



EXPRO

**Innovation drives efficiency in rigless well
abandonment - a case study**

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Expro

Introduction

- **Client:** Major North Sea Operator
- **Location:** SNS gas field
NUI
Initial field reserves of 250bcf

- **1996**

- First gas production

- **2016**

- Low levels of gas production with significant water production
- Platform now considered sub-economic
- Decision taken to permanently abandon all wells and decommission the facility

- Well abandonment duration planned for 70 days



Project outline

Priority: safe and cost-effective abandonment operation

How: 5-well rigless thru-tubing abandonment supported by self erecting jack-up barge

Services: Permanent Bridge Plugs

Tubing/Casing Perforators

Tubing Cutters

Well	Permanent Bridge Plug	Perforate Tubing	Perforate Tubing and First Casing String	Perforate Tubing, First and Second Casing Strings	Tubing Cut
1	✓	✓	✓		
2	✓	✓	✓		
3	✓	✓	✓		
4	✓	✓	✓		
5	✓	✓	✓	✓	✓

All services to be run on slickline

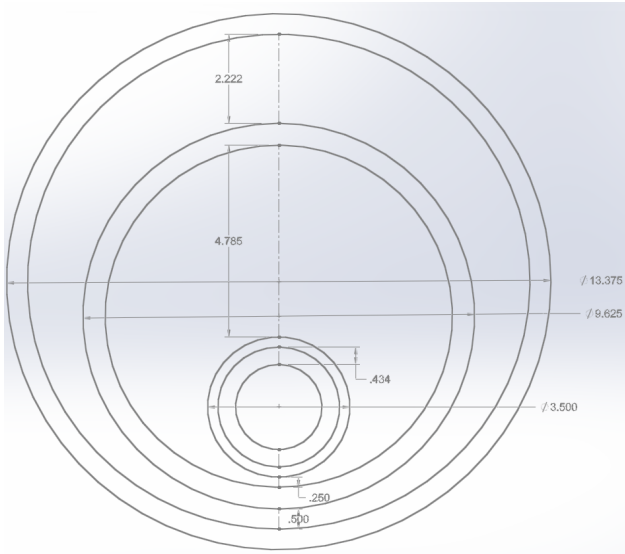
Key

	Existing Plug and Perforating Gun Technology Available
	New Perforating Gun Technology Required
	Existing Tubing Cutter Technology To Be Tested to Confirm Acceptance

By: Multi-discipline 3 man intervention crew

Key challenges

- Perforating through **multiple barriers** with **limited damage** to the final barrier



3 1/2" Tubing

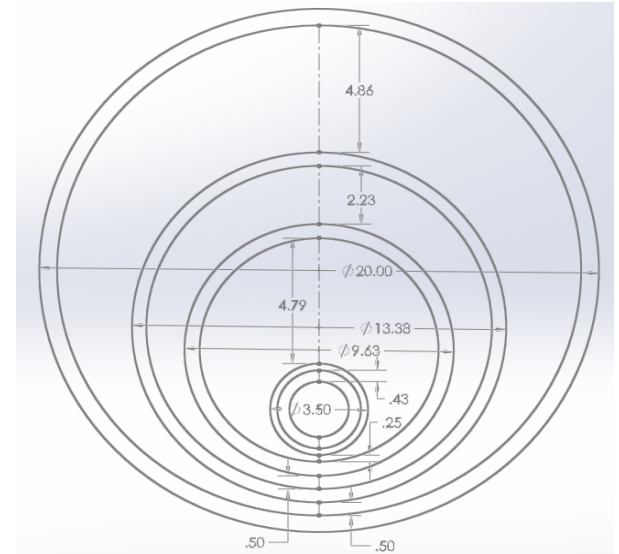
4 1/2" Tubing

5 1/2" Tubing

9 5/8" Casing

13 3/8" Casing

20" Casing

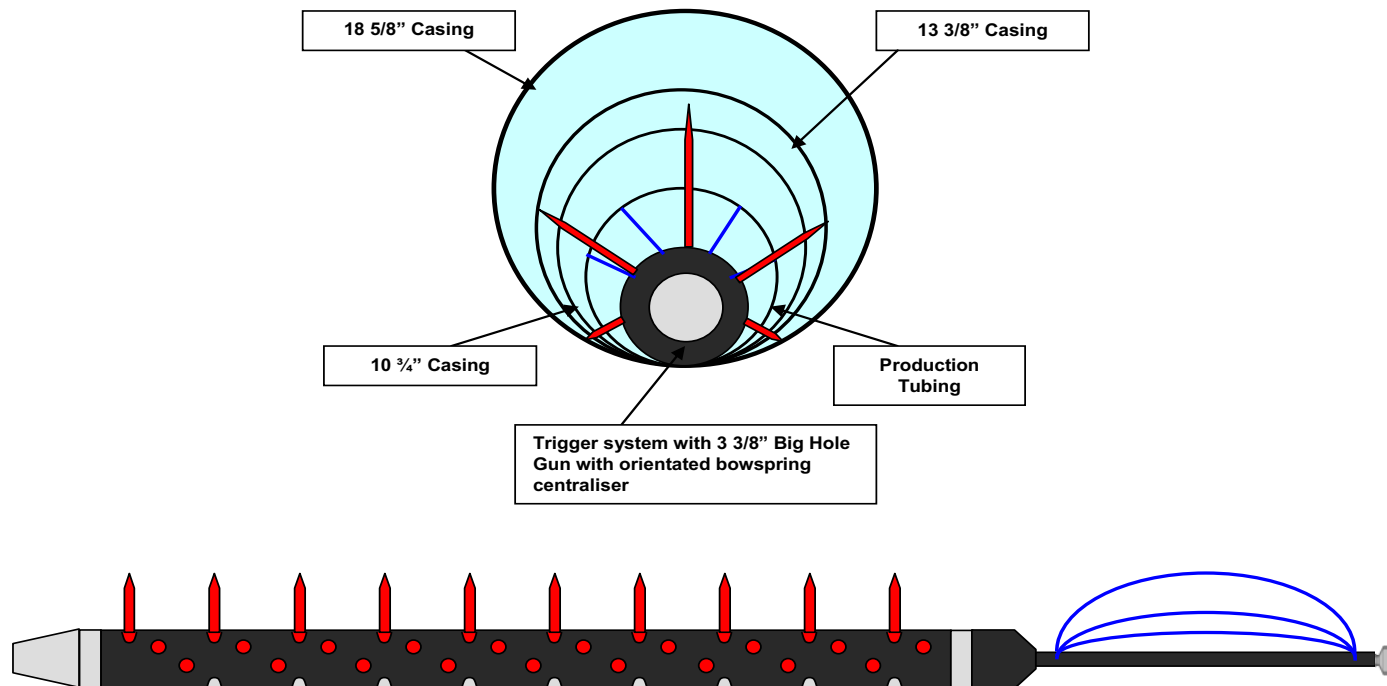


- Short **time scale** to develop and deliver new perforating charges/guns
- Cut tubing and triple encapsulated injection line to ensure **no conduit is left through cement plugs**
- Potential salt accumulations in wells **restricting wellbore access**

Existing perforating technology

Perforating through **multiple barriers** using standard DP or BH perforating charges

3 3/8" BIG HOLE GUN CHARGE ORIENTATION FOR PERFORATING PRODUCTION TUBING, 10 3/4" & 13 3/8" CASINGS ON BP MILLER ABANDONMENT WELLS



- 10 x Charges to be downloaded from the low side of 3 3/8" 11ft 6spf Big Hole Gun leaving 50 shots at 60 deg phasing.
- Modified bowspring centraliser fitted to the bull plug with 4 x fins orientated on the same plane as the upper high side shots (this will ensure that the gun is forced to the low side of the tubing ensuring the 18 5/8" casing is not penetrated).

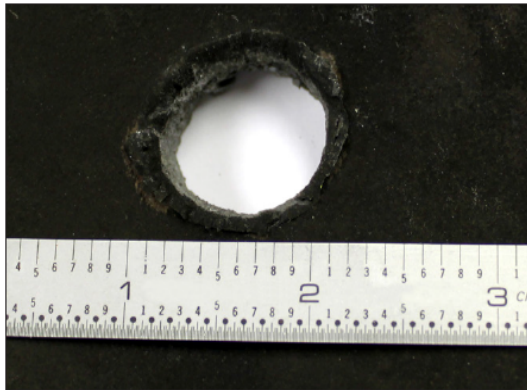
New perforating technology - PAC™

- **Owen PAC™ – Plug and Abandonment - Circulation**

- Superior option to standard tubing/casing perforators
- 0° - 360° coverage
- Large diameter exit holes
- Designed and developed to produce **limited damage to secondary string** regardless of primary to secondary string orientation



Single Charge Test - 9 5/8" Casing with 13 3/8" Witness Plate



- **Multiple tubing/casing string penetration**

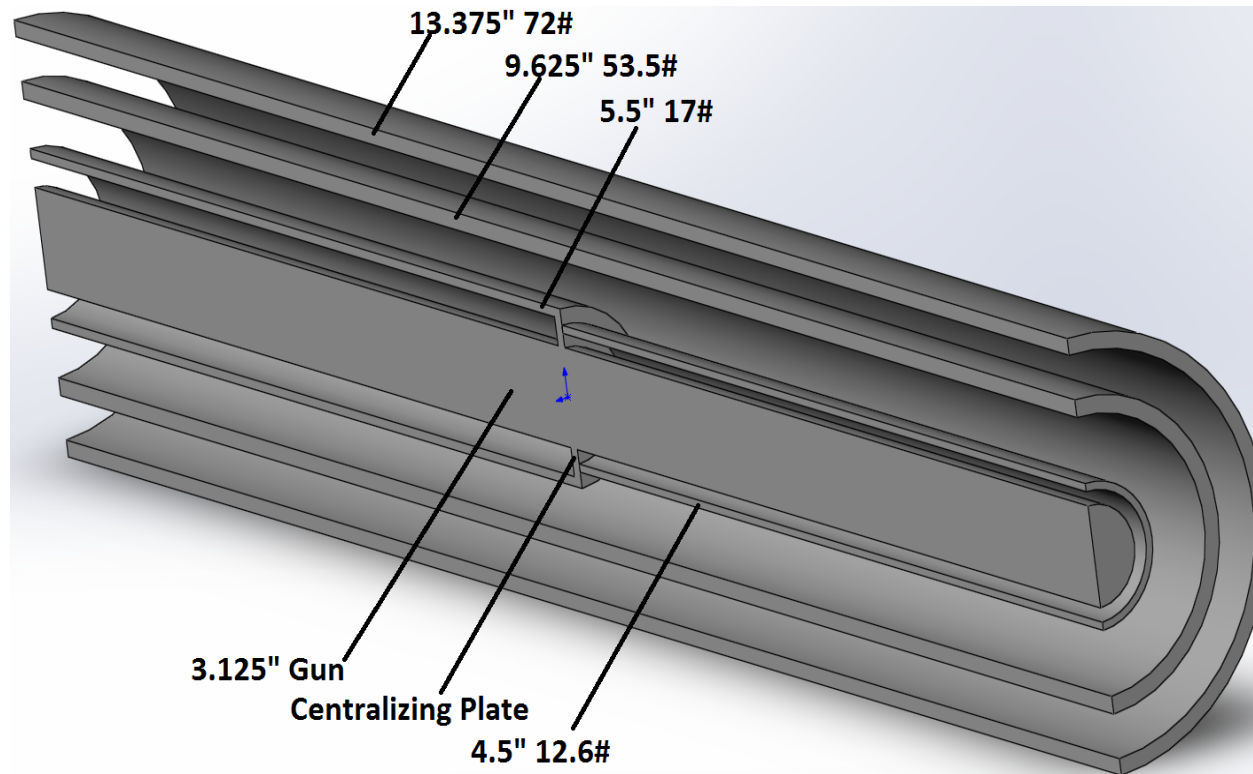
Project timeline

- 28/1/16 First discussion with Client regarding wells abandonment project
- 18/2/16 Charge/gun development proposal submitted to Client
Estimated mobilisation date to platform - 9/5/16
- 23/2/16 Charge/gun development proposal accepted by Client
- 24/2/16 Project plan for charge/gun development signed off by Expro
Project lead time estimated at 10 weeks
Estimated guns ex-works Dallas 4/5/16
Estimated delivery of guns to Aberdeen 11/5/16
- 26/4/16 Revised load out date to platform circa 20/5/16
- 26/5/16 Mobilisation of equipment to platform



Perforating charge/gun development - project 1a

- 3.125" OD gun to perforate 4 ½", or 5 ½" tubing, and 9 5/8" casing with limited damage to 13 3/8" casing
- Centralised gun, centralised tubing/casing - **determine ability of charge to deliver 360° coverage**



Perforating charge/gun development - project 1a

Centralised Gun, Centralised Tubing/Casing



9 5/8" Casing

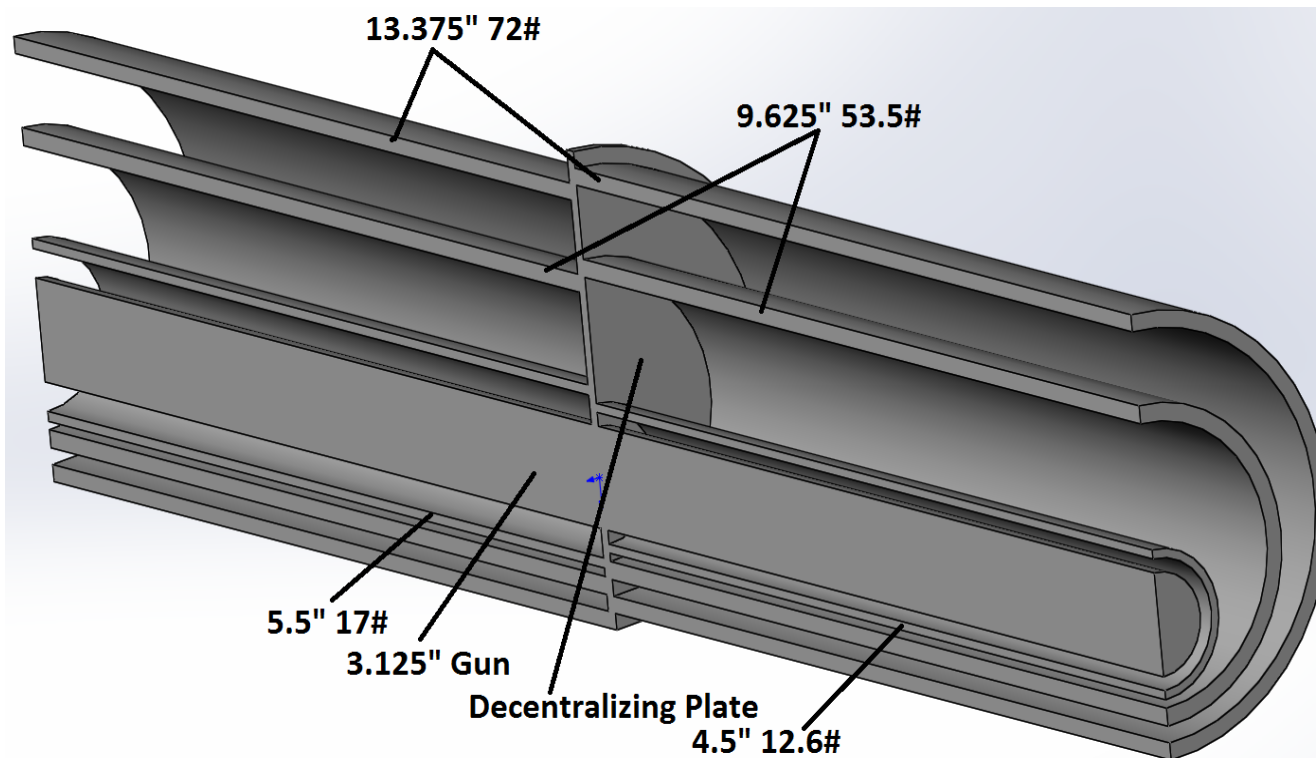


13 3/8" Casing

Test Scenario	4.5"/5.5" Hole Size (in.)	9.625" Hole Size (in.)	13.375" Damage (in.)	Comments
1	0.50	0.27	0.007	Achieved 360° Perforation
2	0.40	0.28	0.015	Achieved 360° Perforation

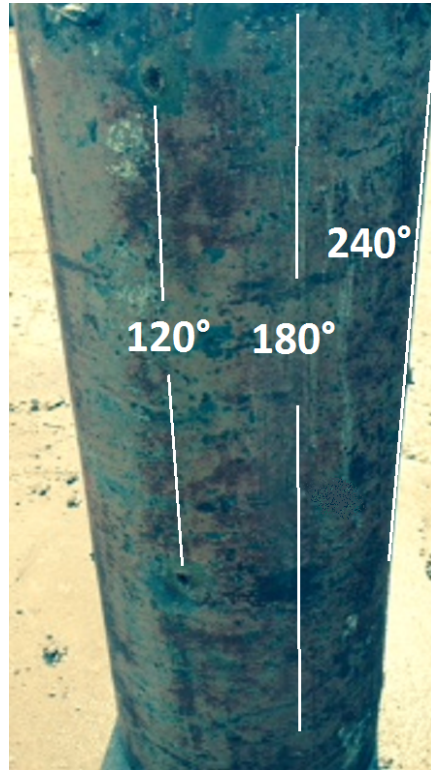
Perforating charge/gun development - project 1b

- 3.125" OD gun to perforate 4 ½", or 5 ½" tubing, and 9 5/8" casing with limited damage to 13 3/8" casing
- Centralised gun, de-centralised tubing/casing - **determine the maximum damage to 13 3/8" casing**



Perforating charge/gun development - project 1b

Centralised Gun, De-Centralised Tubing/Casing



9 5/8" Casing

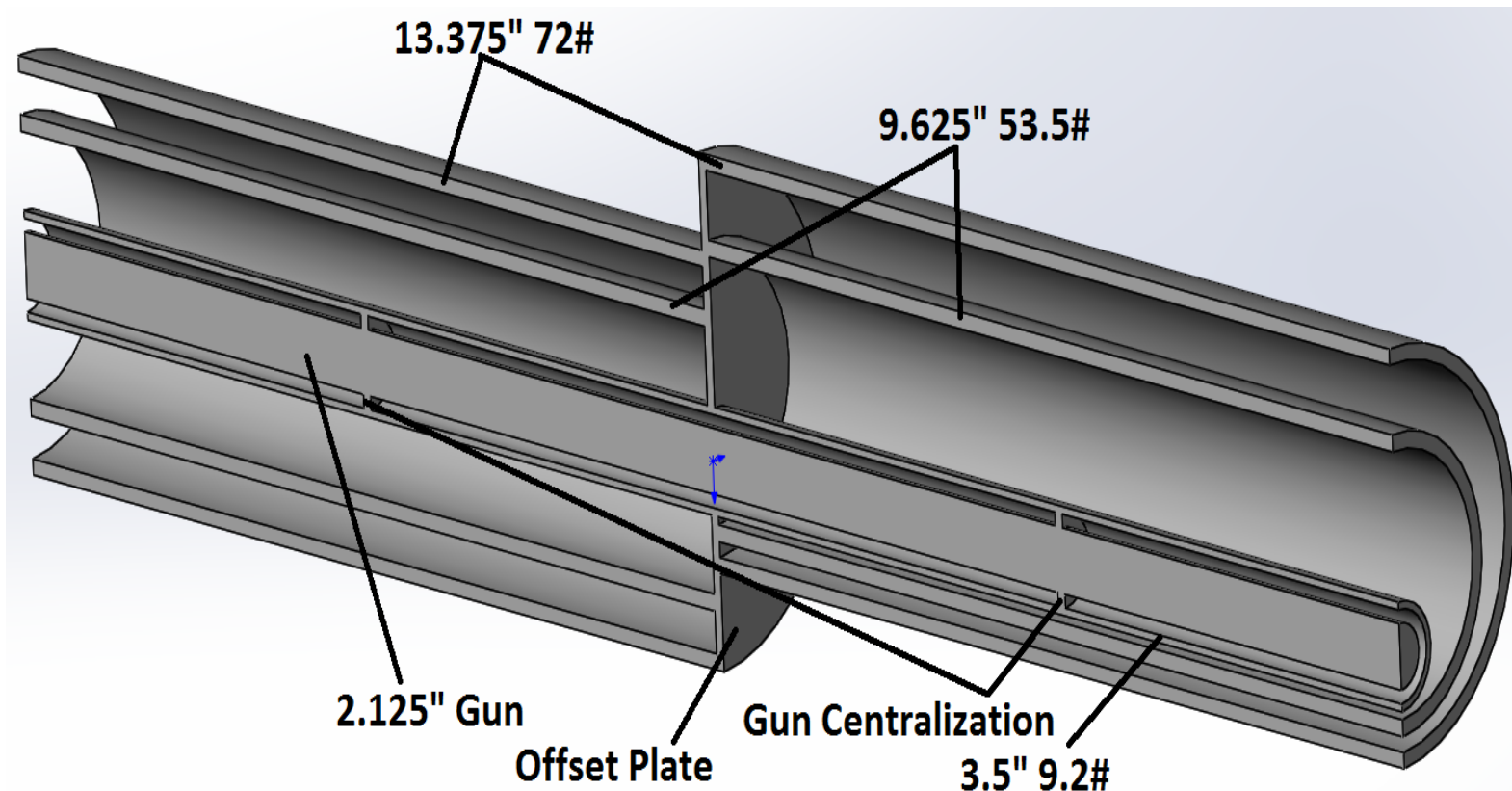


13 3/8" Casing

Test Scenario	4.5"/5.5" Hole Size (in.)	9.625" Hole Size (in.)	13.375" Damage (in.)	Comments
1	0.50	0.26	0.186 MAX	Achieved 240° Perforation
2	0.40	0.26	0.202 MAX	Achieved 240° Perforation

Perforating charge/gun development - project 2a

- 2.125" OD gun to perforate 3 ½" tubing and 9 5/8" casing with limited damage to 13 3/8" casing
- Centralised gun, centralised tubing/casing – **determine charge penetration**



Perforating charge/gun development - project 2a

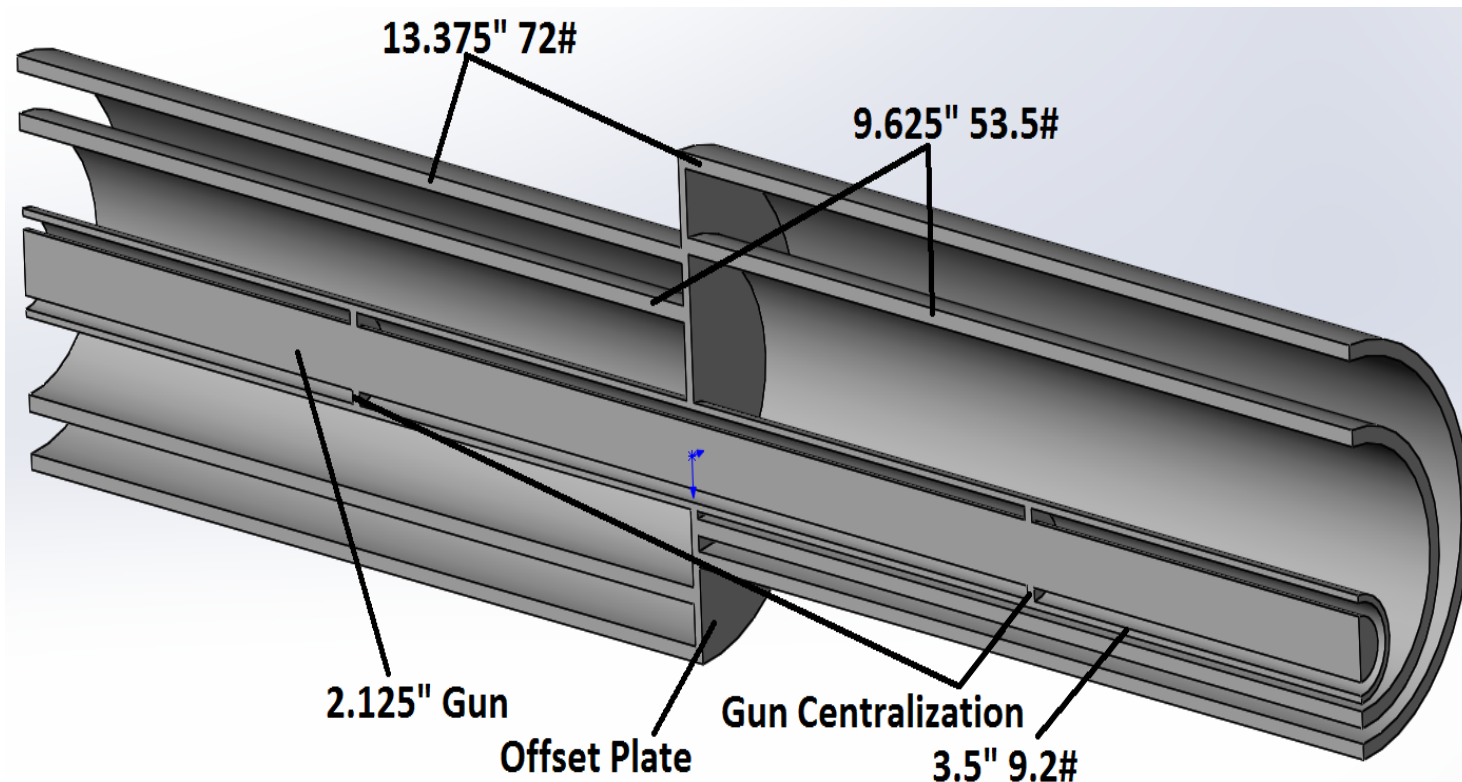
Centralised Gun, Centralised Tubing/Casing



Test Scenario	3.5" Hole Size (in.)	9.625" Hole Size (in.)	13.375" Damage (in.)	Comments
0°	0.300	0.190	0.000	3 out of 5 perforated 9.625"
180°	0.290	0.190	0.000	4 out of 5 perforated 9.625"

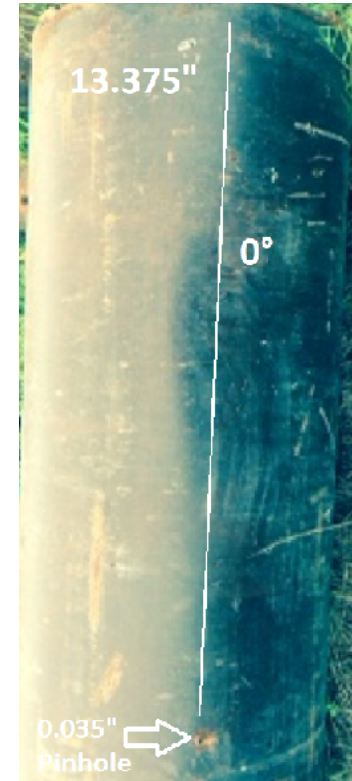
Perforating charge/gun development - project 2b

- 2.125" OD gun to perforate 3 ½" tubing and 9 5/8" casing with limited damage to 13 3/8" casing
- Centralised gun, de-centralised tubing/casing – **determine the maximum damage to 13 3/8" casing**



Perforating charge/gun development - project 2b

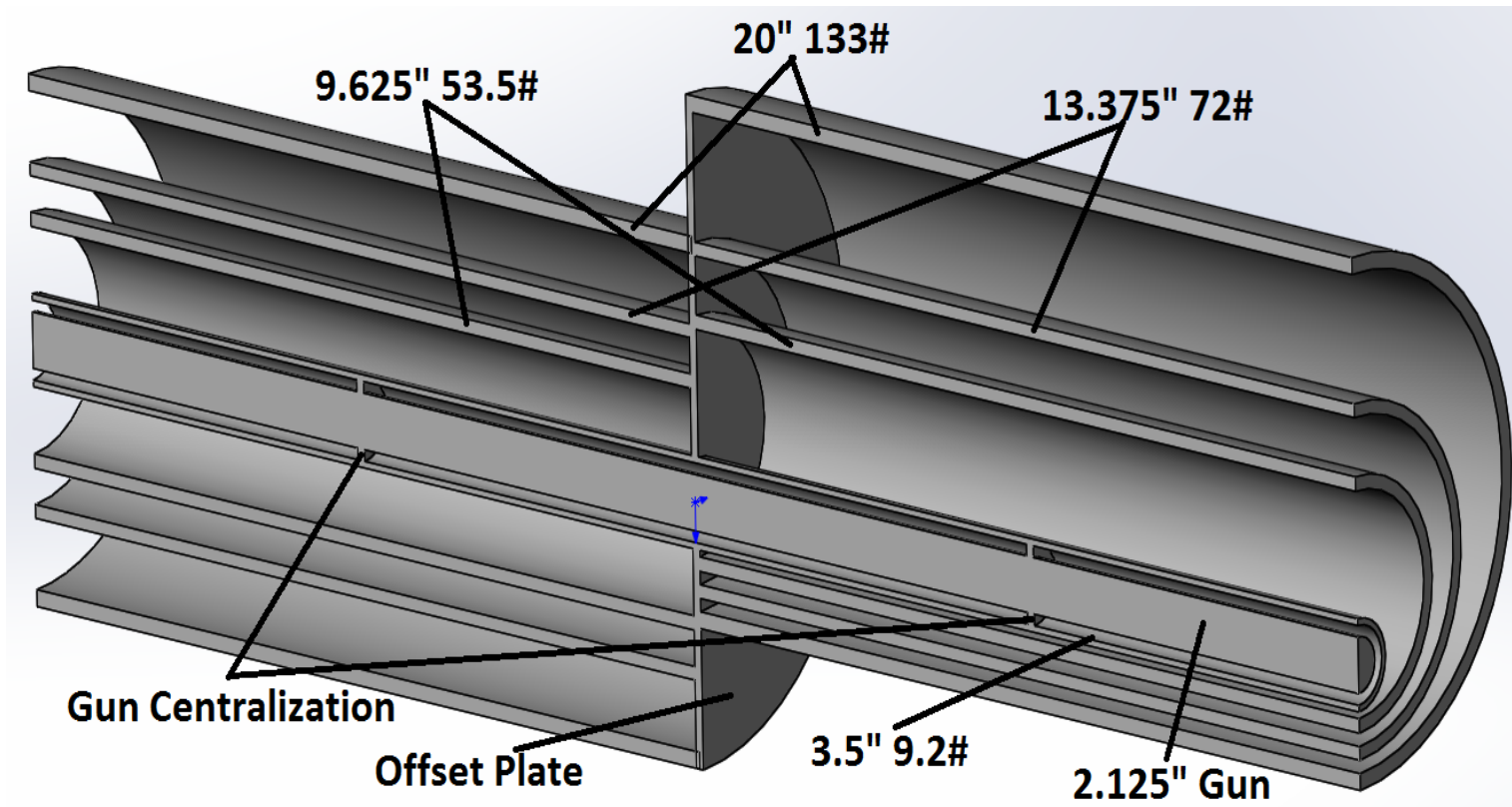
Centralised Gun, De-Centralised Tubing/Casing



Test Scenario	3.5\" Hole Size (in.)	9.625\" Hole Size (in.)	13.375\" Damage (in.)	Comments
0°	0.290	0.210	.190	1 out of 5 Pin-holed through 13.375"
180°	0.290	N/A	N/A	Failed to perforate 9.625"

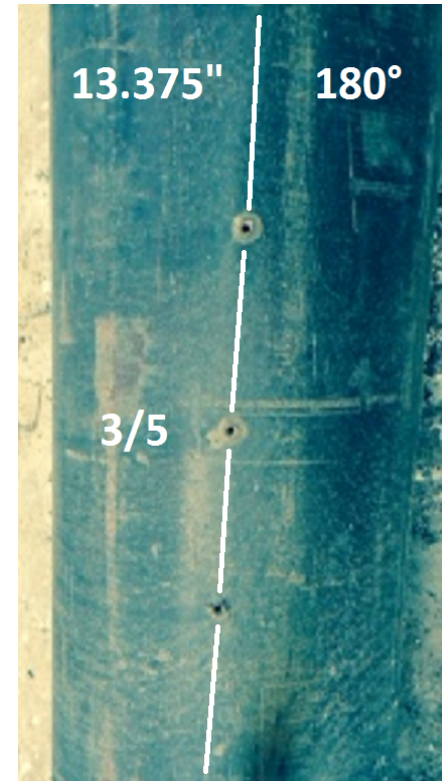
Perforating charge/gun development - project 3a

- 2.125" OD gun to perforate 3 1/2" tubing, 9 5/8" casing and 13 3/8" casing with limited damage to 20" casing
- Centralised gun, centralised casing – **determine charge penetration**



Perforating charge/gun development - project 3a

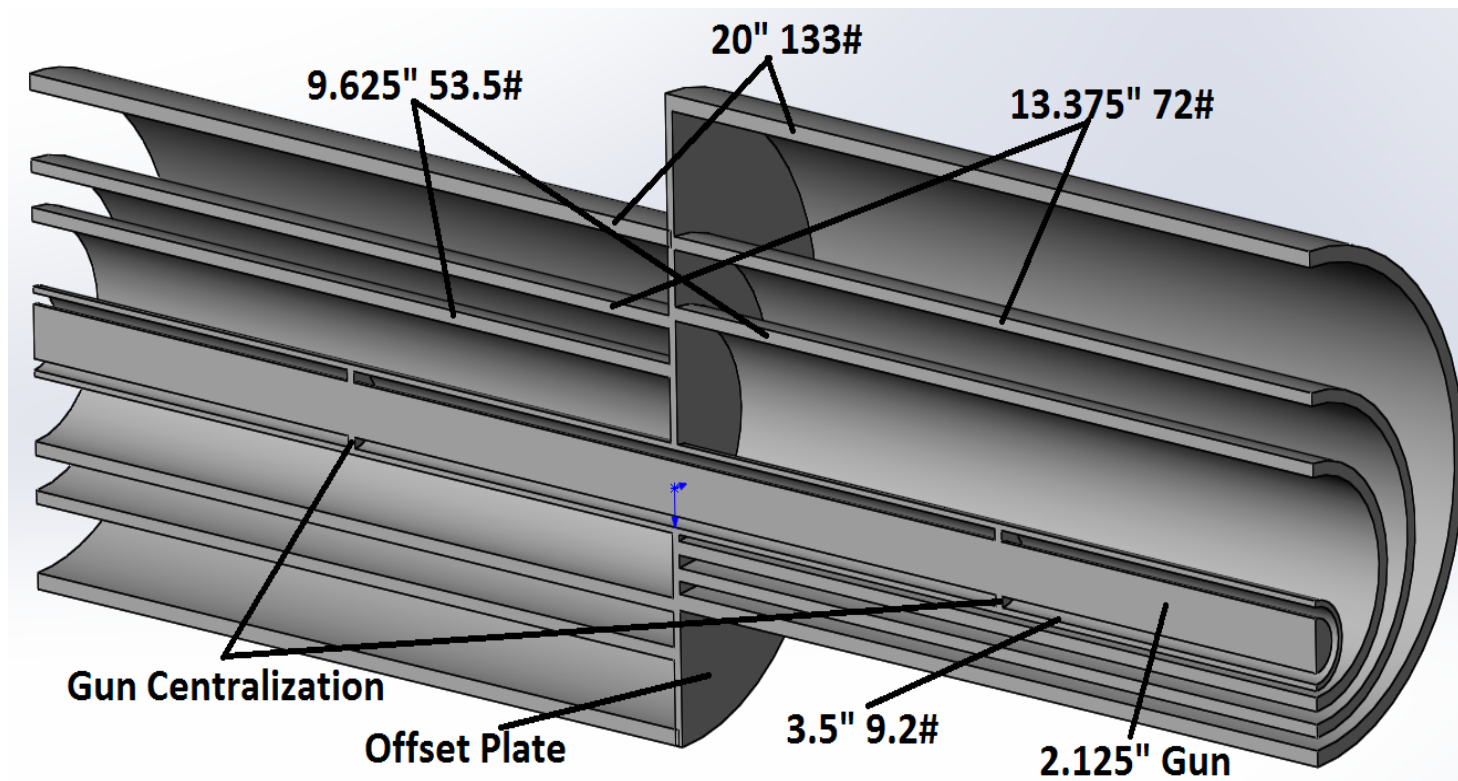
Centralised Gun, Centralised Casing



Test Scenario	3.5" Hole Size (in.)	9.625" Hole Size (in.)	13.375" Hole Size (in.)	20" Damage (in.)	Comments
0°	0.250	0.170	0.150	0.00	2 out of 5 perforated 13.375"
180°	0.260	0.170	0.150	0.00	3 out of 5 perforated 13.375"

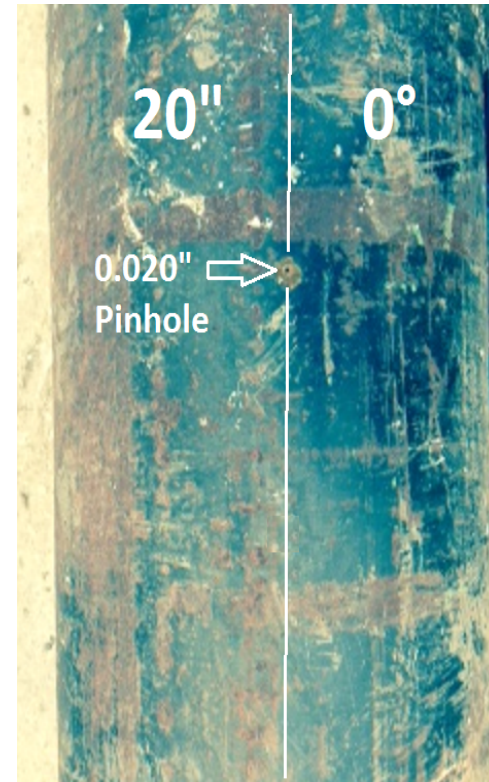
Perforating charge/gun development - project 3b

- 2.125" OD gun to perforate 3 ½" tubing, 9 5/8" casing and 13 3/8" casing with limited damage to 20" casing
- Centralised gun, de-centralised tubing/casing – **determine the maximum damage to 20" casing**



Perforating charge/gun development - project 3b

Centralised Gun, De-Centralised Tubing/Casing

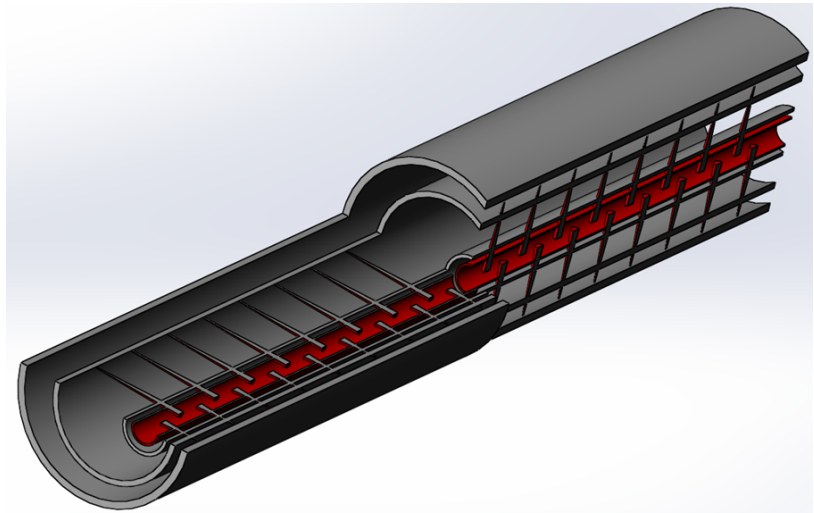
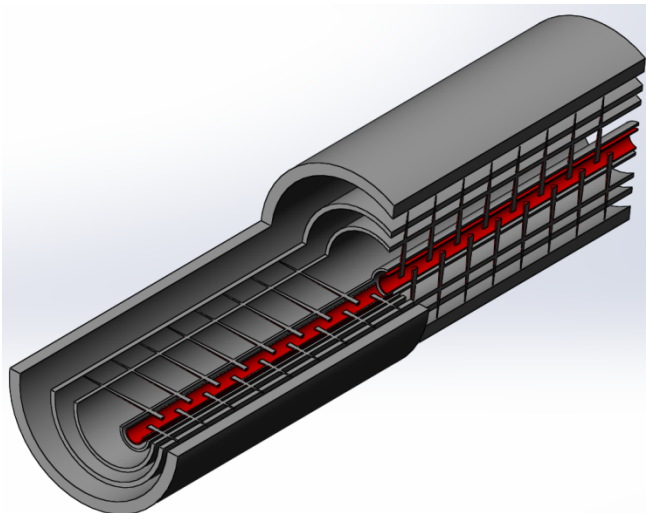


Test Scenario	3.5" Hole Size (in.)	9.625" Hole Size (in.)	13.375" Hole Size (in.)	20" Damage (in.)	Comments
0°	0.260	0.210	0.190	0.287	1 out of 5 Pin-holed through 20"
180°	0.250	0.130	N/A	N/A	Failed to perforate 13.375"

Perforating charge/gun development

- **Conclusions**

- All 2.125" and 3.125" PAC™ perforating guns to be **run fully centralised for all wells**
- 2.125" charge **only compatible** with a 0/180deg phase
- 2off 2.125"10ft gun systems to be run **bolted together with 90deg offset**



Tubing cutter

- Cut 3 ½" tubing and triple encapsulated injection line using an **explosive jet cutter**
- Test conducted and witnessed by Client



- Successful test, **injection line cut at same point as tubing**



Job summary

- Successful design, development, testing, build and delivery of **3 new PAC™ gun systems in 82 days**
- **All guns run and successfully fired**
 - 5 off 2.125" guns
 - 12 off 3.125 guns
- A total of **12 cement plugs squeezed** through the perforated zones to fully comply with abandonment regulations
- **3 successful tubing cuts performed** including cutting of the **triple encapsulated injection line**
- **Client commendation** received for performance during abandonment project

Efficiencies

- Tubing remained in well – **no rig required**
- No requirement for E-line – one PCE rig up per well **saving time**
- Multi-disciplined intervention crew – **reduced personnel costs**
- Overall approach – **safe, cost effective, technology-driven solution**



Questions?



EXPRO

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