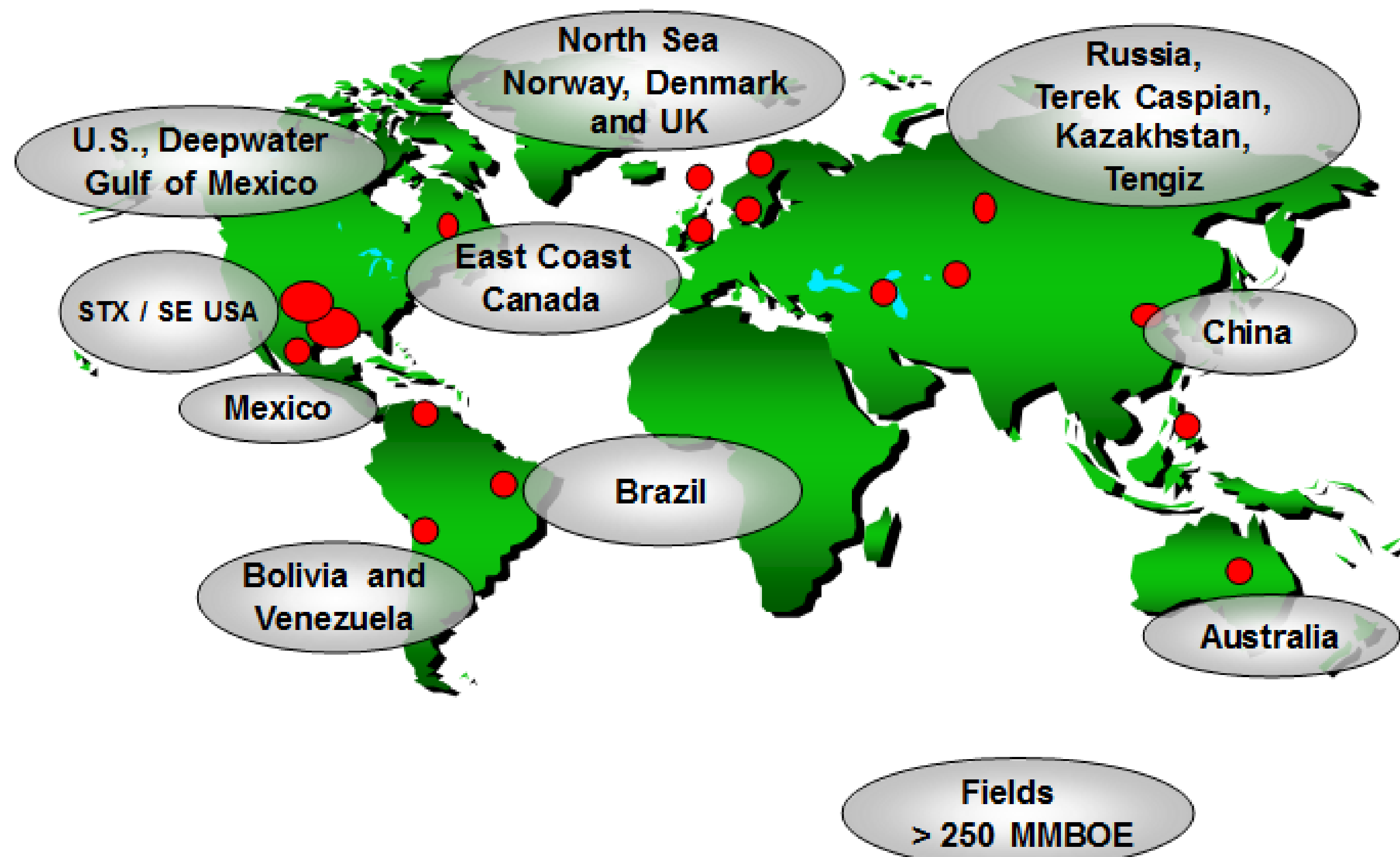


Qualification Procedures for TCP HPHT Wells

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SLAP-17

Halliburton Worldwide Presence in HPHT Environments



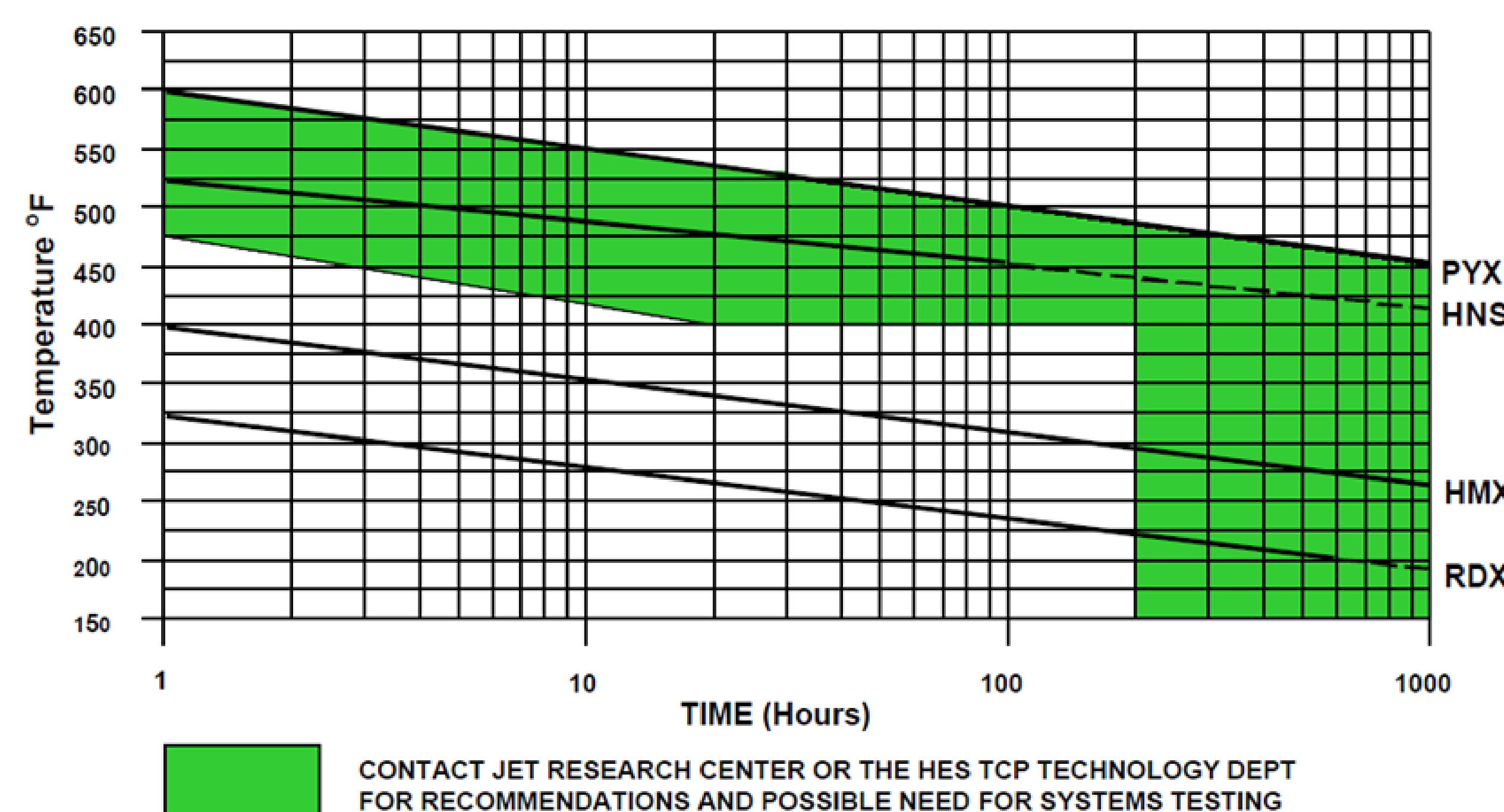
What Constitutes a HPHT Job?

There are several definitions of what constitutes a HP/HT job. On most TCP jobs this refers more to temperature rather than pressure. For our purposes, we will go by the type of explosives used. If, based on the time/temp. chart, we need to use HNS explosives, we will categorize it as a HP/HT well

If total wellbore pressure exceeds 13,000psi then the well needs to be treated as high pressure. Special attention needs to be used for O-Ring selection and tools pressure ratings

OPERATIONAL LIMITS FOR HOLLOW CARRIER GUN SYSTEMS (°F)

NOTE: THIS CHART IS VALID FOR THE EXPLOSIVE TRAIN INSIDE HOLLOW CARRIER GUNS ONLY: (NON ELECTRIC BOOSTERS, DETONATING CORD, AND SHAPED CHARGES) IT IS NOT VALID FOR TCP FIRING SYSTEMS, ELECTRIC DETONATORS, OR CAPSULE GUNS. CONTACT JRC OR HES TECHNOLOGY DEPTS. FOR INFORMATION REGARDING THESE OTHER COMPONENTS.



Steps to be followed to setup HPHT Services

- ❖ Verify that the choice of charge is available in HNS
- ❖ Verify the maximum pressure rating on all explosive hardware (guns, firing heads, etc)
- ❖ Verify the maximum temperature, pressure and wellbore fluids
- ❖ Refer to the O-Ring selection charts for proper selection
- ❖ Verify that the appropriate elastomers are available for the selected guns and other tools
- ❖ Use LPS-A-151 degreaser and remove all oily or greasy residue from all internal surfaces of the gun assembly. This includes guns charge holder tubes, end alignment fixtures, charges clips and tandems
- ❖ All plastic components should be eliminated, this would primarily be the substitution of standard PAI's in favor of Aluminum Alignment Inserts
- ❖ Refer to the appropriate gun manuals for additional procedures
- ❖ We will normally not recommend additional systems testing until the maximum temperature on a job exceeds 425 degrees F and the time exceeds 200 hours

TCP O-Ring, Fluid Compatibility, Temperature and Pressure Recommendation Chart

General Information			
ASTM D1418 Designation	NBR - Peroxide Cure ²	FKM ²	FKM ²
Trade Name	BUNA- Nitrile	Vitro [®]	Arise [®]
Specification	599.33001	600.33001	993.20
Temperature Limits			
Max. Temp. °F (°C) without backup rings	325 (163)	350 (177)	NA
Max. Temp. °F (°C) with backup rings	325 (163)	400 (204)	500 (260)
Pressure and Temperature Limits With ¹ and Without ² Backups			
Max. Pressure at 500°F ⁵	NA	NA	NA
Max. Pressure at 500°F ⁵ with BU	NA	NA	20,000 psi (103,410 kPa)
Max. Pressure at 400°F ⁵	NA	NA	NA
Max. Pressure at 400°F ⁵ with BU	NA	20,000 psi (103,410 kPa)	20,000 psi (103,410 kPa)
Max. Pressure at 350°F	NA	13,000 psi (89,630 kPa)	NA
Max. Pressure at 350°F with BU	NA	20,000 psi (103,410 kPa)	20,000 psi (103,410 kPa)
Max. Pressure at 325°F	13,000 psi (89,630 kPa)	13,000 psi (89,630 kPa)	NA
Max. Pressure at 325°F with BU	20,000 psi (103,410 kPa)	20,000 psi (103,410 kPa)	20,000 psi (103,410 kPa)
Chemical Compatibility			

Fluid Type	BUNA	FKM	FKM
Gases	H ₂ S	3, 6	3, 6
	CO ₂	6	3, 6
	CH ₄ (Methane)	6, 9	6, 9
Oil Base Fluids	N ₂	6, 9	3, 6, 9
	Sweet Crude	6, 9	3, 6, 9
	Diesel	3	3
	Aromatic hydrocarbons & Solvents (Xylene & Toluene)	8	8
	Oil- Based Muds / Fluids	7	7
Water Base Fluids	Ester-based drilling mud	8	3, 9
	Amine / Oil Inhibitors	8	3
	Water based inhibitors	8	8
	Steam	8	8
	Salt Water	8	3
	Zn Bromide	8	3
	Ca Bromide (<14.2 ppg)	8	3
Other Fluids	Na Bromide (<12.4 ppg)	8	3
	Formates	8	3, 9
	High pH fluids (>9)	8	3, 9
	Alcohols	8	3, 9
	Methanol	8	3, 9
	HCl & HF Acid Mixture	8	3, 9
Other Fluids	Weak Acid (HCL<15%)	8	3, 9
	Strong Acid (HCL>15%)	8	3, 9
	Acetic & Formic Acids	8	3, 9
		8	3, 9

Recommended

STILL RECOMMENDED Slightly affected, but no significant chemical change

Operational conditions must be considered. Consult material engineer before running

Not Recommended

General Notes and PEEK Backup Ring Requirements and Limitations

1. Temporary or non-permanent use downhole (service duration typically measured in hours not days). Call Global Advisor or Materials Specialist if exceeding 5 days.
2. Above 13,000 psi run Virgin PEEK backup rings.
3. Always use Virgin PEEK backup ring.
4. With Virgin PEEK backup rings, the maximum pressure is 20,000 psi (137,880 kPa). Per HES Specification 993.19.
5. Run Aluminum PAI when temperature > 350 F.
6. Rapid gas decompression is compound dependent and could damage seals or elements. Consult Elastomer Best Practices for ED Resistant compounds.
7. Testing is recommended due to variability of proprietary ingredients of oil based muds
8. Data from Tools and Testing Short Term Seal Selection Guide

30,000psi TCP Hardware for HP Jobs

Time-Delay Firer (TDF)

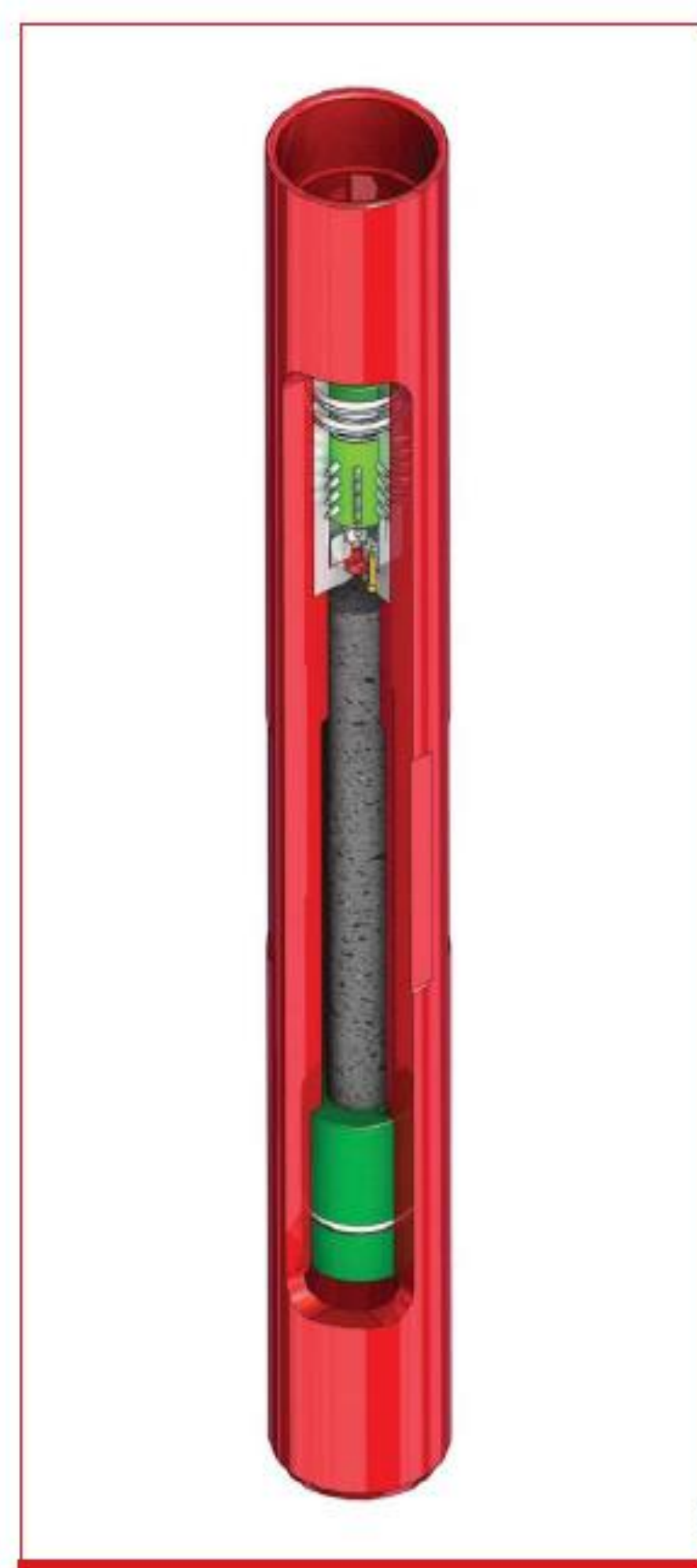
Halliburton's Time-Delay Firer (TDF) allows under- or overbalanced perforating through the use of a pressure-actuated firing head with a time-delay fuse. The delay fuse burns for a predetermined time, between five and seven minutes depending on the bottomhole temperature, and detonates the perforating assembly.

Operation

The TDF is run with a predetermined number of shear pins for specific well conditions. The tubing is pressured to the maximum actuating pressure slowly. The maximum pressure shears the pins in the shear set and forces the firing piston into the primer. The primer ignites the pyrotechnic delay fuse. The delay fuse burns for a predetermined time, between five and seven minutes depending on the bottomhole temperature, and detonates the perforating assembly.

Features and Benefits

- Allows independent perforating of selected zones
- Allows maximum use of under- or overbalanced pressure
- Can be run in heavy mud systems
- Can be used with full-opening or non-full-opening tools
- Helps reduce costs by allowing the running of multiple guns without gun spacers
- Ideal for production completions, drillstem testing, and dual completions
- Recommended for running on the top and bottom of gun assemblies
- Allows additional extended delay fuses for increasing delay time



7 inch, Ultra-High Pressure Perforating Gun

Halliburton offers the world's first 7 inch, 30,000 psi rated perforating gun.

As more challenging and complex wells are explored, unmatched technology is needed for the difficult ultra-deep water and high pressure reservoir targets. Halliburton's unique proprietary design, customized manufacturing, and specialized metallurgy help ensure full system integrity even at extreme depths.

The 7 inch, 30,000 psi High Pressure Gun System can be conveyed on tubing, wireline, or slickline and can meet the challenge of the most demanding 9-5/8 inch, 9-7/8 inch, and 10-1/8 inch casing projects.

As with all Halliburton gun assemblies, this Ultra-High Pressure Gun uses bi-directional boosters, non-lead azide explosives, specialized connectors and inserts, and high velocity-low shrink detonating cord to help meet proprietary specifications for safety and reliability assurances.

Applications

- Ultra-deep water
- High pressure reservoir targets

Benefits

- Explore challenging reservoir targets with confidence
- Maintain the integrity of the well and perforating system at extreme depths
- Provide greater function windows for downhole, pressure-operated tools

Features

- Proprietary design
- Specialized metallurgy
- Customized manufacturing process

