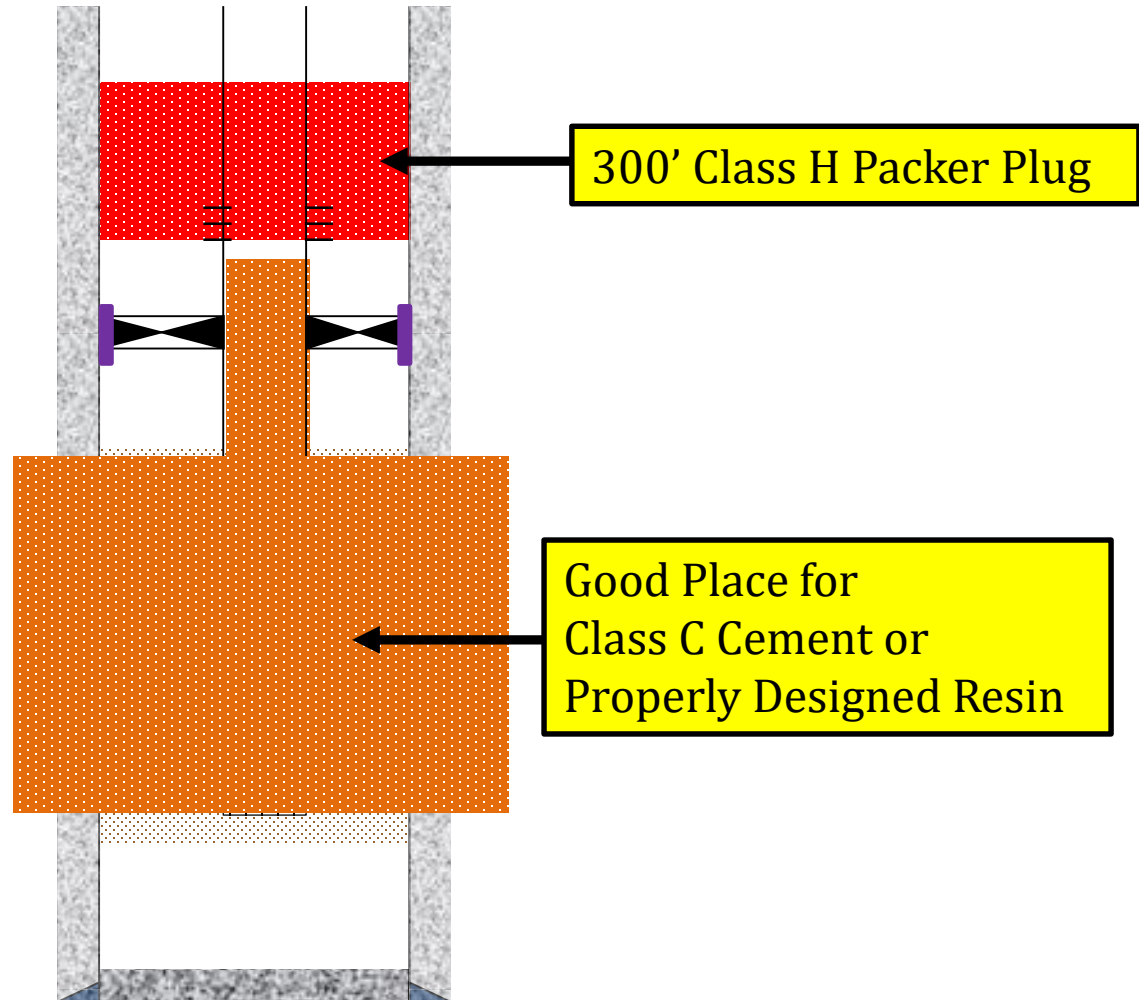
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The Critical Packer Plug

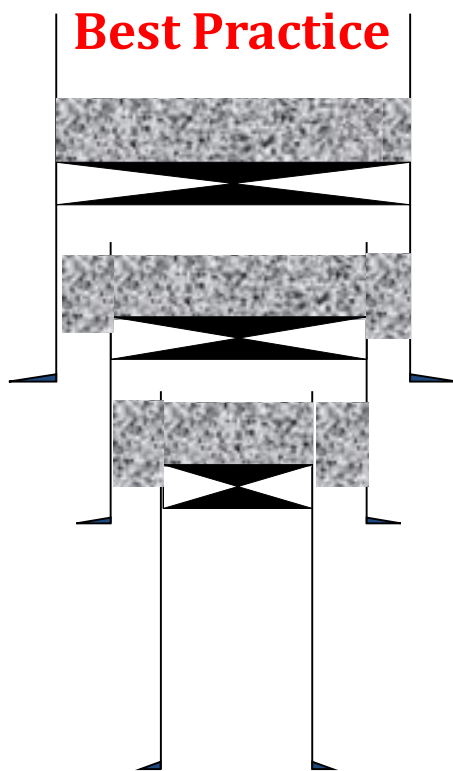


Technical Recommendations on P&As

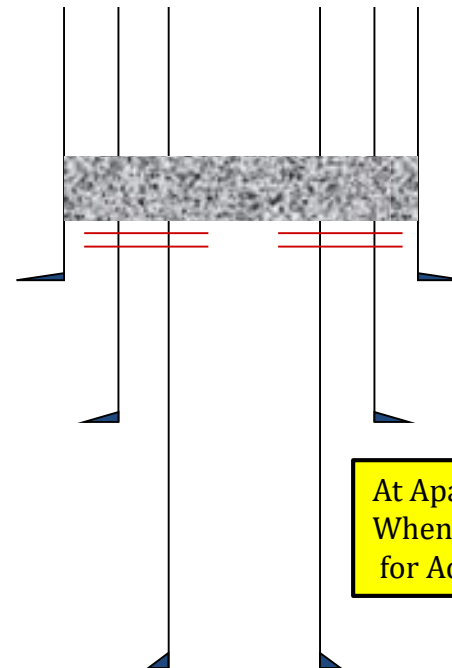
- **GoM Rigless P&As**
 - Major - 4 CIBPs and 5 Cement Barriers in 21 to 28 “Daylight” Days If No Well Problems
 - Apache - 4 CIBPs and 5 Cement Barriers in 7 to 10 “Daylight” Days If No Well Problems
- **North Sea Rigless P&A**
 - 58 Days for 2 Wells With 2 Plugs Each
- **I Suggest That The Number of Plugs Was Not the Reason That It Took So Long**
 - **Don't Cut Corners on the Fundamental Solution When the Real Cost Problem is Bureaucracy**

Technical Recommendations on P&As

- Cutting and Pulling Casing Versus Multi-Annulus Circulated Plugs



**Emergency Only
Example – Downed Platforms**



At Apache - 30% Success Rate
When Used as a Plug
for Additional Assurance.

Technical Recommendations on P&As

- **Concerning the Industry's Current Fascination with Resins**
 - **Past Failures / Improving Processes Now**
 - **Resins Need Laboratory Testing at Well Conditions Just Like Cement Slurries**
 - Many Resins Reactions Are Exothermic. The Cooler Parts of Your Wellbore Are a Massive Heat Sink.
 - **Know Your Resins.** Some Shrink During Curing. Some Resins Can Shrink Over Time. And Some Can Bubble During Their Exothermic Reaction.
 - **Resins Need Long Term Controlled Tests – Think Years At Pressure and Temperature – Before We Consider Them as Cement Alternatives**
 - **Try Them as a Squeeze Material in Your Shut-In Wells on Active Platforms. And Then Monitor Them for Decades.**

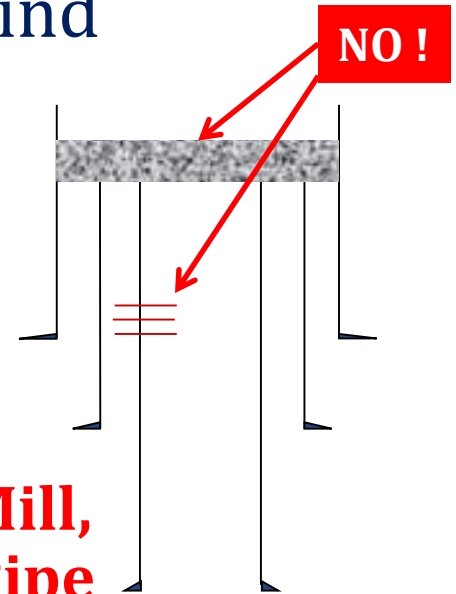


Technical Recommendations on P&As

- **Attack Higher Pressure Annular Pressure Problems Deep**
 - Extremely Difficult to Shut Off High Annular Pressure Shallow
- **Consider Class C Cement Blends**
 - Over Class H Cement Blends to Improve Gravel Pack and/or Formation Penetration
- **Consider Proven But Inexpensive Cement Additives**
 - Magnesium Oxide as an “Expansion” Agent
 - Surfactants as a Gas Blocking Agent
- **Pre-Flush to Improve “Bond” to Pipe**
 - Recompletion Example
- **Learn the Value of Cement Bond Logs**
 - Great at Showing Settled Out Mud Too
- **Downhole Video May Have Limitations in Fluid**
 - But They Work Great in Gas (Try Injected Nitrogen)

Technical Recommendations on P&As

- Consider Monitoring Every Well for One Year Between Plugging and Removal
- **Always Consider the Possible Need for Re-entry in Your P&A Design**
- Don't Leave Open Circulating Perfs Behind
 - Example – Below Cement Retainers
- **Don't Remove Deepwater Wellheads**
 - If You Are Forced to Remove DW Wellheads, Then Don't Cap All Strings with a Final Plug
 - **Re-Enter Only with a Centralized Pilot Mill, Expect a Big Kick, and Hold on to That Pipe**



Technical Recommendations on P&As

- P&As Are Always About Well Control First
 - Stray Zones Above the Packer Are Often a Bigger Long Term Threat Than the Produced Zones
- Enjoy a Longer Career by Assuming that There Is No Such Thing as a Dead Well

Summary

- **No Plan Survives Contact with the Enemy**

- Helmuth von Moltke the Elder



- Field Marshall [Helmuth Karl Bernhard Graf von Moltke](#) ([26 October 1800](#) – [24 April 1891](#)) was Chief of Staff of the Prussian General Staff from 1857 to 1871 and then of the Great General Staff (GGS) from 1871 to 1888. He was an architect of Germany's Wars of Unification (1864–71). He is often referred to as Moltke the Elder to distinguish him from his nephew, [Helmuth Johann Ludwig von Moltke](#).

Back Up Slides

Resins with Too Much Mass / Heat

Mass Consideration on Curing

Epoxies cure through an auto-catalytic process. This means that heat is generated during bond formation and the initial cross-linking process. This generated heat speeds up the curing reaction, which then generates additional heat, speeds up the reaction further and so on. The larger the volume of reacting material, the faster it will cure and the more heat is built up during the cure. Large masses of materials may build up so much heat during curing that a runaway reaction occurs and they actually expand during the cure. This is referred to as an excessive exotherm. In extreme cases, highly exothermed materials may appear to have “foamed” due to the large amounts of air present in the expanded state. Severely exothermed materials may exhibit weakened mechanical properties as they have essentially become a foamed system.

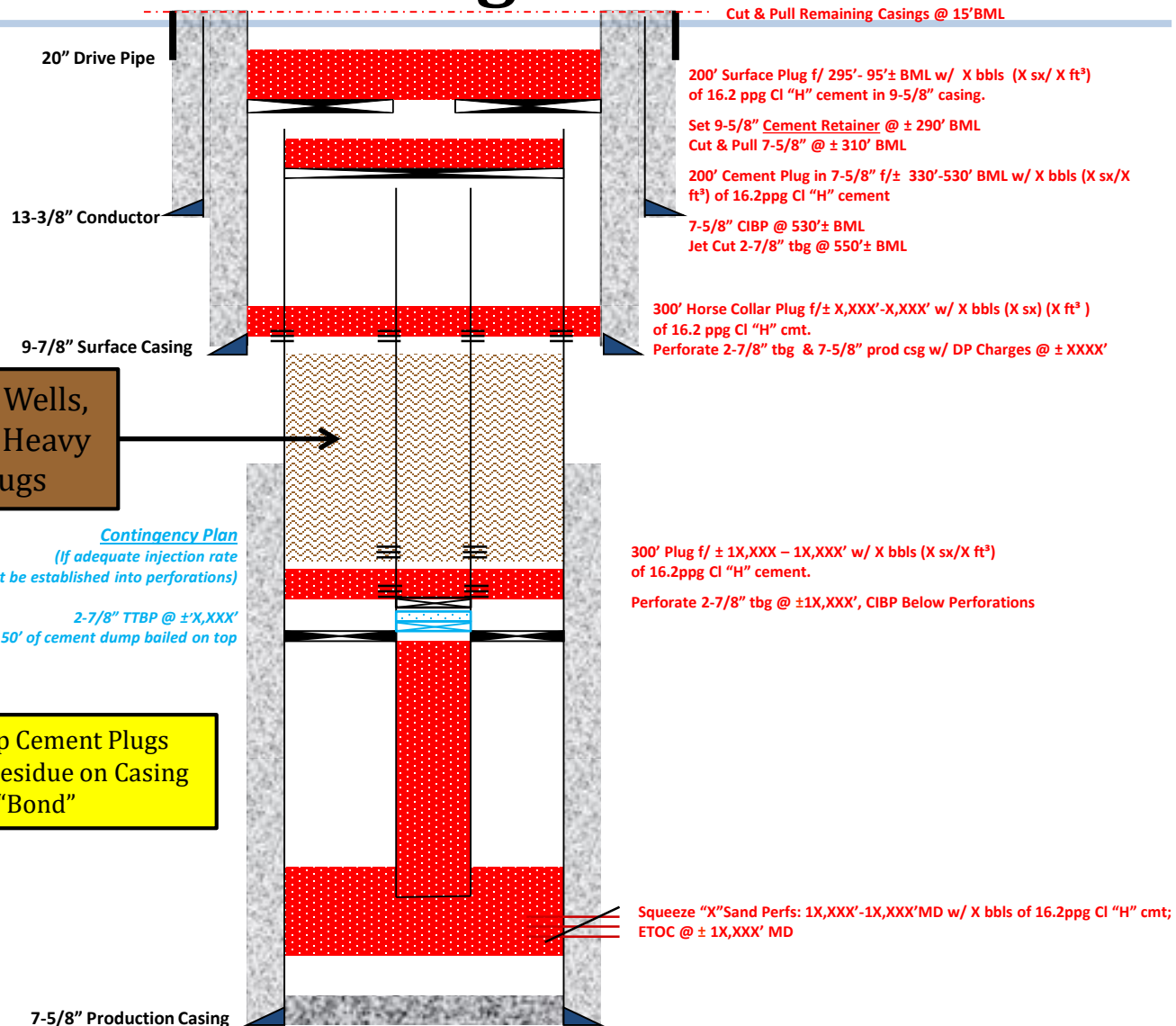


Source: “Cure Matters - Determining the Proper Cure Schedule” Epoxy Technology, Inc.

Why Rock-Cement-Rock Not Required

- Darcy's **Linear** Flow Equation
 - Very Different Than Darcy's Radial Flow Equation
 - Very High Differential Pressures Can Be Restrained by Permeable Materials if the Flow is Linear
 - Example – Plugging Tubing with a Few Feet of Formation Sand
 - Points to Channels or Micro Annulus Being the Real Culprit Behind Sustained Casing Pressure

BP / Apache P&A Design



Note: Always Tried to Pump Cement Plugs in Seawater to Avoid Mud Residue on Casing Creating Issues for Cement "Bond"