Woodford Shale Casing Conveyed Perforating Western Oklahoma

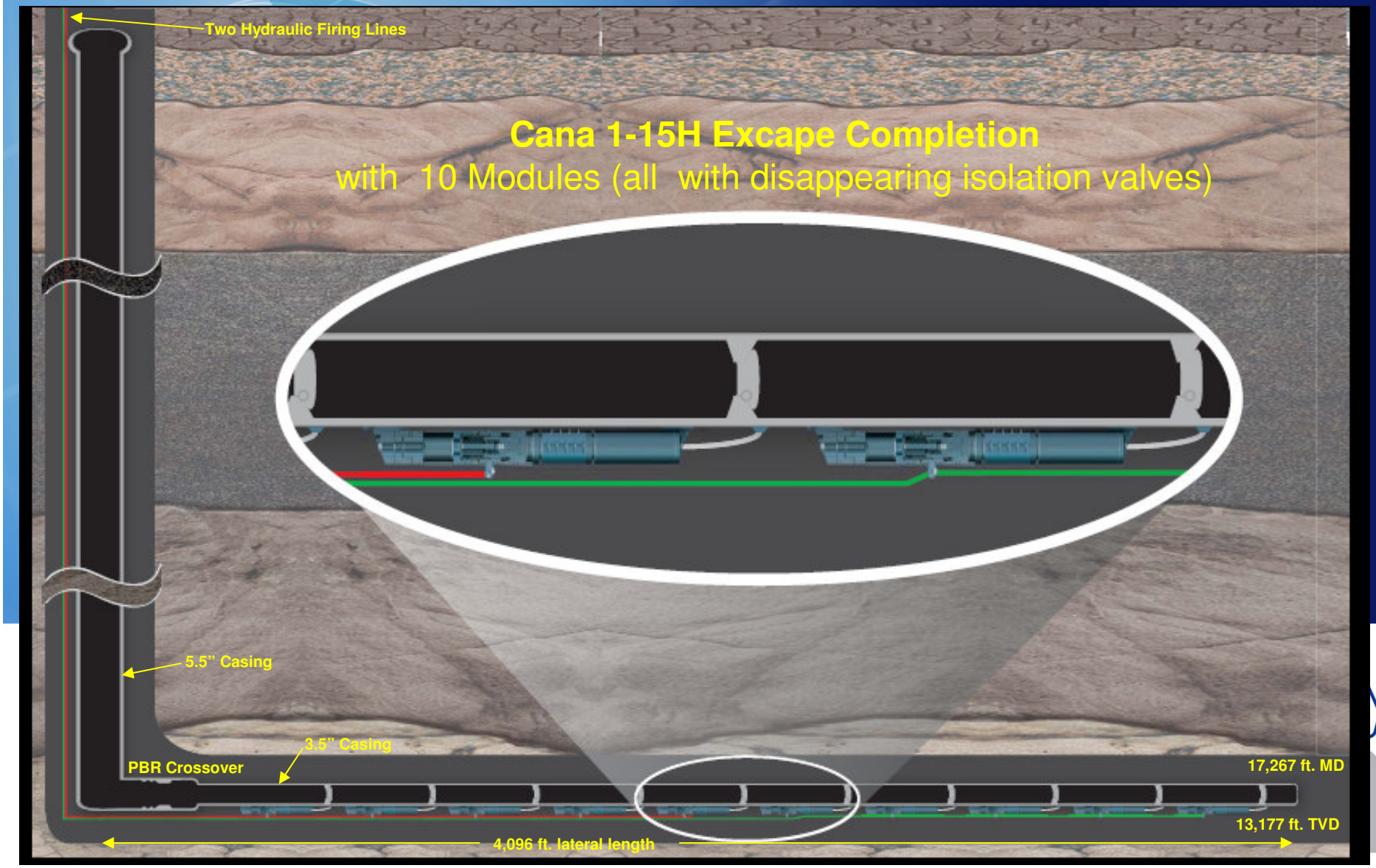
Case History of the World's First Totally Interventionless Completion

AADE Presentation - Oklahoma City

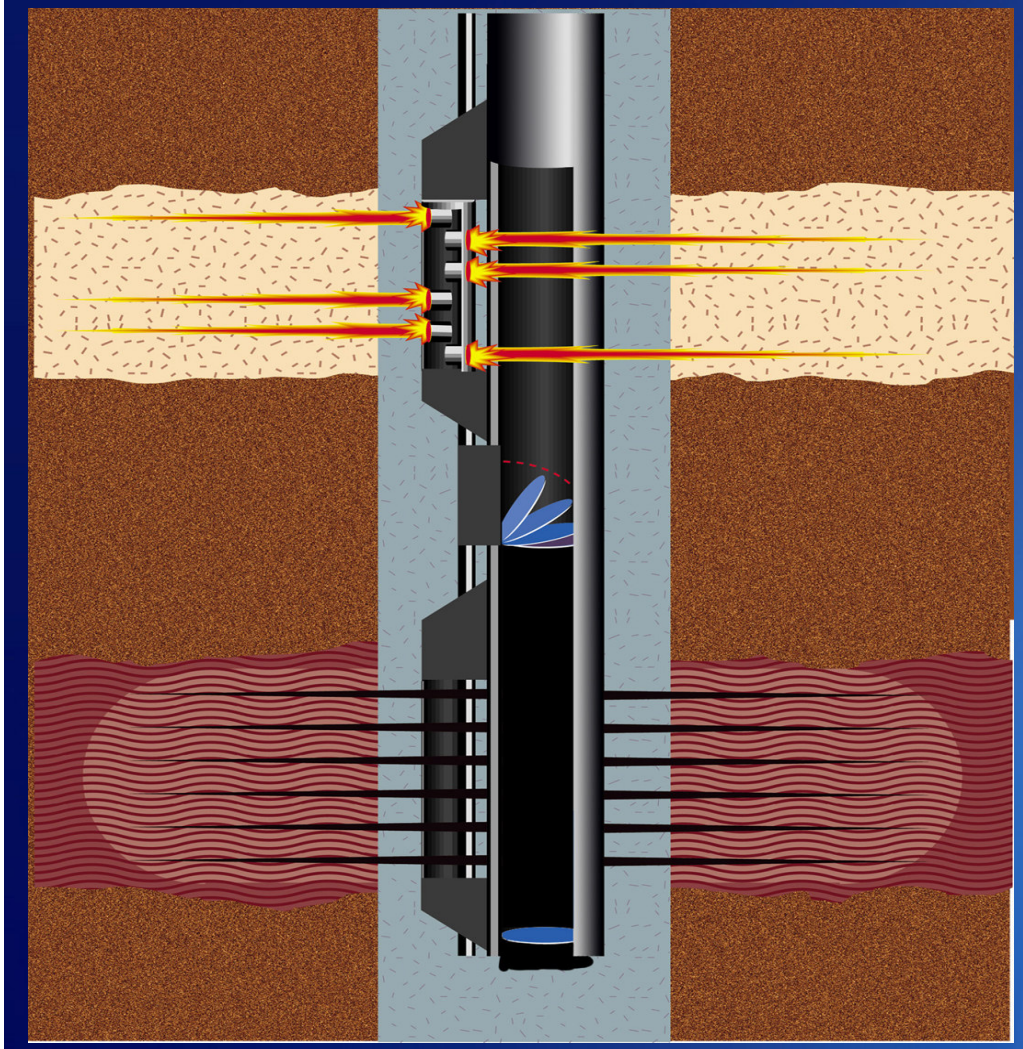
January, 2009

Marathon

Woodford Shale – Western Oklahoma

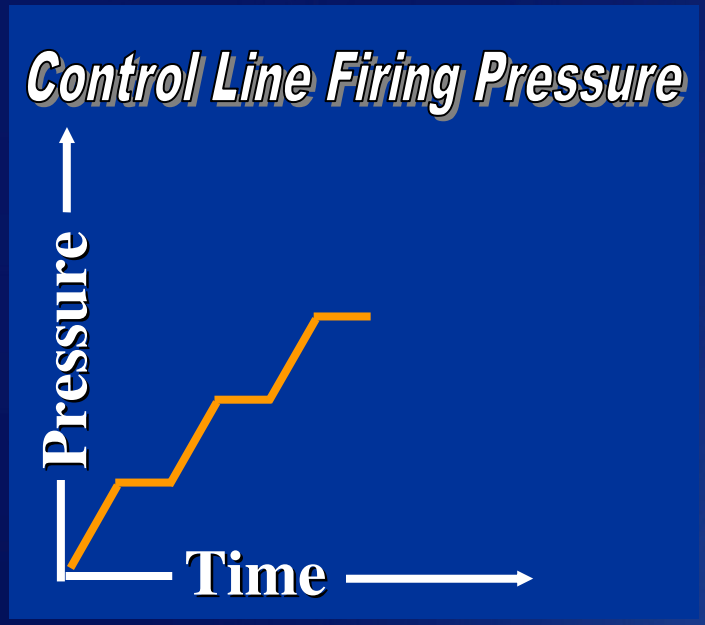


External Perforating Gun & Isolation Valve

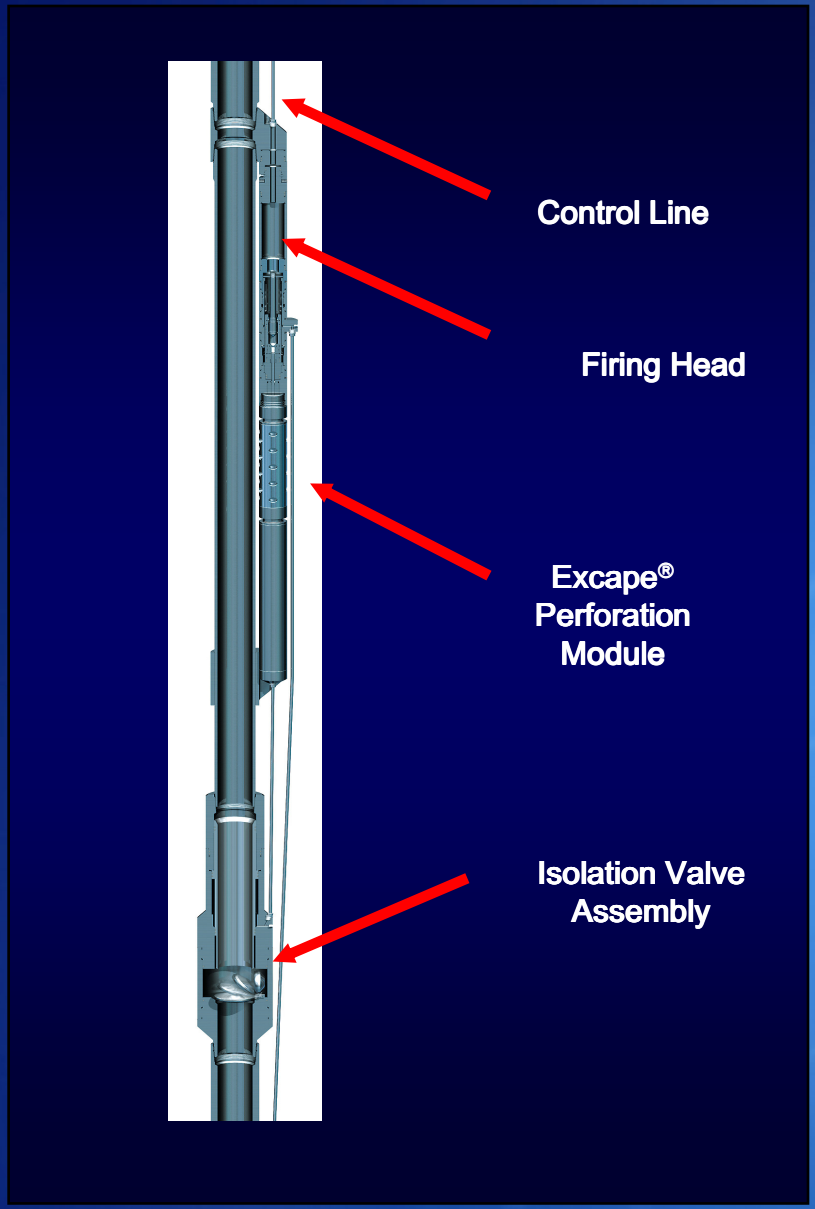


- Firing the gun actuates a lower isolation valve.
- Valve actuates when a protective sleeve shifts.
  - Compatible with cementing and fracturing operations
- RECENT IMPROVEMENT: Lower Isolation Valve Removed when NEXT GUN Fires.
  - Firing Module 3 Removes Module 2 Isolation Valve.

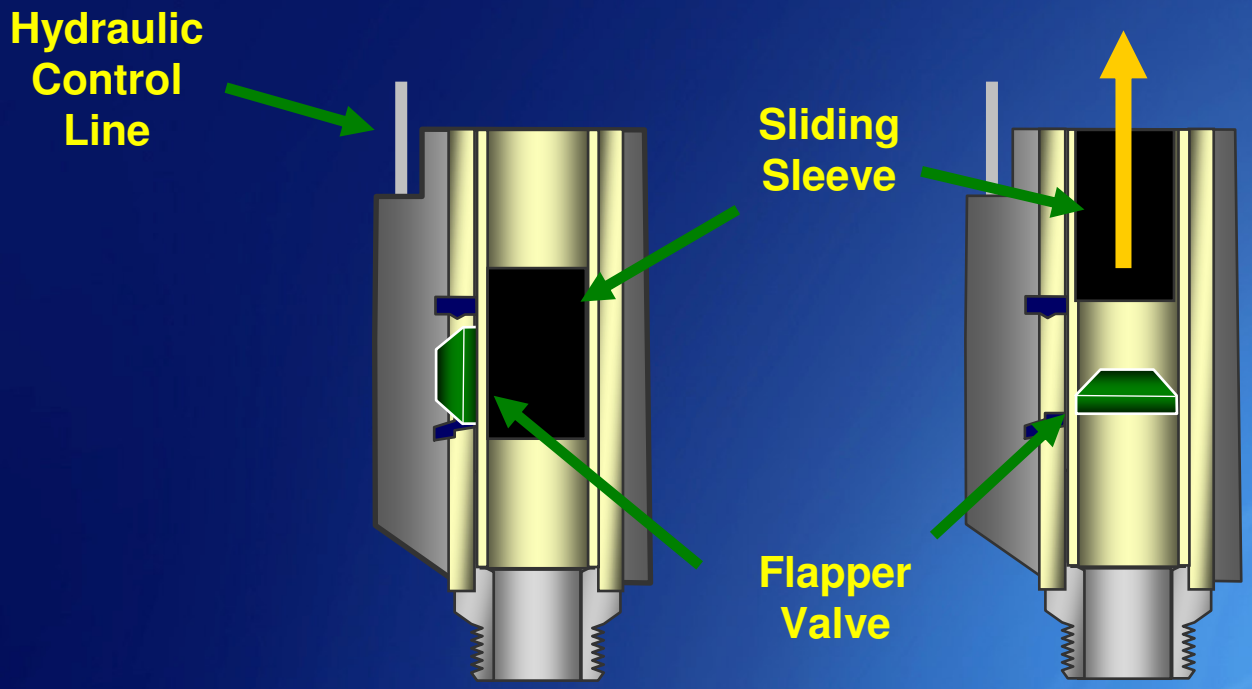
Control Line Firing Pressure



Typical Excape® Module

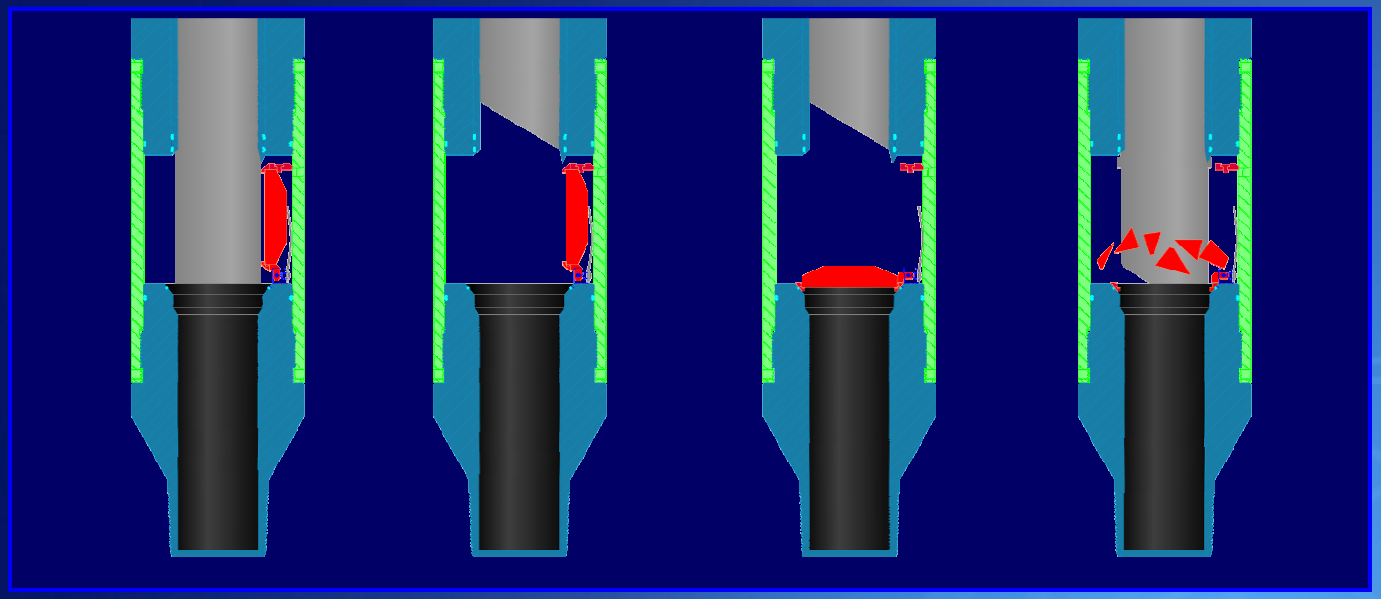


Zonal Isolation Device - Original



- Remotely actuated from the surface
- 7,500 to 14,000 psi differential rating
- Allows upward flow for cleanup w/o removing
- Removable w/ coil tubing or slickline

Disappearing Isolation Valve

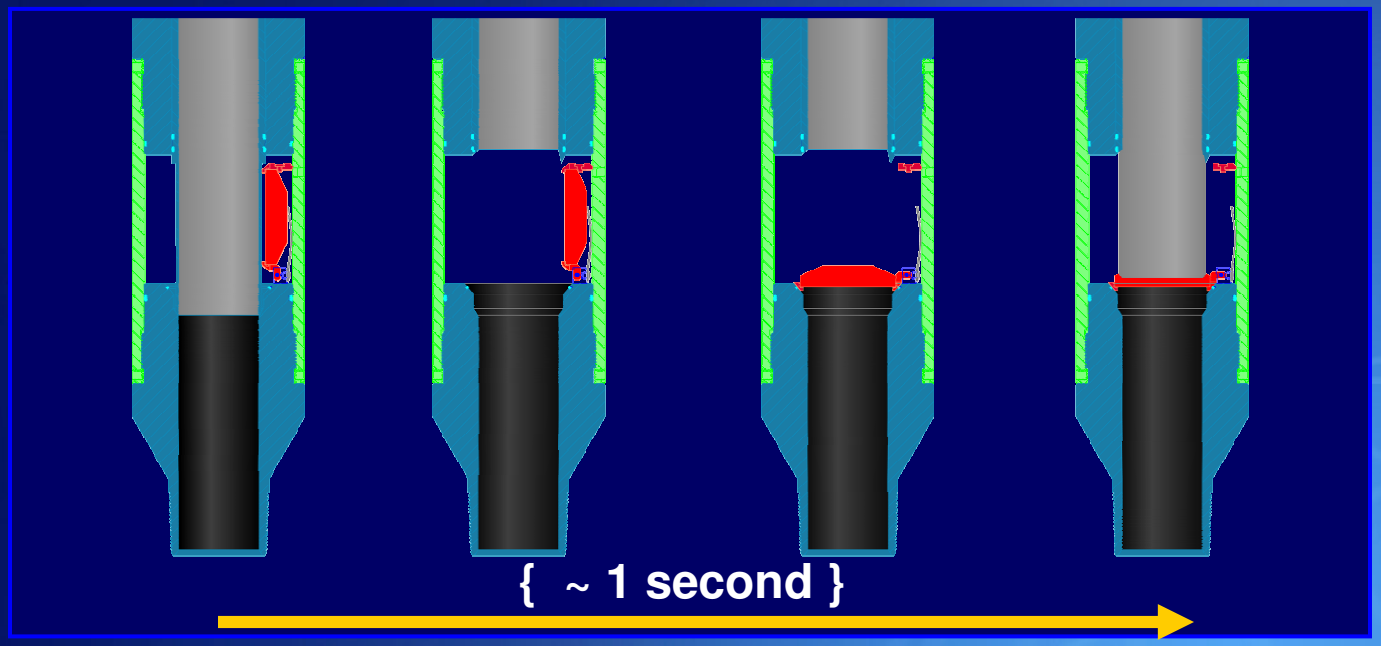


Before Actuation	Sleeve Shifts Up After Perforating	Flapper Valve Closes and Zone Is Frac'd	Sleeve Driven Through Isolation Valve

When NEXT Zone Perforated

- Eliminates coiled tubing for isolation valve removal
- Successfully used in multiple wells

Reclosing Isolation Valve



Before Actuation

Sleeve Shifts Up After Perforating

Flapper Valve Closes

Sleeve Immediately Moves Down

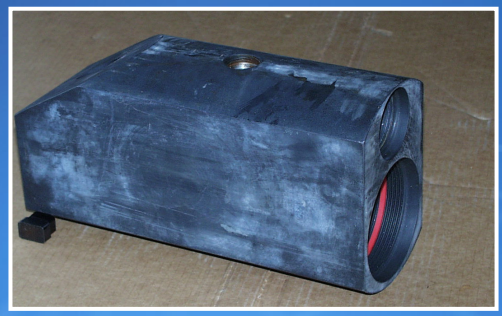
Stops .060" above Flapper

- **Developed for and successfully used in Alaska**

System Components

Perforating Gun on "Y" Blocks

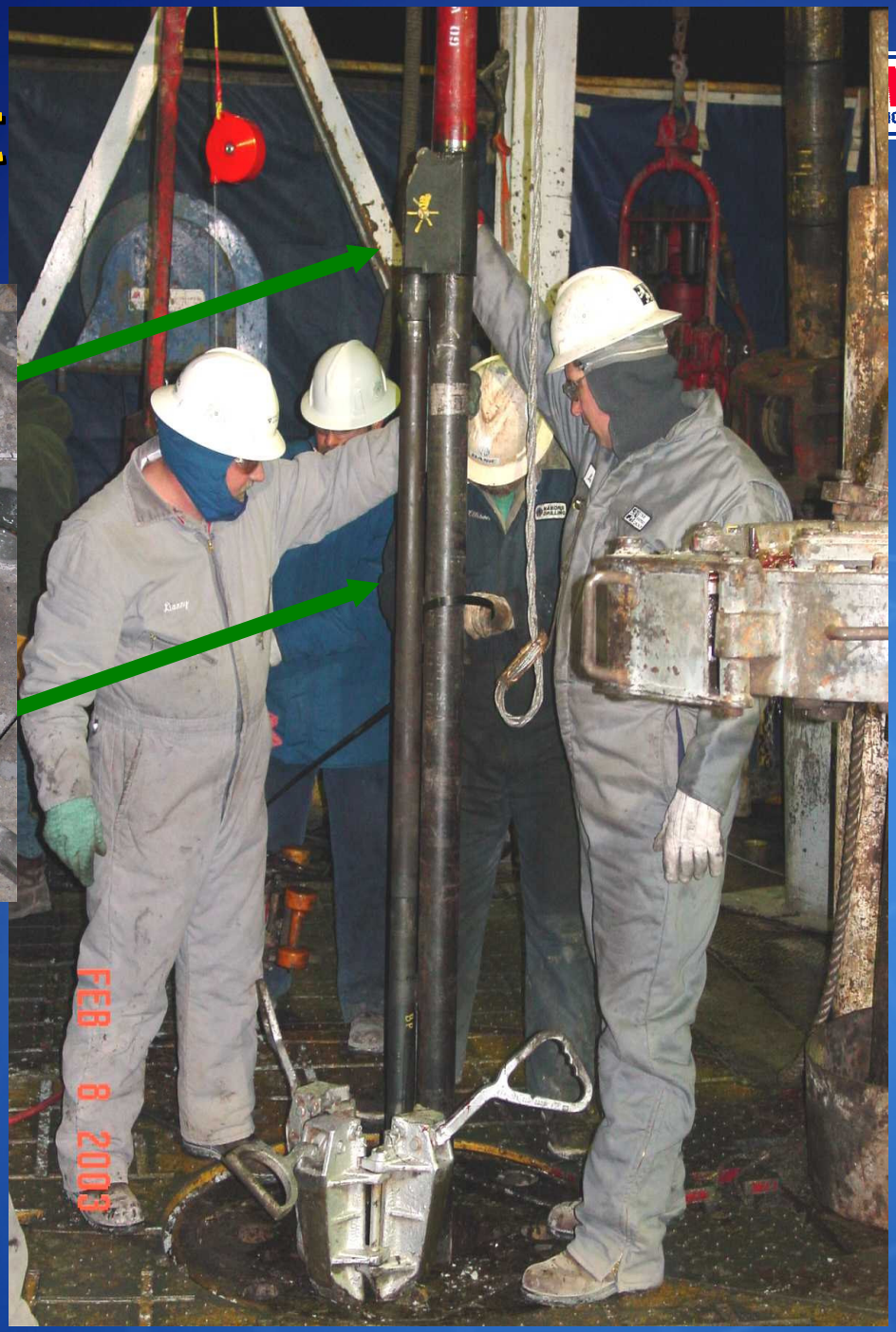
"Y" Block with RA Marker



3 ½ Straight Vane Eccentric

Lower Gun Guide Assembly

Module Placement



Control Line Placement

¼” Stainless Steel Control Line

$^{7}/_{16}$” Protective Line

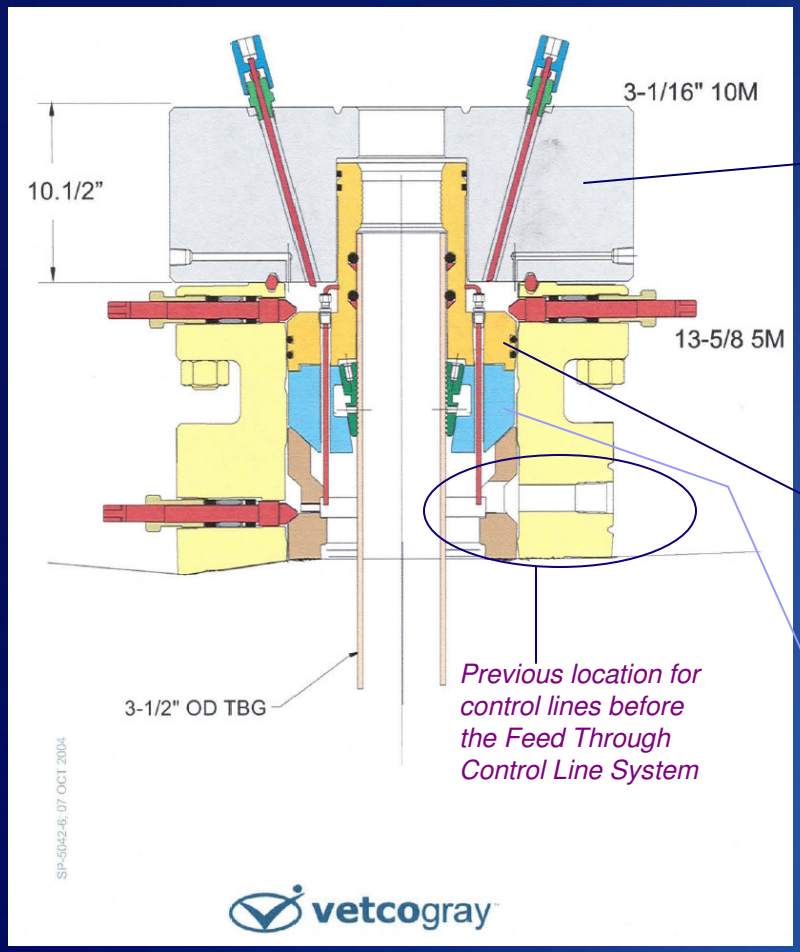
Protection across Collars

- Protectors /centralizers on the joints
  - Pre-installed on the pipe rack
  - Run on every joint

Cementing Operations

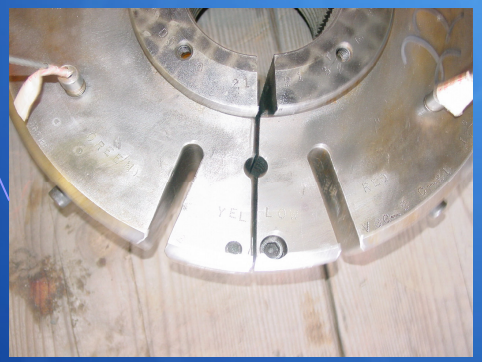
- Using Cement. Not advocates of most open hole packer systems
  - tubing movement during stimulation can damage them.
- Wells are Tapered String Completions
  - With multiple ID's across modules (3.75" casing, X nipples)
- Important to insure no cement is above wiper plug
  - Flush clean to rig floor, and clean up ALL lines
  - Used two stage wiper plug with ball
- PUMP 'TILL YOU BUMP
- Marathon has had excellent success
  - Seems to be a concern to others in non – Excape wells?

Control Line Termination



Tree Bonnet

Pack Off



Hanger

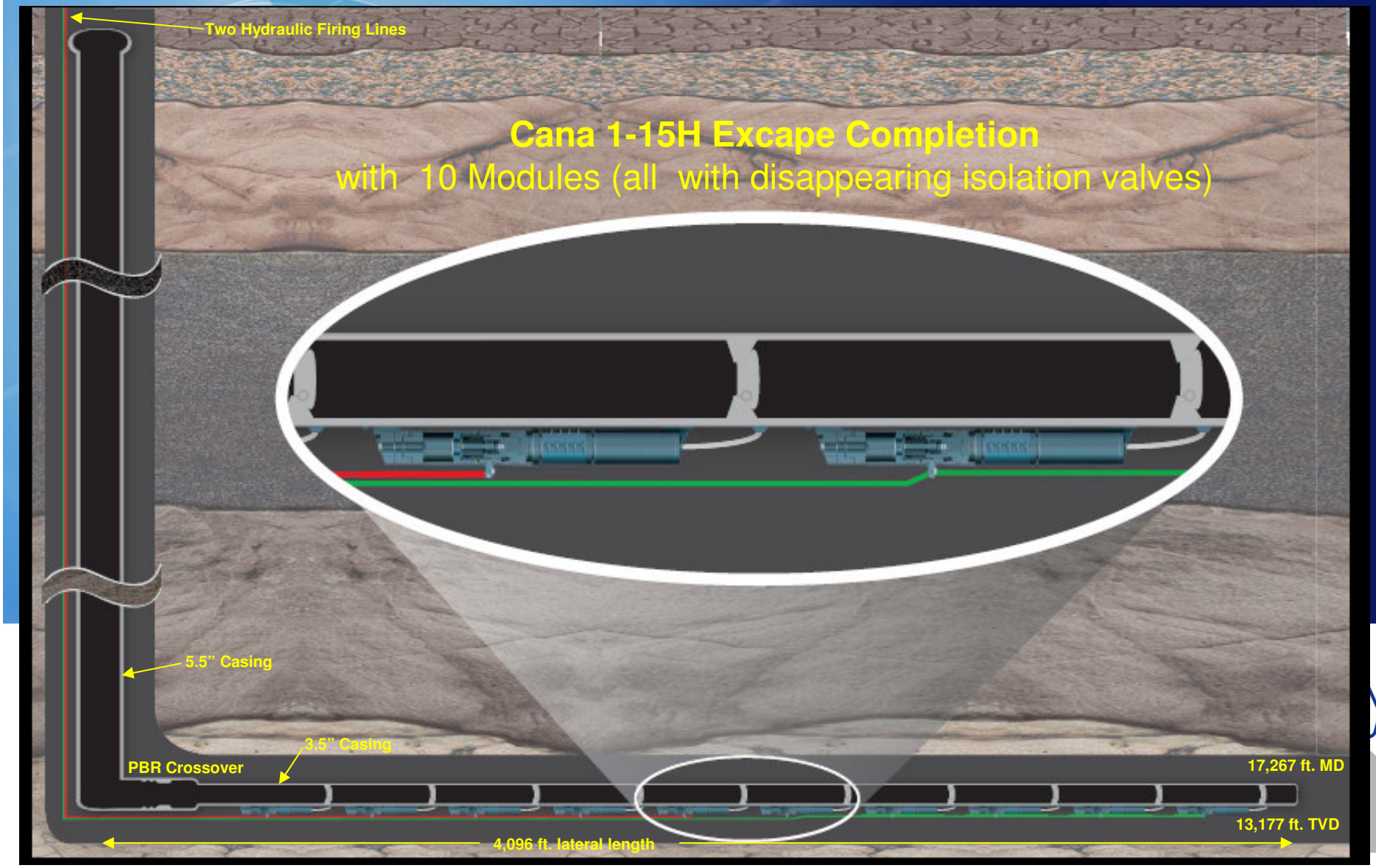
Pack-off in Place above hanger

Installing Tree Bonnet

Control Line Termination at Tree Bonnet

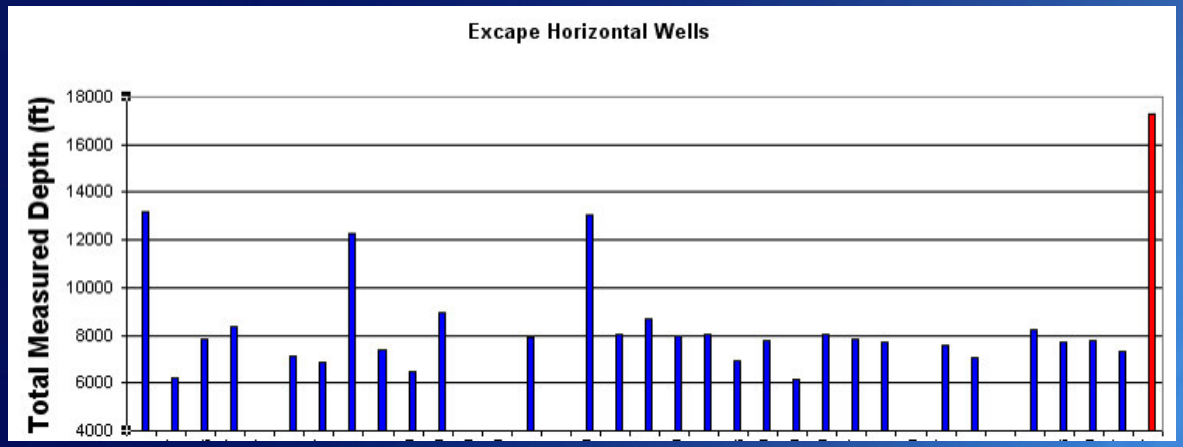
Control Line Valves Protected with Deflector Plate

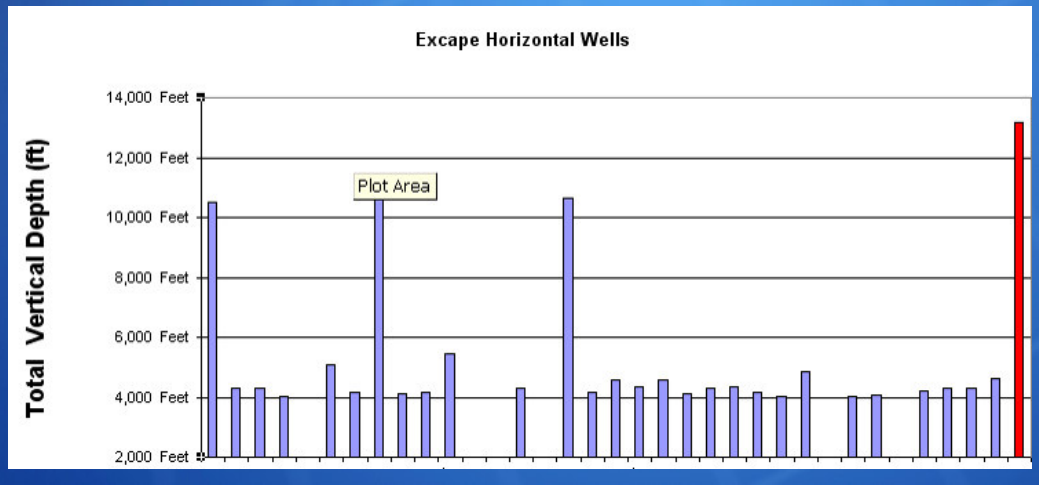
Woodford Shale – Western Oklahoma



Marathon's First Horizontal Woodford Shale Well Utilized Casing Conveyed Perforating Technology

- A significantly more challenging application
  - 17,300 feet deep, 14 lb/gal mud, 10 modules, 5.5" x 3.5" tapered string
    - everything worked as designed





Why This Approach was Utilized: Pre-Job Estimates

- **Cost Reduction**
  - Estimated $380,000 lower completion costs
  - Actual Savings were an additional $300,000
- **Safety** – Reduced personnel exposure

Excape - Cana 1-15 H Well COMPLETION Phase		*Conventional - Cana 1-15H Well COMPLETION Phase*	
MAN DAYS	205 man days	MAN DAYS	321 man days
Man Hrs.	4,908 man hours	Man Hrs.	7,692 man days
High Risk Man Days	8 man days	High Risk Man Days	51 man days
High risk Man Hours	192 man hours	High risk Man Hours	1,224 man hours

Man Hr. Reduction for Completion	2,784 man hours
Personnel Exposure Reduction	36%

High risk Man Hr. Reduction for Completion	1,032 man hours
High Risk Personnel Exposure Reduction	84%

Interesting Highlights

- **Cana 1-15H is believed to be the world's first totally intervention-less completion.**
  - Individually perforated each interval remotely (10)
  - Individually fracture stimulated each interval (10)
  - Actuated each isolation valve remotely (9)
  - Removed each isolation valve remotely (9)
  - Placed the well on production
    - With nothing, (not even a ball) being run or pumped inside the well.

Some Woodford Shale Learning's First Job

- Hardware worked well. Numerous concerns did not materialize.
  - Could detect all guns firing fairly easily.
  - Overlap of firing pins did not present a significant problem.
    - Possible to add two or three additional modules.
  - Currently Marathon is at ~550 modules installed
    - with a 99.8% firing success
- Two examples in the Cana 1-15H well where being able to remotely fire allowed operations to continue without having to mobilize coil
  - ~$300K savings.
- Concern about eroding disappearing isolation control line apart did not materialize
- Woodford Shale does not like it when you stop /start pumping.
- Strategy to space modules farther apart toe to heel was reasonable.

Some Lessons Learned
Woodford Shale Excape Well

- Chemical Tracers were of high value
  - Allows one to know all zones are open without well intervention.
- Cement Zonal isolation was effective.
- Replace Tree Saver with 15K frac valve assembly
  - Much better operational flexibility, especially with Excape®
  - Probably lower cost and lower risk.
- Don't shoot Module 1 ahead of time.
- Many fracture stimulation learning's
  - Not discussed as part this presentation

Path Forward: Woodford Shale

- Two Additional Wells are drilling
- Plan to again utilize Casing Conveyed Perforating
- Next Well: Fiber Optics to be included
- Plan to run 11 or 12 Modules

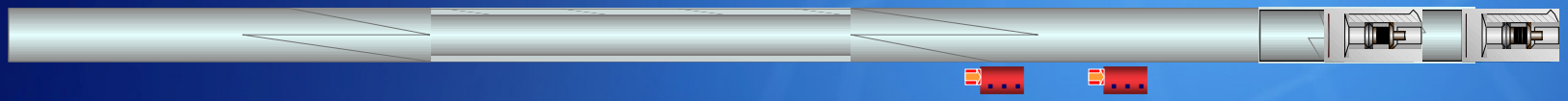
Casing Conveyed Toe Guns

- Firing Head
- Perforating Gun
- Detonating Cord inside 3/8” Control line

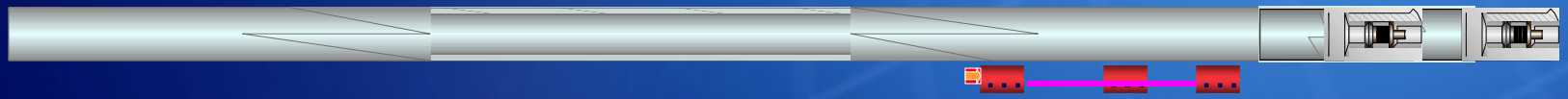
Option 1

5.5” csg.

Float Equipment



Option 2



Technical Operating Efficiencies

	Marathon	Total Industry	Horizontal
Modules Attempted to Install	501 modules	1001 modules	329 modules
Modules Actually Installed	501 modules	984 modules	312 modules
Module Installation Success Statistics	100.0%	98.3%	94.8%
Modules Attempted to Fire	493 modules	946 modules	303 modules
Modules Successfully Fired	491 modules	923 modules	290 modules
Firing Success Statistics	99.6%	97.6%	95.7%
Successful Well Installation Count	44 wells	96 wells	32 wells

Review Date 10/4/2008

Conclusion

- The technology worked in this difficult well
- There are cost benefits
- There are safety benefits