



G L O B A L F O R U M



**On Flaring and Venting Reduction
and Natural Gas Utilisation**

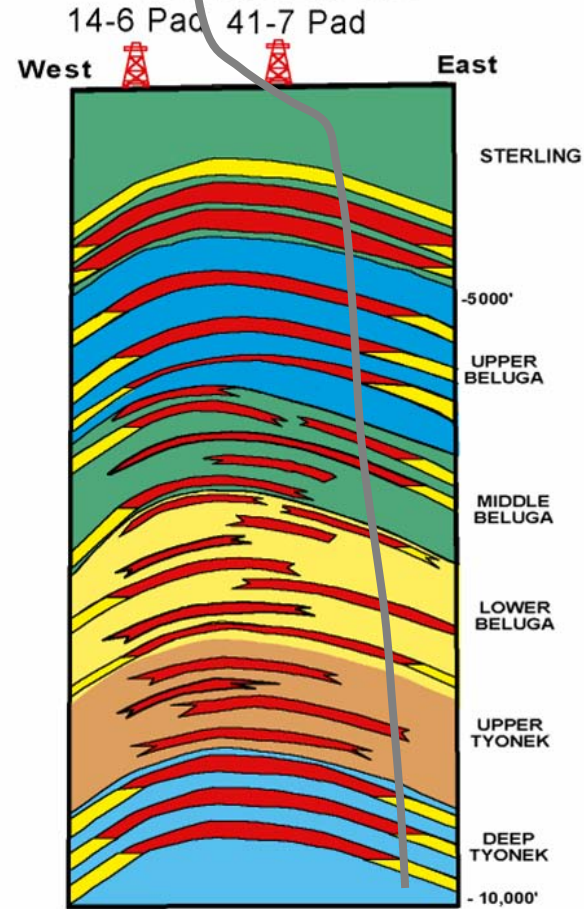
Advanced Well Completion Technology to Reduce Methane Emissions and Use of Infrared Cameras for Leak Detection

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Marathon Oil Company

How am
I going
to frac
this???

KENAI GAS FIELD DIAGRAMMATIC
CROSS SECTION

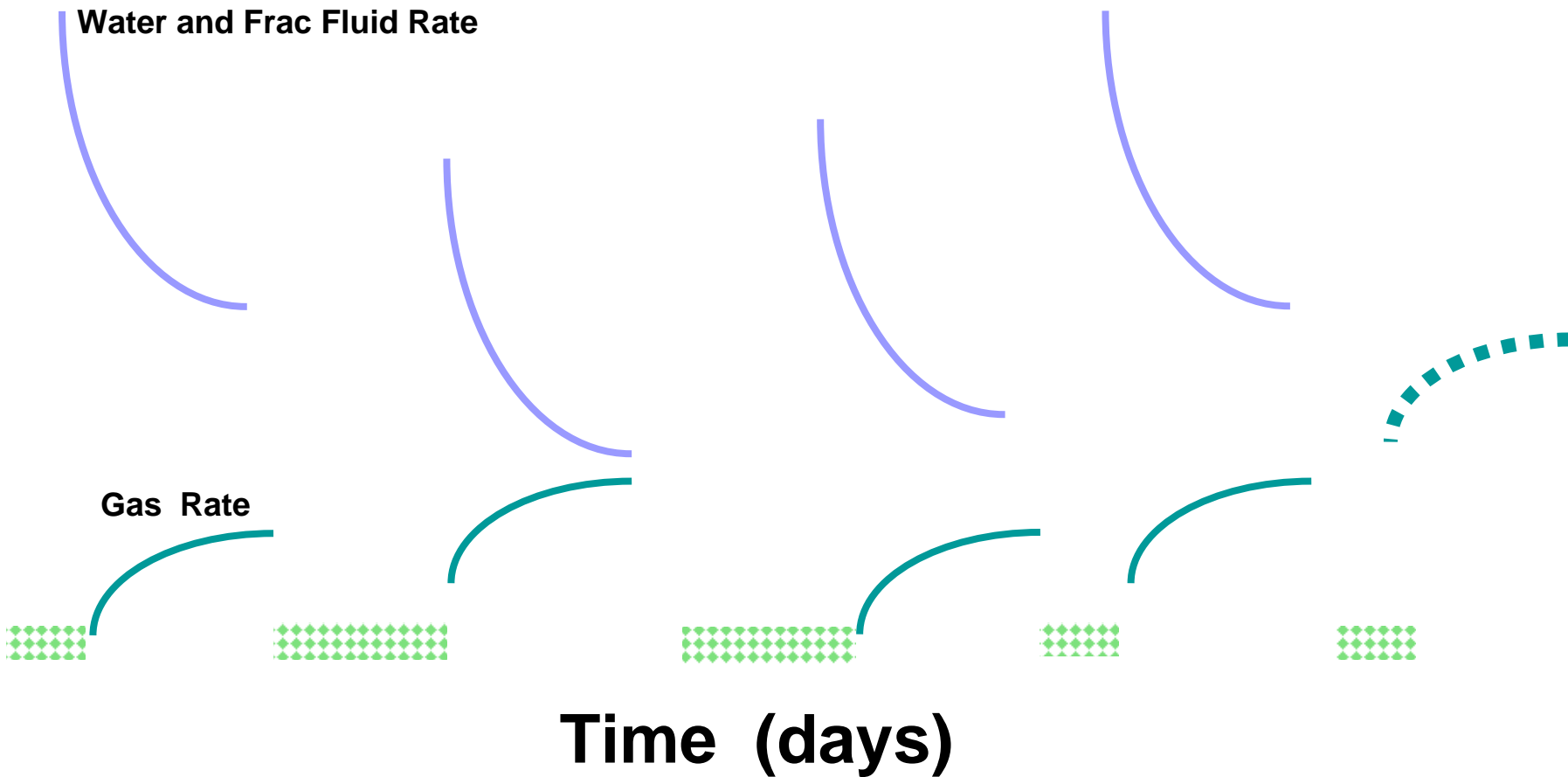


Conventional Industry Solution

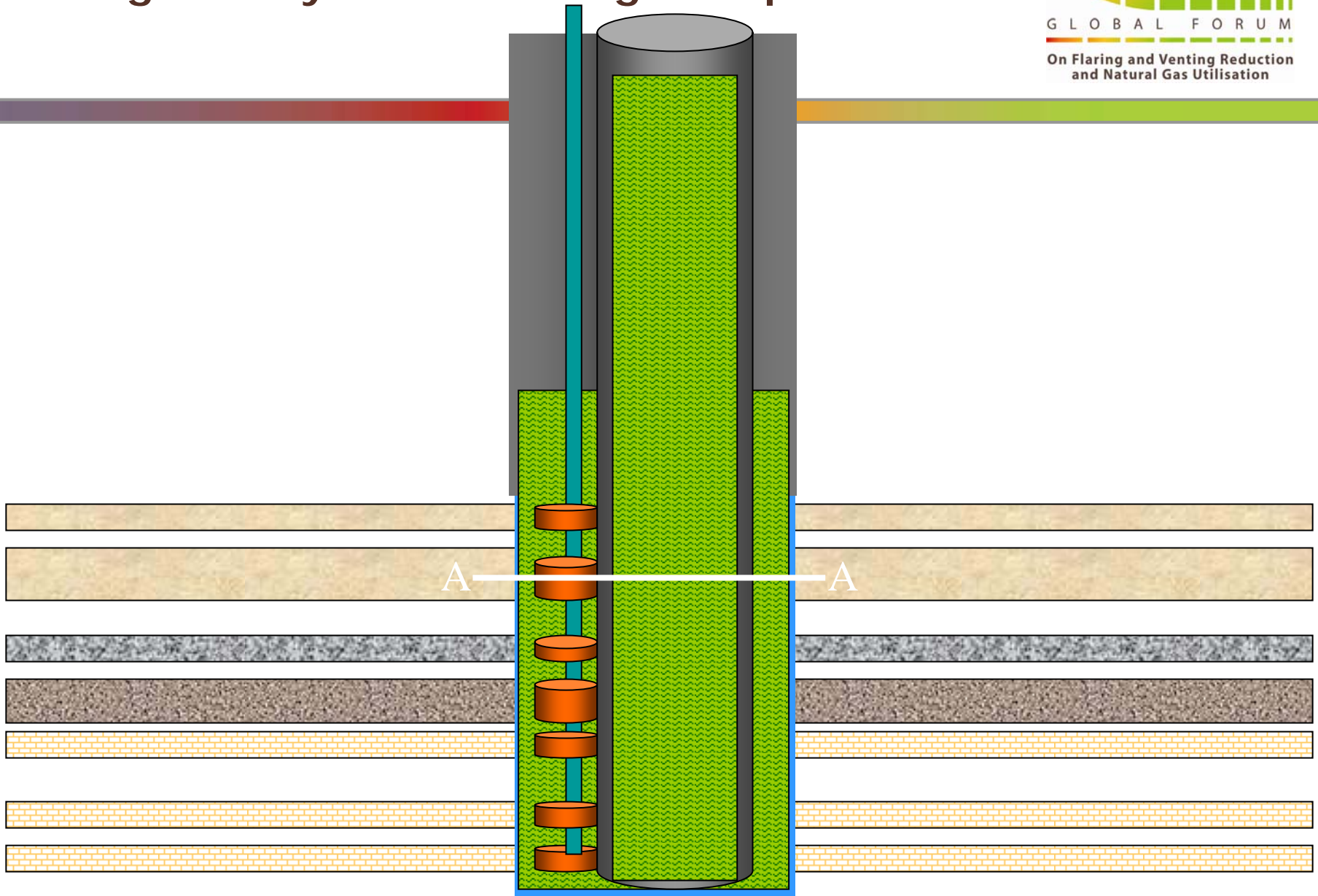
a few years ago

- Common stimulation technique
 - “cherry pick” individual zones
 - Perforate and attempt to stimulate multiple intervals
 - Flow back (venting gas)
 - Isolate lower intervals
 - (repeat process multiple times)
 - Remove all isolation devices and flow well.
- Not very effective
 - Inevitably bypass much pay
 - Compromise stimulation design
 - Time consuming and costly
 - Infrastructure issues in certain locations

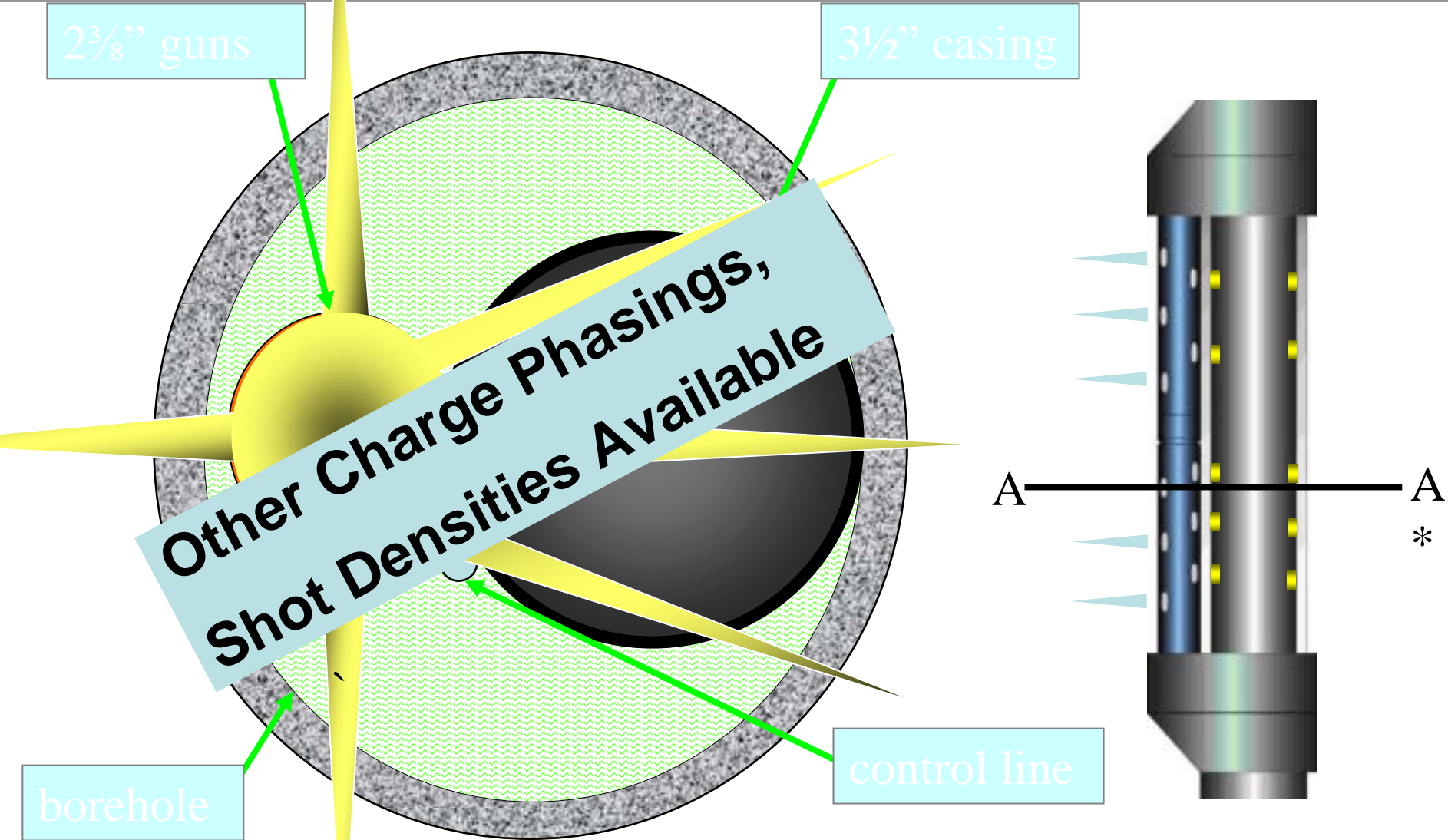
Conventional Well Completion



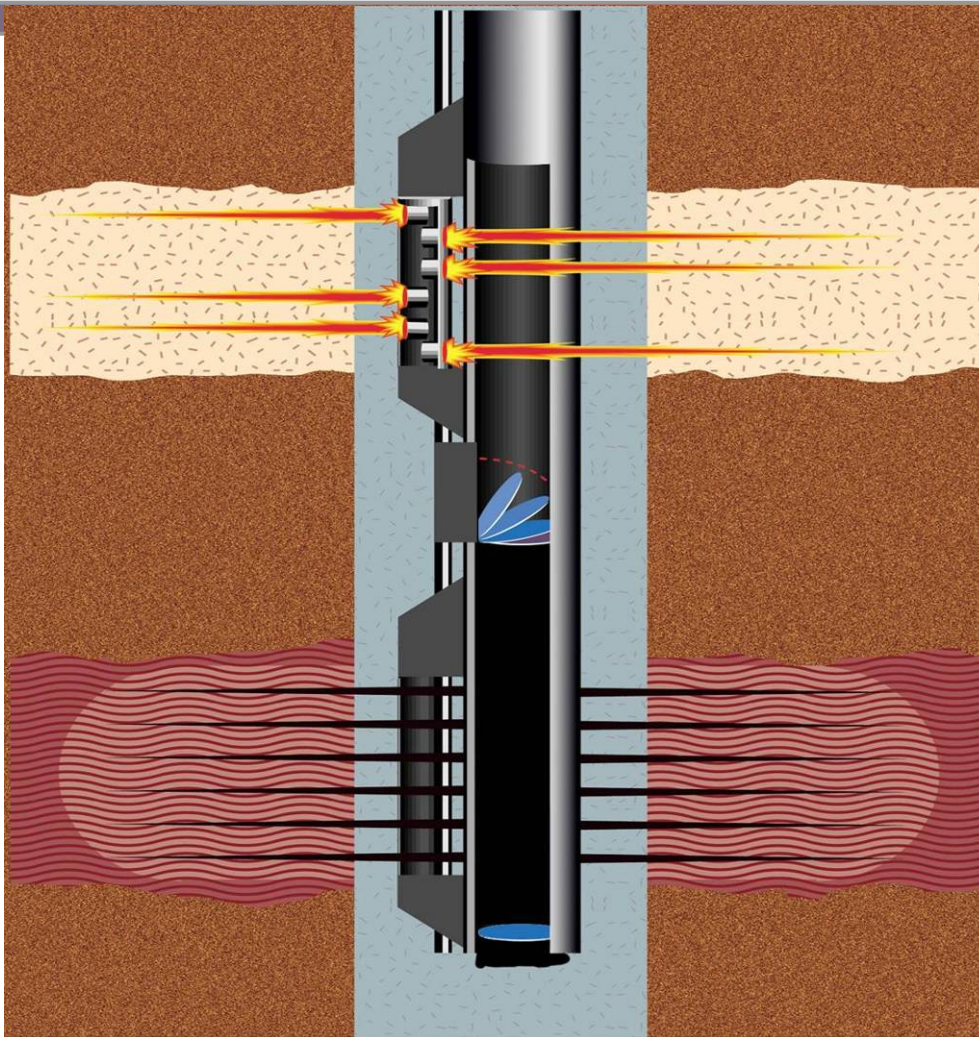
Casing Conveyed Perforating Completion



Cross-Section of Gun Assembly



Isolation Valve Below External Perforating Gun

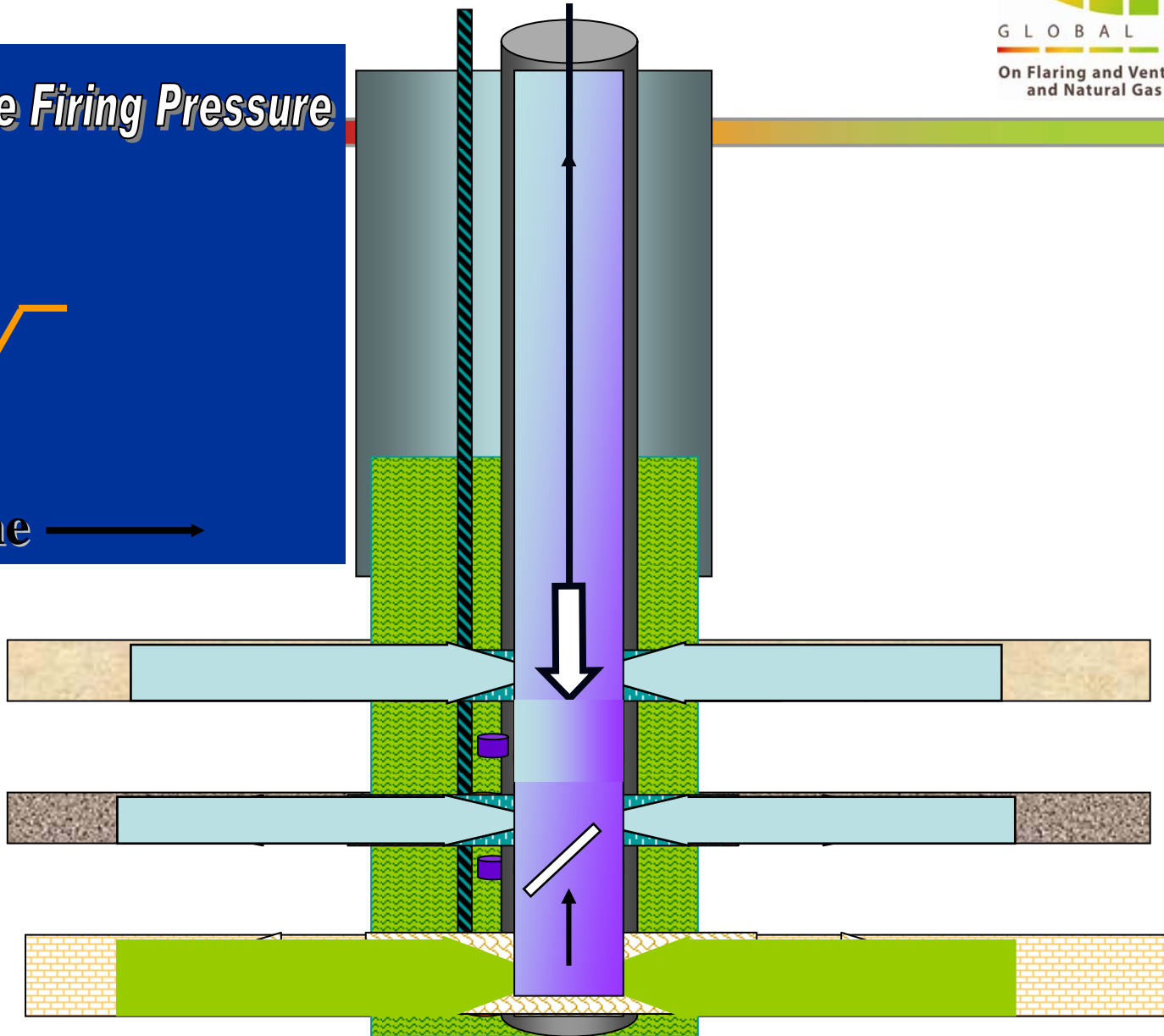
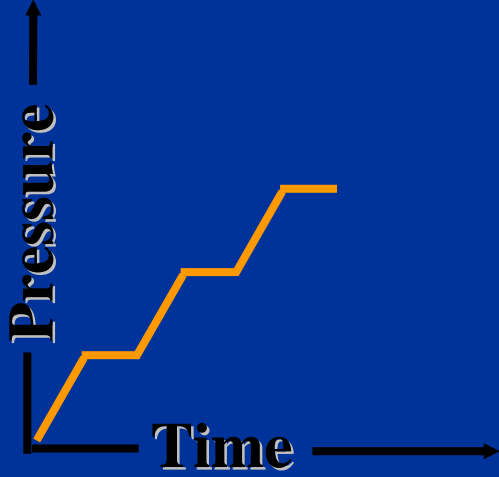


- Firing the gun actuates a lower isolation valve.
- Valve actuates when a protective sleeve shifts.
 - Compatible with cementing and fracturing operations
- Frangible; flapper valve removal is usually easy
 - PAST: with coiled tubing.
 - NOW: DISAPPEARING
 - Next firing removes the lower isolation valves

Module Placement



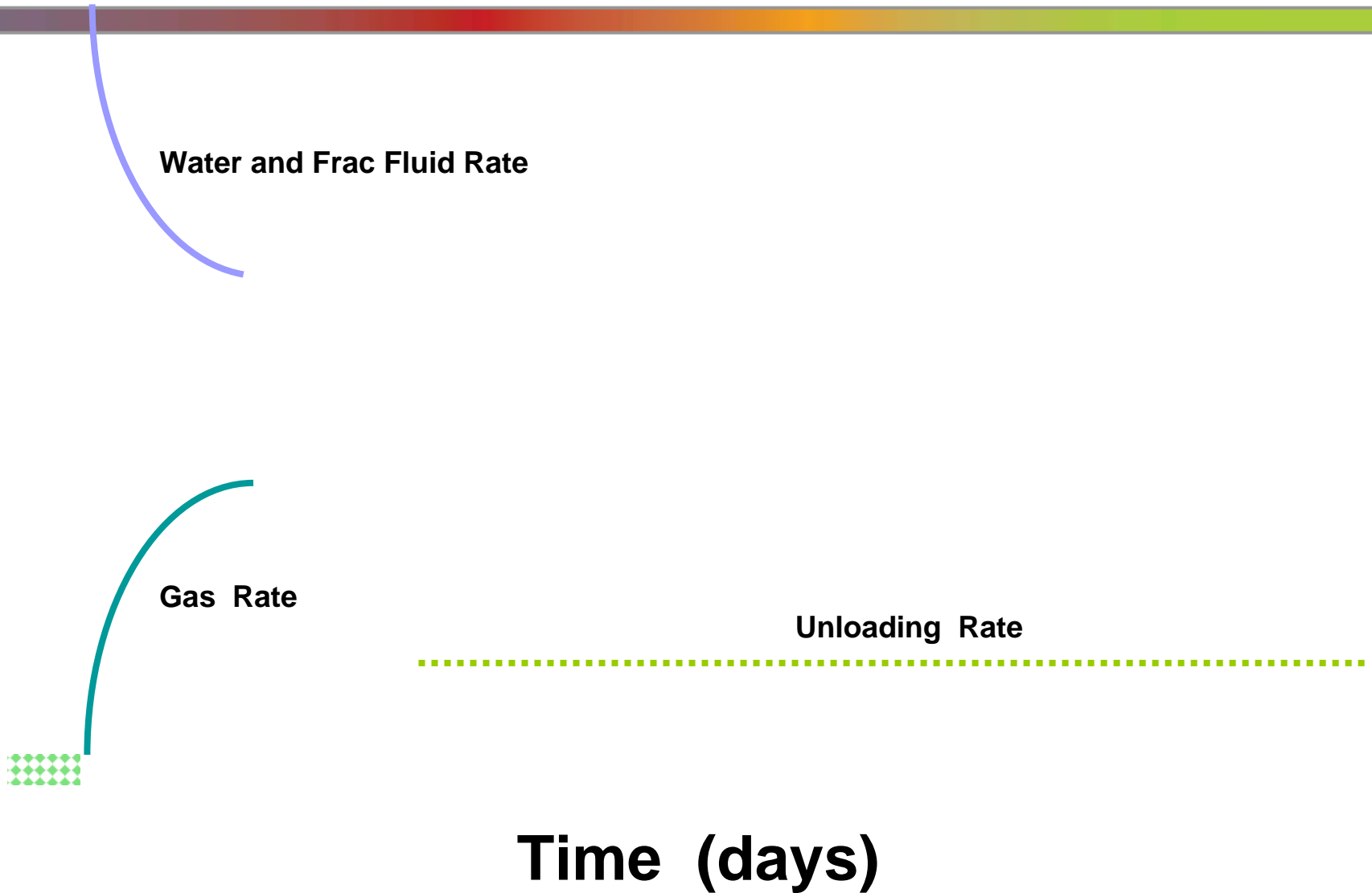
Control Line Firing Pressure



Technical Achievements Marathon Alaska

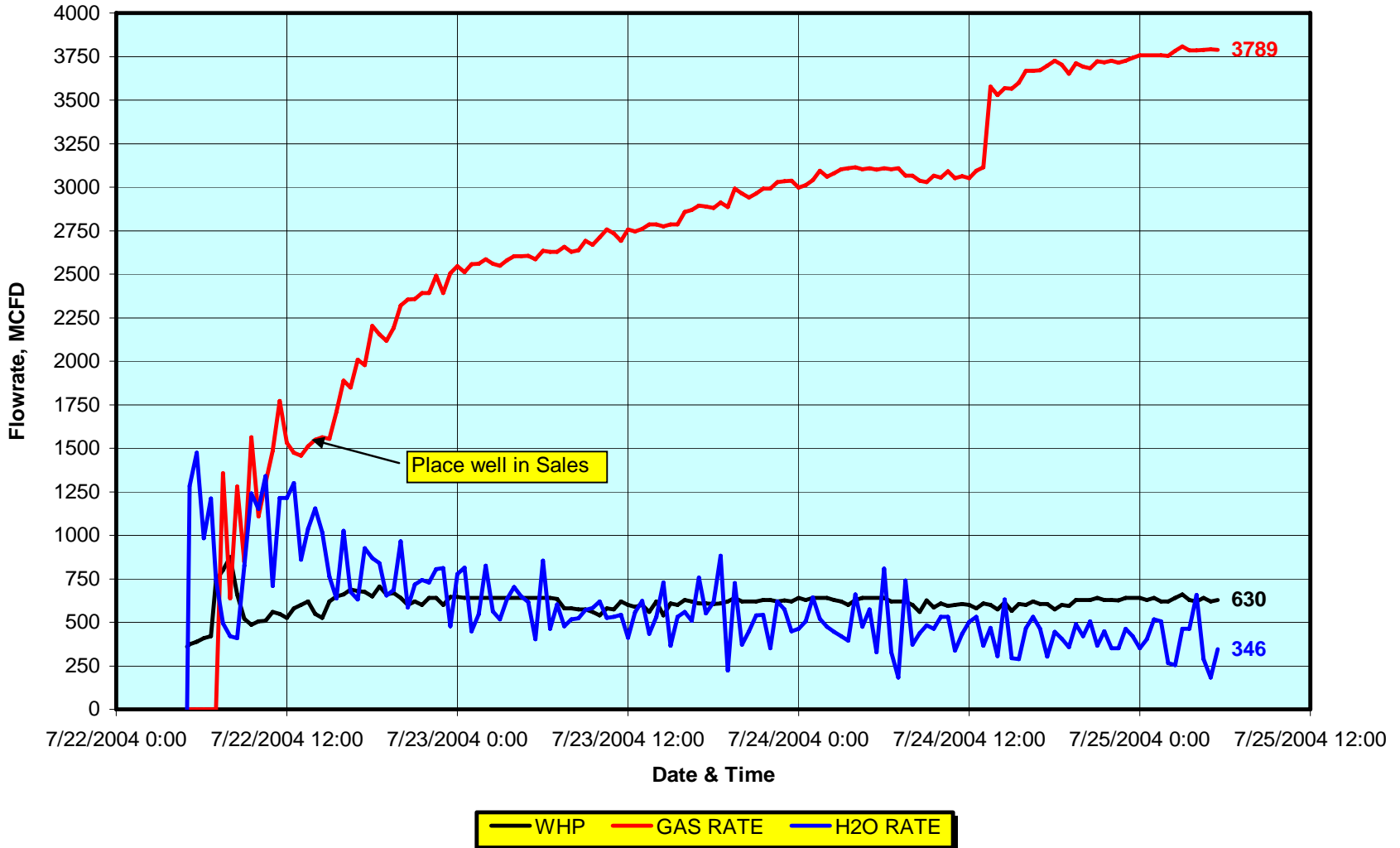
- Single Day Completion – 24 hour period
 - 16 stages fracture stimulated
 - with well cleanout and isolation valve removal
 - gas to sales within 30 hours

Escape Well Completion



Marathon Alaska Escape Well Post –Completion Production Data

KBU 23-7 Test Data
As of 0530 7/25/04



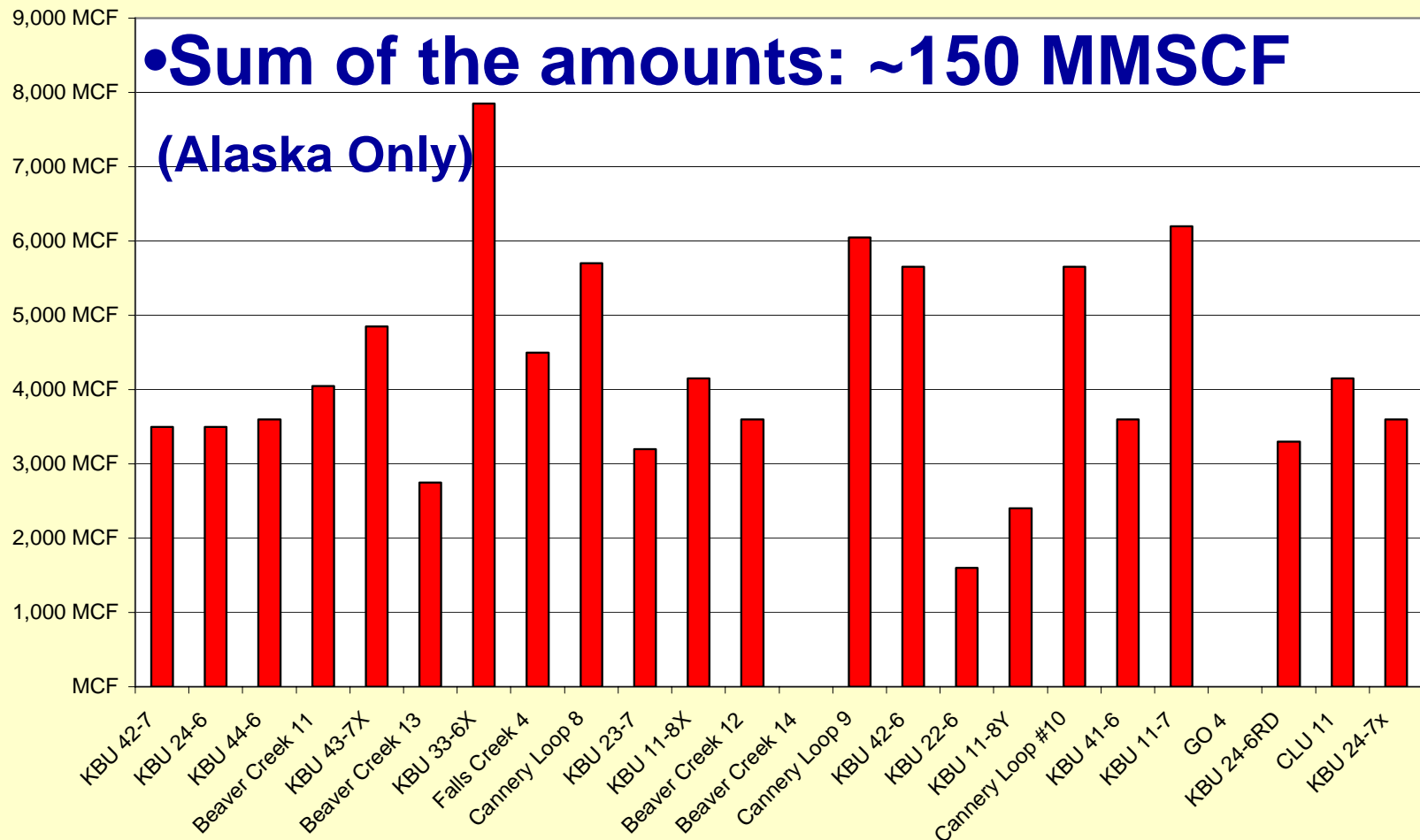
How Much Gas Was Not Vented? Marathon Alaska Escape Wells

Escape Completion Process Well Name	Location	Depth	Modules Completed (Zones Completed)	IP	Escape: Estimated Venting Before Sales	Total Vent time
KBU 42-7	Alaska	7,500 feet	15 modules	3,150 MCFD	700 MCF	

Conventional: Number of Frac Stages	Conventional: Estimated Venting per day, per Stage	Conventional: Estimated Number of Venting Days Per Stage	Conventional: Total Vented Volume	Reduction in Venting Volume
4	350 MCFD	3. days	4,200 MCF	3,500 MCF

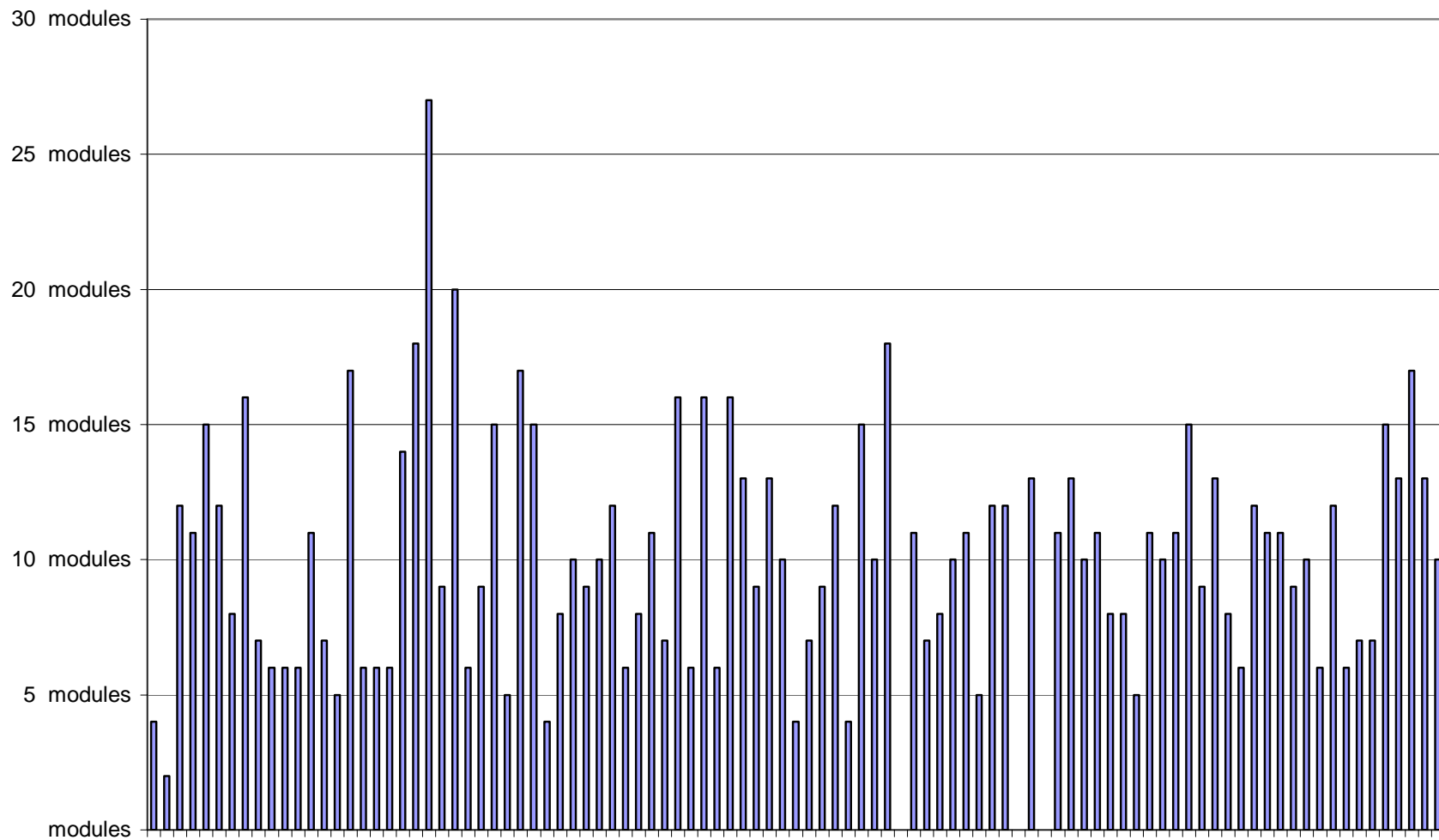
Estimated Gas Not Vented

Reduction in Venting Volume



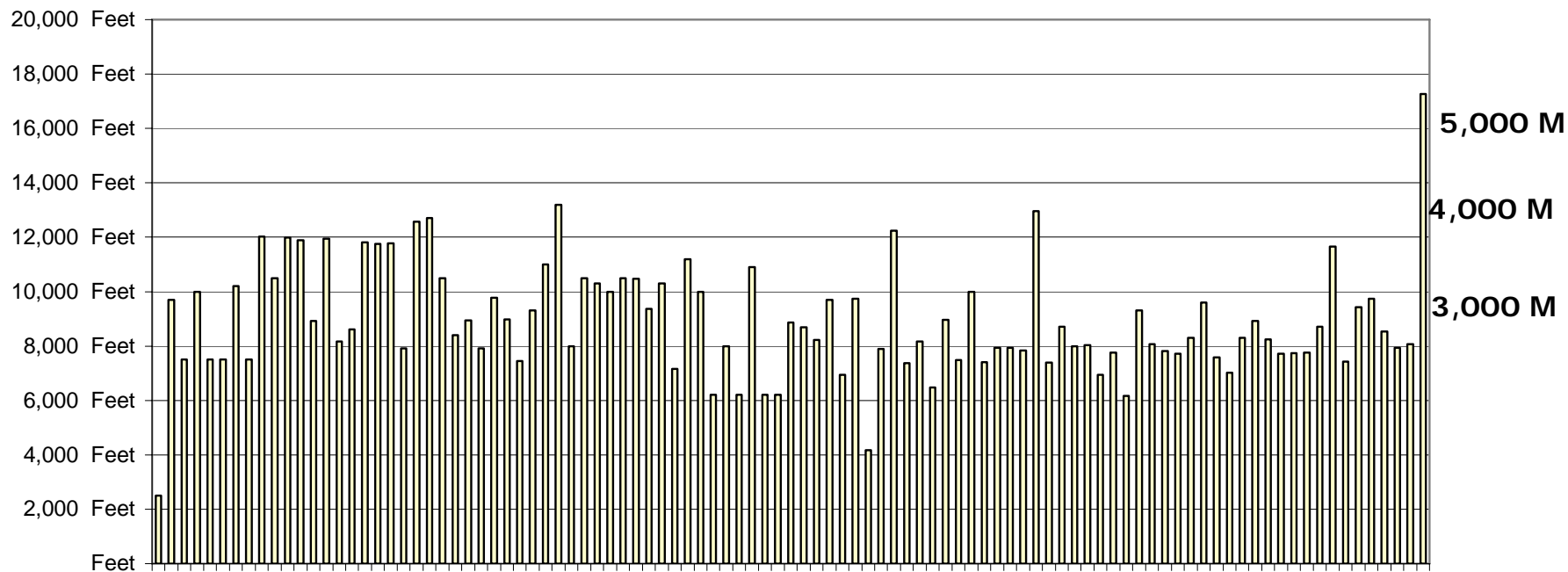
Modules Run Per Well

Modules Run Per Well



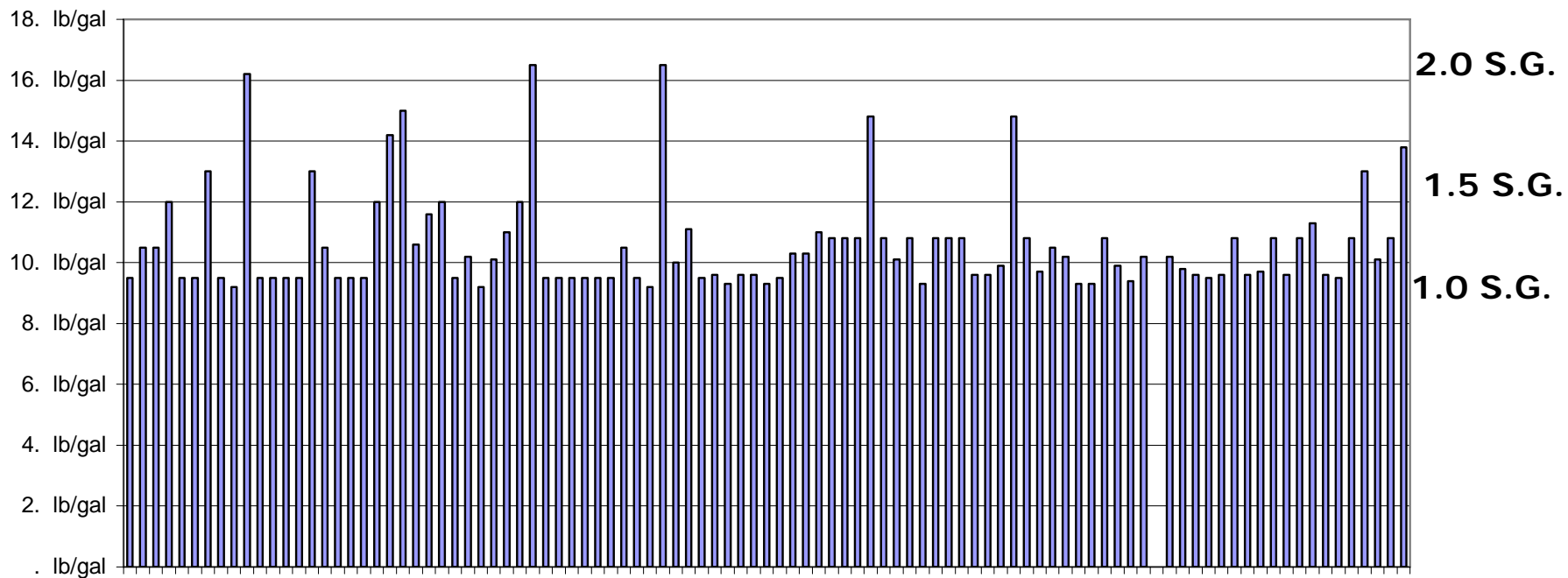
Well Depths Well

Escape Installations, Well Depth



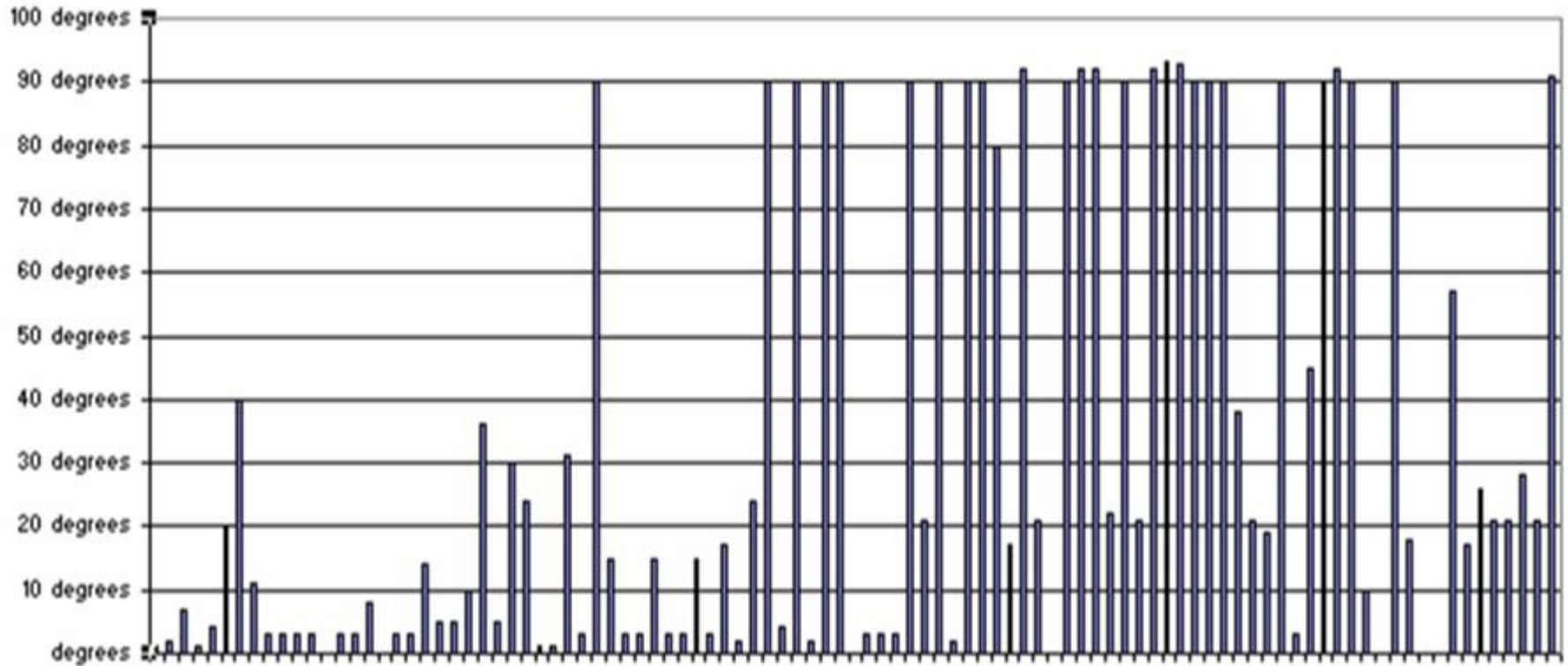
Mud Weights Encountered

Escape Installations, Mud Weights



Well Deviations

Maximum Open Hole Deviation



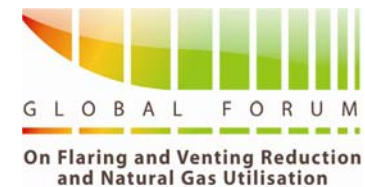
Excaped:

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
<i>Review Date 10/4/2008</i>			

Recent Marathon Horizontal Well

Depth: 17,300 feet (5,300 meters)



Cana 1-15H Woodford Shale Well

Conventional Completion Costs	\$ 4,374,500
Excape Completion Costs	\$ 3,994,200
Estimated Savings	\$ 380,300

- Cost Reduction

*note: extra time for drilling rig during completion is included

- Safety

Excape - Cana 1-15 H Well COMPLETION Phase		Conventional - Cana 1-15H Well COMPLETION Phase	
MAN DAY\$	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%

Believed to be world's first totally intervention-less completion

Conclusion

This Technology is reliable, and has safety and environmental benefits

(~50% reduction in man hours, less exposure)

It has led to development of competing multi-zone stimulation techniques, which is beneficial to industry as a whole.

The amount of gas which can avoid being vented is very significant.

ThermaCAM GasFindIR Camera

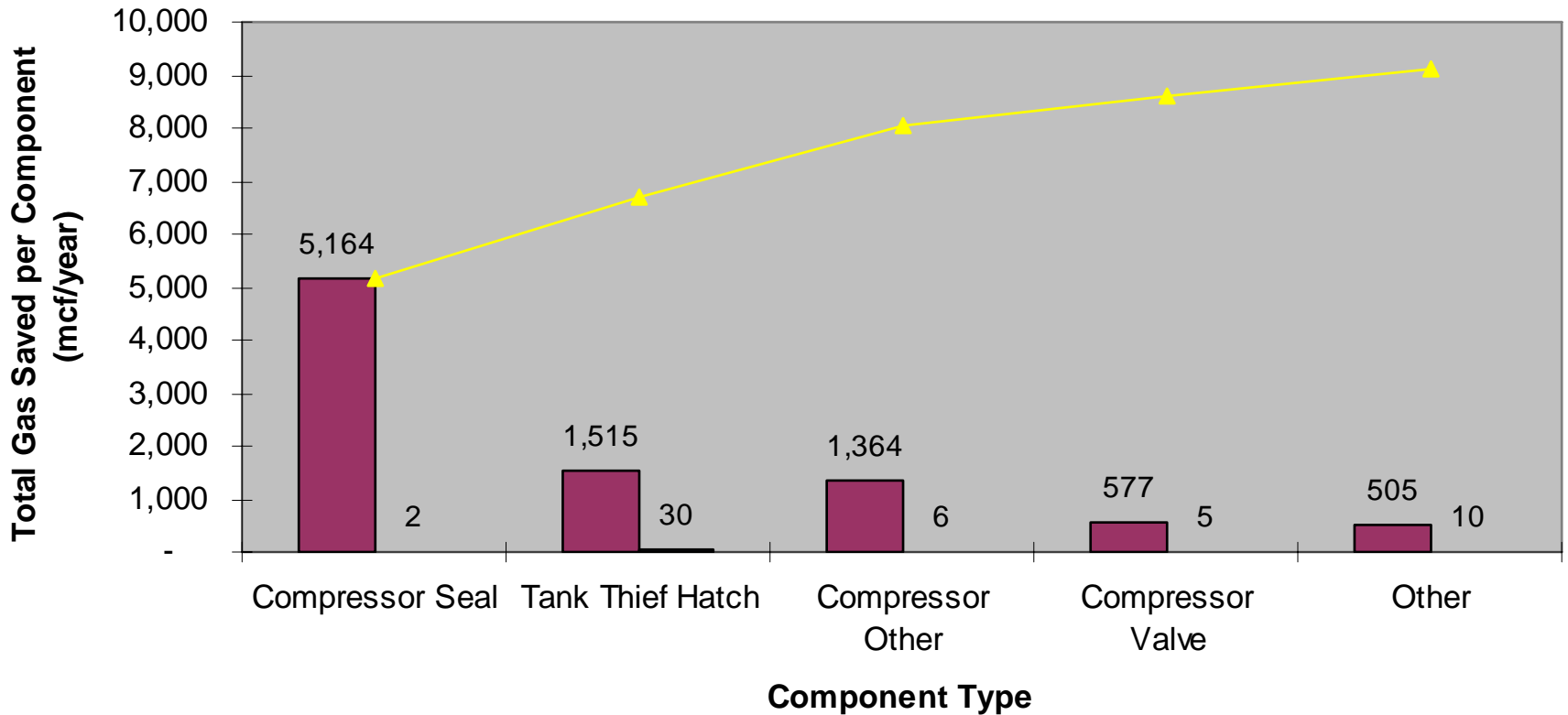


- The hand-held infrared (IR) camera is a screening tool
- Can detect emissions not visible to the naked eye
- Provides actual images of the gas plume in real-time

ThermaCAM GasFindIR Camera

- Can see natural gas & other volatiles:
 - **Benzene**
 - **Butane**
 - **Ethane**
 - Ethylbenzene
 - Ethylene
 - Heptane
 - Hexane
 - Isoprene
 - MEK
 - **Methane**
 - Methanol
 - MIBK
 - Octane
 - **Pentane**
 - 1-Pentane
 - **Propane**
 - Propylene
 - Toluene
 - Xylene
- Cannot detect H_2S , CO_2 , CO , or NO_x
- Cannot differentiate the gas components or quantify the emissions

IR Survey: Total Gas Saved per Component per Year



Total Gas Saved per Component
 Total # of Leaks per Component
 Cumulative Gas Saved

Component Type Leaks:

- Valve (37)
- Tank Thief Hatch (30)
- Other (10)
- Compressor Other (6)
- Compressor Valve (5)
- Connection (4)
- Open Ended Line (3)
- Compressor Seal (2)
- Flange (2)
- Compressor Connector (2)
- Compressor Open Ended Line (2)
- Pressure Relief Valve (1)
- Compressor Pressure Relief Valve (1)

Camera Video

- **Video 1**
- **Video 2**