Oregon
Kate Brown, Governor

Water Resources Department
North Mall Office Building
725 Summer St NE, Ste A
Salem, OR 97301
Phone: 503-986-0900
Fax: 503-986-0904

February 11, 2022

JESUS MARIEZCURRENA WWC#2012
WELSCO CORP
PO BOX 5245
FALLON, NV 89407

FINAL ORDER

Dear Mr. Mariezcurrena:

The Special Standards Request Form you submitted for owner: Oregon Institute of Technology, Start Card number: 1055500, is hereby approved for the following: You may repair this well (KLAM 11830) as described on your Special Standards Request Form dated February 7, 2022 with a couple of stipulations as described below:

-The surface seal shall extend to a minimum of 25-feet below land surface and be placed in an oversized bore hole that is at least 4-inches larger diameter than the permanent well casing.
-The lower seal must extend at least 15-feet below the bottom of the existing 12-casing and 15-feet above the top of the stage cementing collar.

All other well construction standards must be adhered to. A copy of your Special Standards Request Form is enclosed.

As a note of caution, if this repair is unsuccessful there will be limited alternatives to address the deficient construction of this well and it will likely have to be permanently abandoned.

The Well Construction Standards serve to protect ground water resources. By approving and issuing this special construction standard the Oregon Water Resources Department is not representing that a well constructed in accordance with this condition will maintain structural integrity or that it meets engineering standards. The well constructor/or landowner is responsible for ensuring that a well is constructed in a manner that protects ground water resources as required under Oregon Administrative Rules 690-200 through 690-240.

If you have any questions regarding this letter, I may be contacted at (503) 302-8618, or by e-mail at Travis.N.Kelly@water.oregon.gov.

Sincerely,

Travis Kelly,
Well Construction Compliance Coordinator
Well Construction and Compliance Section

Enclosure

cc: William Nashem, Well Inspector, Southcentral Region

This is a FINAL ORDER other than contested case. This final order is subject to judicial review under ORS 183.484. Any petition for judicial review of the final order must be filed within the time specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Special Standards
Request Form

REQUEST FOR WRITTEN APPROVAL TO USE CONSTRUCTION METHODS NOT INCLUDED IN OREGON ADMINISTRATIVE RULES 690-200 THROUGH 690-240

Before the request can be considered, this form must be completed. Requests shall be submitted to the Well Construction Program Coordinator, Water Resources Department, 725 Summer Street NE, Suite A, Salem OR 97301-1266. Requests may also be considered by the appropriate Regional Manager.

Date of request: 07-Feb-2022 **Oral approval date (if applicable):** _____

Bonded Well Constructor (**name, license #, and mailing address**): Welsco, Jesus Mariezcurrena #2012, Dave Anderson #2013. 2510 Beasley Drive Fallon, NV 89406, PO Box 5245 Fallon, NV 89407

(1) Location of Well: _____ 1/4 _____ 1/4 Tax lot #04900 Section 20SE-NE ,
Township 38 S , Range 9 E , Klamath Falls County
Address at well site: Oregon Institute of Technology, 3201 Campus Drive

(2) Start Card Number(s)(for work to be done): _____

(3) Name and Address of Land Owner: Oregon Institute of Technology
3201 Campus Drive, Klamath Falls, Oregon, 97601

(4) Distance to the nearest septic tank, drainfield, closed sewage line (if water supply well)

(5) The unusual site conditions which necessitate this request: See Appendices A-B-C.

(6) The proposed construction methods that the bonded well constructor believes will be adequate for this well: (attach additional pages if needed)
See Appendices A-B-C.

(7) Diagram showing the pertinent features of the proposed well design and construction: (attach additional pages if needed)

See Appendices A-B-C.

PLEASE NOTE:

(1) The Well Construction Standards serve to protect ground water resources. By approving and issuing this special construction standard the Oregon Water Resources Department is not representing that a well constructed in accordance with this condition will maintain structural integrity or that it meets engineering standards. The well constructor/or landowner is responsible for ensuring that a well is constructed in a manner that protects ground water resources as required under Oregon Administrative Rules 690-200 through 690-240.

(2) If it should be determined at some future date that the well, due to its construction, is allowing ground water contamination, waste or loss of artesian pressure, the undersigned shall return to the site and rectify the problem.

(3) If oral approval was granted, a written request must be submitted to the Department either within three (3) working days of the date of oral approval or prior to the completion of the associated well work. Failure to submit a written request as described above may void prior oral approval.

I have read and understand the above information. I further attest that the information provided is accurate to the best of my knowledge.

Bonded Constructor Signature: Jesus Mariscurrena

Startcard Number: 1055500

Received: 1/31/2022

License Nbr 2012 Phone Nbr 775-423-6619

Driller Name JESUS MARIEZCURRENA

Driller Company WELSCO CORP

Owner Information

Company OREGON INSTITUTE OF TECHNOLOGY

First Name THOM Last Name DARRAH

Street1 3201 CAMPUS DRIVE

Street2

City KLAMATH FALLS State OR Zip 97601

Home Phone 5418851661 Work Phone

Email THOM.DARRAH@OIT.EDU

Type of Work

Fee Required: ☐ New ☐ Conversion ☐ Deepening

No Fee Required: ☑ Alteration ☐ Abandonment

Original Startcard# Original Well Tag# 11830

Construction

Proposed Commencement Date 2/25/2022 Existing/ Proposed Depth(ft) 1716 Diameter (inches) 10

Use

☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Livestock Other:

☐ Monitoring ☐ Piezometer ☐ Dewatering GEOTHERMAL HEATING

Proposed Well Location

Street address of well 3201 CAMPUS DRIVE, KLAMATH FALLS, OR 97601

County Klamath Township 38.00 S Range 9.00 E Section 20

QQ/Q SE NE Lattitude 42.25281100 Longitude -121.78034400

Taxlot 4900

OWNER PLEASE NOTE: This is not a water right application. The owner is responsible for obtaining a water right through the Water Resources Department, if required. The Oregon Health Division requires plans to be submitted and approved prior to construction if the well is to be used as a public system.

APPENDIX-A: Special Standards Request Technical Justification

This document provides detailed description of the repair plan for OIT Well #5 in reference to the Well Construction Standards, Oregon Administrative Rule, Division 210, 690-210-0150, regarding the Sealing of Water Supply Wells in Consolidated Formations.

The Method 1 (Continuous Seal) and the Method 3 (Under-Reaming) of the said rule is not technically achievable for Well #5. The impediments to the application of the Method 1 and 3 are mainly based on the very low likelihood of the removal of the 12-3/4' casing, due to lack of structural integrity of this string as confirmed on February 3, 2022 by a caliper log measurement (Figure 1). Details of this operation can be shared upon request.

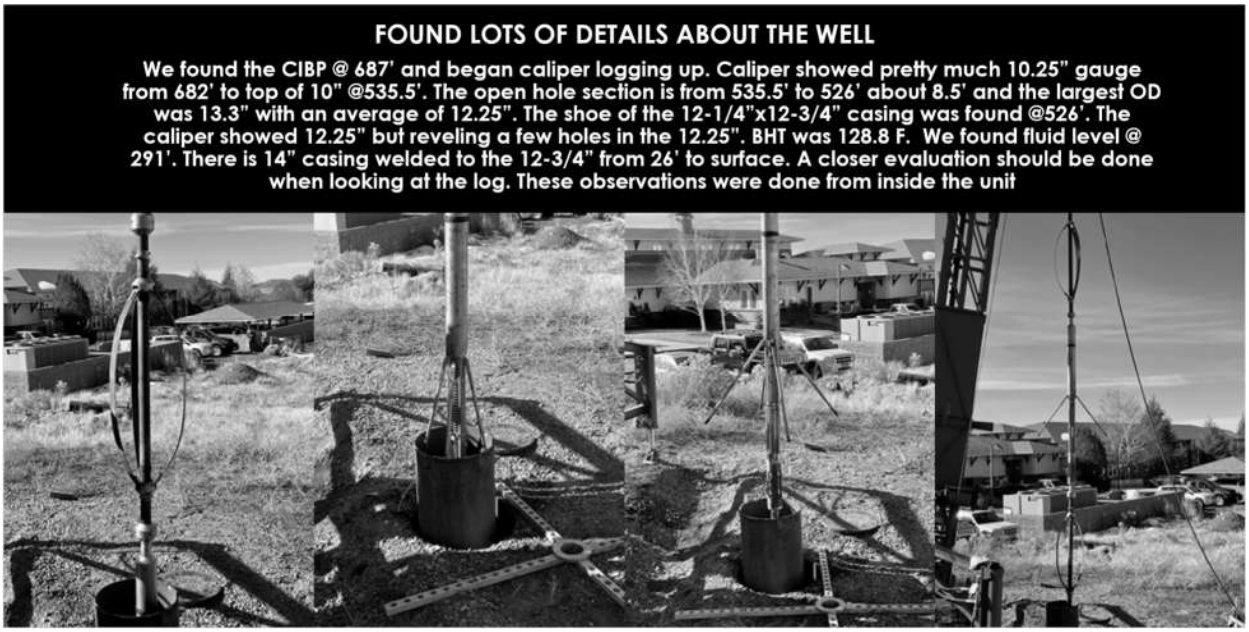


Figure 1. Caliper log report image showing initial findings and logging run photos

The option of plugging, abandoning, and redrilling the well elsewhere is also unfeasible due to the uncertainty of finding a similar productive reservoir with similar parameters (temperature, geochemistry, etc.), as well as the infrastructural restraints at the current location. OIT Well #5 serves as a crucial contributor to the university's district heating system. This well is an integrated part district heating system that was installed by OIT as a government suggested program. Figure 2 shows the 8" geo line to campus which provides heat to all campus buildings totaling over 1M square feet. Additionally, OIT prefers to limit the footprint dedicated to wells and power infrastructure equipment and reserving this area for academic purposes. Finally, it should be noted that this well has undergone numerous and lengthy previous attempts with unsuccessful attempts to remove the 12-3/4" casing.

In alignment with the caliper log findings and previous repair attempts in this well, removal of the 12-3/4" casing is not recommended. There are significant risks associated with this operation due to the current well conditions, such as deterioration of the casing strings due to their age and direct exposure to wellbore fluids, compounded by the annulus outside the 12-3/4" which is backfilled with drill cuttings. Additional attempts to remove the 12-3/4" casing string may induce wellbore collapse, affecting both

upper and lower portions of the well. Wellbore collapse in such an old well may prevent connecting with the 10-3/4" casing and compromise its future productive use.

Figure 2. OIT Campus Map showing Well #5 location and Geothermal Energy System

It is therefore proposed to proceed with Method 2 (Step-Down Casing/Inner Casing) to achieve a split seal by means of the ICP (Inflatable Casing Packer) sealing the open-hole interval, as per the caliper log, from ±530' to 555' (Figure 3), and between the 10-3/4" and 12-3/4" casing strings from the 12-3/4" casing shoe to surface (Appendix-B). The cement will be filling all holes, voids and uncemented areas from the bottom of the ICP to the surface and preventing vertical communication with the upper aquifer.

In reference to section A of Method 2, the 12-3/4" casing is set at ±530'. The open hole section is more than 15' into solid formation between the 12-3/4" shoe at ±530' and open hole to be extended to ±565' with all welded casing to the bottom of the ICP, compliant with sections B and C. There are no perforations to the 10-3/4" casing, also as compliant with section C. In reference to section D and E, cement will be placed in the annulus of 10-3/4" and open hole and 12-3/4" to avoid any vertical communication and fluids from reaching the shallow aquifer at 459', to be compliant with the general well construction requirements. As noted, the cement slurry pressure will fill and seal all of the voids from the depth of the ICP up the well and to the surface.

In reference to 690-210-0200 Steel Casing Joints, all joints on the new 10-3/4" casing and the tieback/cementing assembly is either welded or threaded (Appendix-B). The connection between the tieback/cementing assembly and the old (cut) 10-3/4" casing will be a wicker thread. The wicker thread

engagement during fishing operations. Once over the stub, and confirmation by over pull is made, the casing and assembly will be rotated to the right cutting threads on the downhole stub until it bottoms out against an inserted seal at the top of the casing patch. Successful engagement and pulling up to 280,000 lb of casing out of the hole has been witnessed using the same type of thread. In Welsco's professional opinion, this is as advanced a tool as the drilling industry can provide for this type of operations, to date. Additionally, this connection is lower in the well than the bottom of the split seal (±560') and will be isolated form the upper water bearing formation by the inflatable packer and cement above it. Consequently, this plan will provide the protection to the groundwater as required by the referenced rules in this document. The modified well repair plan outline is as follows (also see Appendix-C):

1. Run in the hole (RIH) with caliper log tool to check casing ID's and find CIBP. Tagged up on cast iron bridge plug (CIBP) @ 687'. Logged with caliper from 682' to surface. Found top of 10-3/4" (10") pipe @ 535.5'. Found bottom of 12-3/4" (12") @ 526'. Found water level @ 291'. Found top of 12" @ 26'. Found 14" pipe from 26' to surface. All measurements taken from top of 14" at surface. Found temp @ 687' to be 128.8 °F

   note: This step has already been completed as to finalize the program

2. Extend the 14" casing to surface if/as required by welding a new 14" pipe at the surface.
   Note: Since there is a significant risk of the formation to cave-in after the 14" is removed, this string will be left until the 10" pipe is set and cemented.

3. Connect to 14" casing via 2 holes perforated at surface and try to pull the casing
   a) If the 14" casing is moving, wait until 10" is cemented to surface and then pull the casing before the cement sets. Replace any of the cement lost due to displacement from the surface or with a tremie pipe as required
   b) If the 14" casing is not moving, wait until the 10" casing cement sets and then wash over the 14" casing with larger ID wash-over pipe and shoe. Cement the 14" casing to surface with tremie pipe at +/-25'
4. RIH w/ open ended drill pipe and dump sand on CIBP @ 687'. Test to see if it is holding, if not, RIH and set a Bridge Plug (BP) at ±600', dump sand, and POH (Pull Out of the Hole)
5. RIH to ±570' with (w/) 10" casing cutter and cut 30' (from 540' to 570') of 10" casing, POH w/ Cutter
6. RIH with spear, bumper sub and jars, Jar cut 10" casing out of the hole
7. RIH, Tag BP (confirm it is still in place), and POH
8. RIH w/ 12.1'' outer diameter (OD) casing patch over-shot with right-handed wicker threads, welded / threaded ACP, welded stage tool, and welded 10" new casing. Threaded casing patch over-shot once confirmed is connected, can be rotated to the right to tighten until the stub is against the seal.

9. Inflate the inflatable casing packer (ICP), open the stage cementing collar, and cement 10-3/4" tieback casing from ±565’ to surface
10. RIH w/ bit, drill out the wiper plug
11. If set, RIH, remove the BP at ±600', and POH; if not set, RIH and drill out the CIBP @ 682’, continue with bit and scraper to 790’, POH
12. RIH to 1,068' w/ bit and casing scraper and POH
13. RIH to 1,715' w/ bit and casing scraper and POH
14. Run a caliper log to verify casing inner diameter (optional/TBD)
15. RIH, circulate to clean well, and POH

Caliper Log

On February 3rd, 2022, a caliper log was run to confirm the depths of the 12-3/4” and 10-3/4” casings as well as the length and size of the open hole section between them. This information is vital to plan a split seal method with an application of an Inflatable Casing Packer (ICP) that will be set in the open hole. On a separate note, the previously shallower set (+/-550’) casing plug was found at 687’.

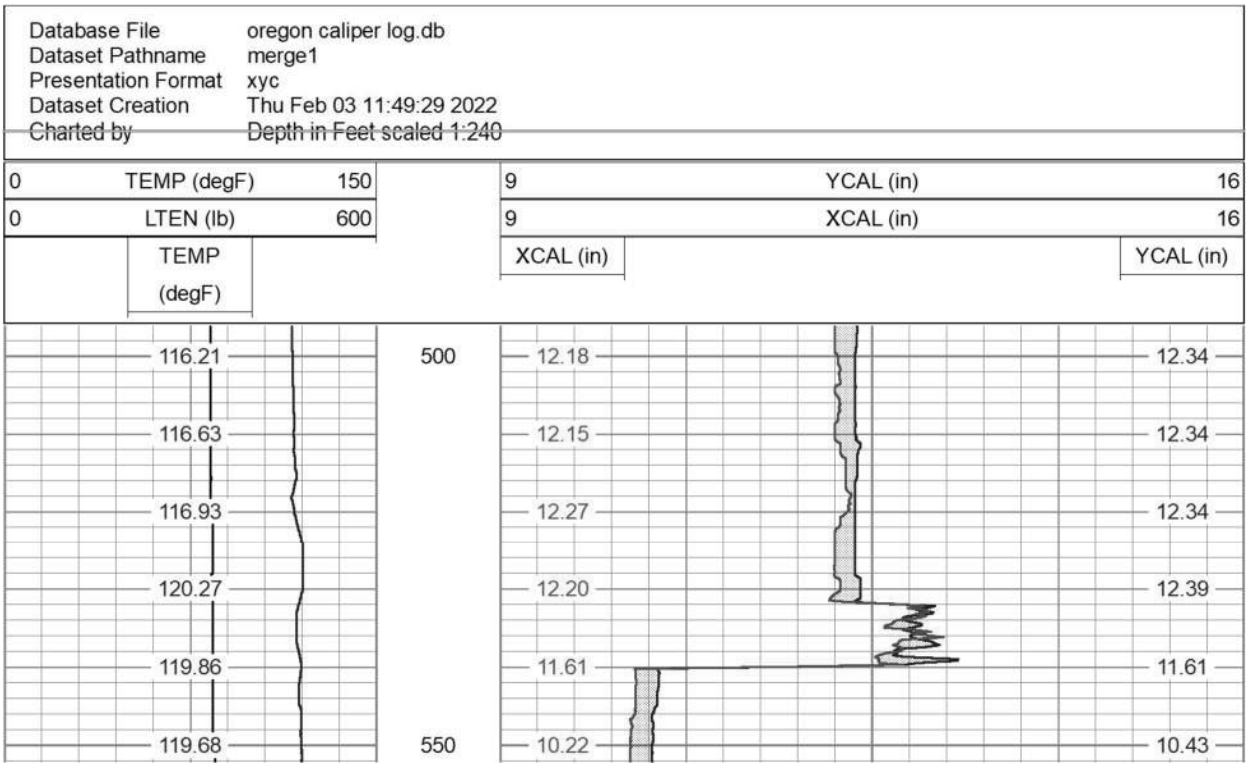


Figure 3. Caliper log report showing open hole section from +/- 530’ to 540’

Referenced Sections of Method 2 (Step-Down Casing/Inner Casing) (OAR 690-210-0150(b)[1]:

(b) Method 2 (Step-Down Casing/Inner Casing):

(A) An upper oversize drillhole, at least four inches greater in diameter than the upper permanent well casing to be installed, shall extend from land surface to at least five feet into a clay interval below a depth of 13 feet.

(B) Unperforated, permanent well casing shall extend to, and be driven into, solid, unfractured, consolidated rock overlying the water- bearing rock formation.

(C) A lower drillhole, at least as large as the inside diameter of the upper permanent well casing, shall be constructed at least five feet into solid unfractured consolidated rock overlying the water-bearing rock formation.

(D) A smaller diameter steel well casing, at least two inches smaller in diameter than the diameter of the upper permanent well casing, shall extend at least five feet into solid unfractured consolidated rock overlying the water-bearing rock formation and at least eight feet into the upper permanent well casing.

(E) The annular space between the upper oversize drillhole and the upper permanent well casing, and the annular space between the smaller diameter lower permanent well casing and the lower drillhole, shall be completely filled with grout using an approved grout placement method after the upper permanent well casing and the lower permanent well casing are set into final position.

Referenced Sections of 690-210-0200[2]:

Steel Casing Joints

All steel casing joints shall be welded or thread coupled and shall be water tight. If welded casing joints are used, the weld shall be a full penetrating weld at least equal in thickness to the wall thickness of the casing. Welded casing joints shall have a tensile strength equal to or greater than that of the casing.

[1] Well Construction Standards, Oregon Administrative Rule, Division 210, 690-210-0150
https://secure.sos.state.or.us/oard/viewSingleRule.action;JSESSIONID_OARD=Y5m2kKgzrUKorS9vYervCHQiVw1svM9bXeCRaYIcWyFXwrohZtv6!-758782503?ruleVrsnRsn=247054

[2] Well Construction Standards, Oregon Administrative Rule, Division 210, 690-210-0200
https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=3184

APPENDIX-B: Tieback and Cementing Procedure, Manuals, and Drawings

CASING PATCH OVER SHOT WITH
INFLATABLE CASING PACKER & MECHANICAL STAGE COLLAR
RUNNING PROCEDURE

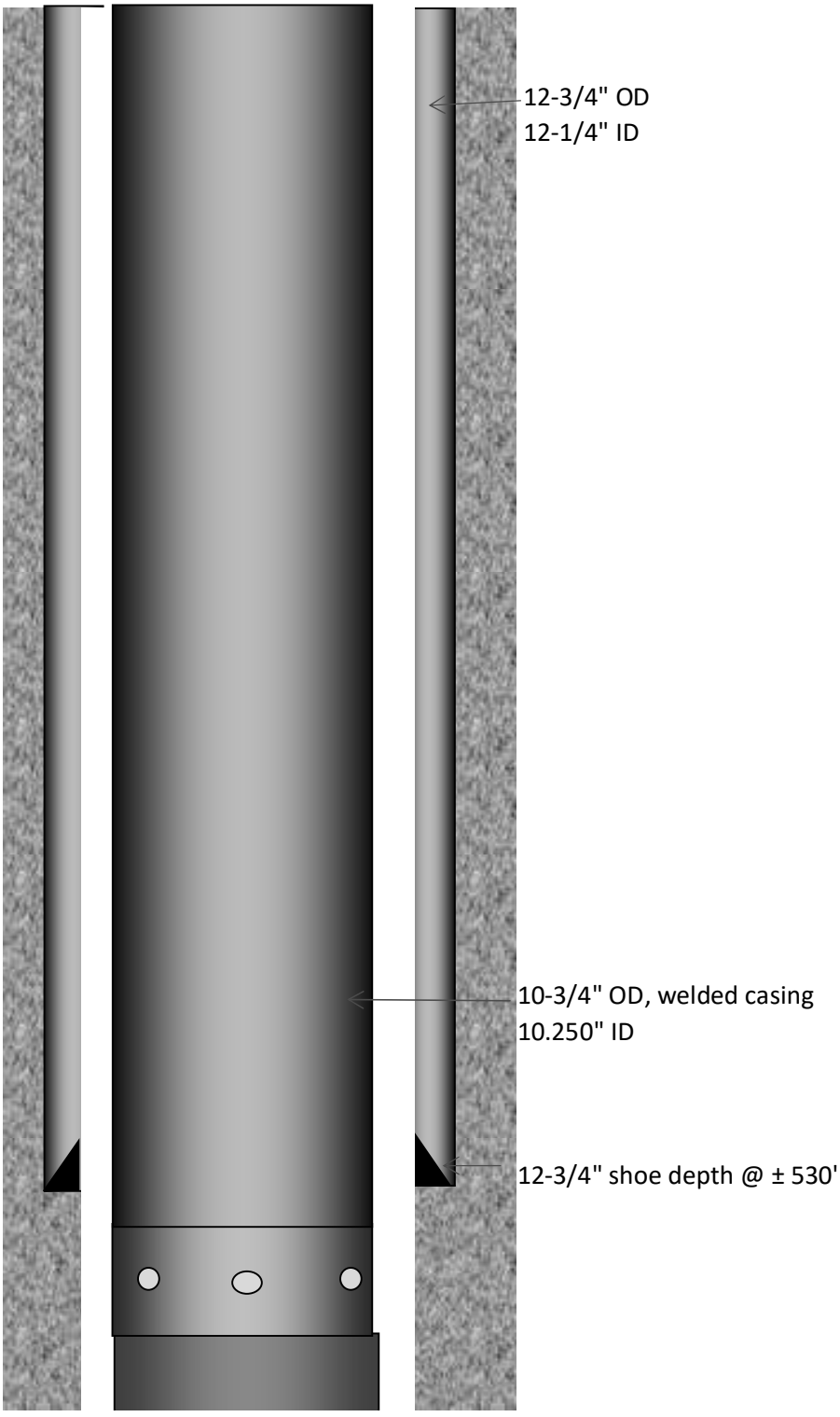
1. Weld tool assembly to first joint of 10-3/4" Pipe, see operator casing running tally. **(Casing Patch Over Shot, Packer, Mechanical stage collar pre-assembled as one unit).**
2. Run desired amount of 10-3/4" casing to depth of interest.
3. Fill casing every few joints.
4. 10' feet prior to 10-3/4" stump depth, Record up and down weight.
5. Locate 10-3/4" casing stump. **Do NOT apply more than 5k pounds of down weight**.
6. Make a chalk mark on the casing level with the rig floor. This mark will serve as a visual indicator after the Over Shot is engaged.
7. Apply a minimum of 10k pounds of down weight while rotating to the right for full engagement with wicker threads**. (More than 10k pounds can be applied if available)**
8. Slowly pick up string weight, Additional weight should be seen on hook load in comparison to string weight before engagement.
9. If Over Shot is not engaged, repeat Step 7 with additional down weight.
10. **Packer Inflation:** Increase pressure to 500 psi and top off displacement tank.
11. Increase surface pressure in increments of 200 psi to balance pressure at the ICP plus rated differential shear pin rating. Hold pressure for 1 minute at every pressure increase.
12. Once opening pressure of 1,800 psi is reached, the pressure will drop as the packer element takes fluid. Monitor pressure decline. **Do NOT let surface pressure decline below 1,200 psi of closing valve shear pin setting.**
13. If pressure did not decline continue increasing pressure in 200 psi increments. **Do NOT exceed 2,500 psi of surface pressure.**

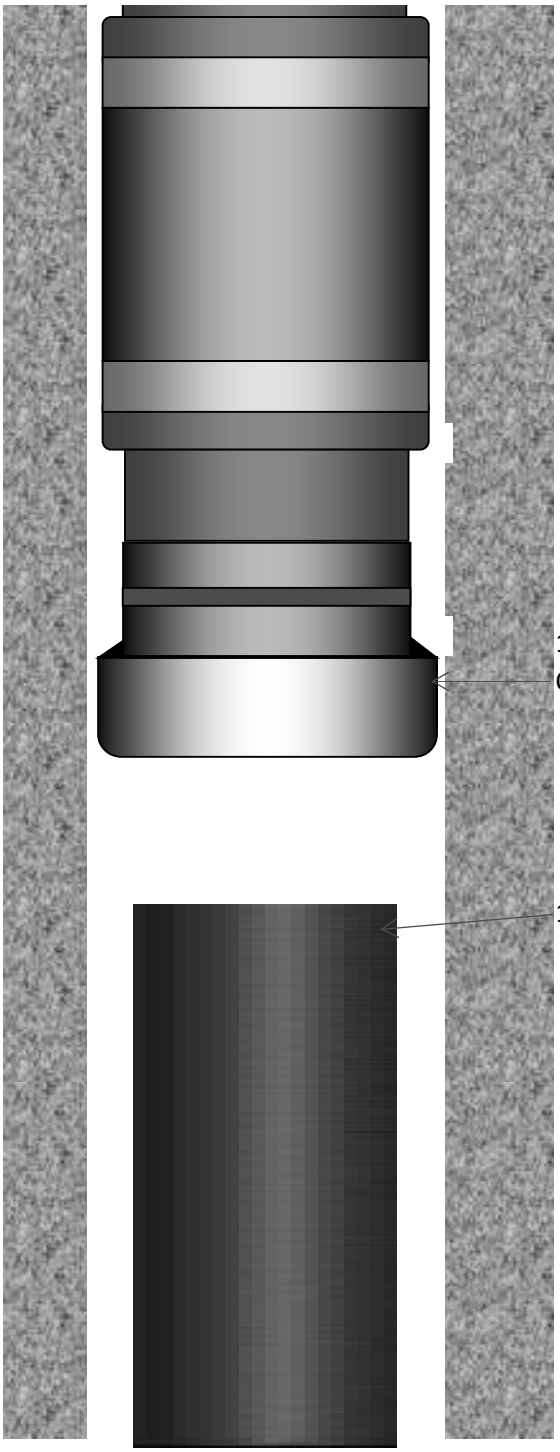
14. When packer element is fully inflated, surface pressure will stabilize and will not decline. **In small inflation volume installations (less than ¼ bbl), you may not be able to see a pressure bleed off indicating valve action.**
15. Bleed surface pressure to 500 psi and record volume in displacement tank for net inflation volume calculation. **Closing shear wire set at 1,200 psi.**
16. Hold pressure for 5 – 10 minutes.
17. Bleed surface pressure to zero. Record flow back volume from displacement tank. Packer is now inflated, and valve is in the closed position.
18. Drop opening cone and allow to free fall at a rate of 200 feet per minute. Allow additional time if opening cone is traveling through high density fluids.
19. Once opening cone lands on opening seat, Increase pressure to 450 psi to open stage collar ports**. If the stage collar does not open, release pressure and allow additional time for opening cone to reach the opening seat on the collar, then repeat pressure increase.**
20. Circulate and condition well for cement job.
21. Mix and pump cement job per cementers program.
22. Release closing plug once cement job has been pumped, verify closing plug has left the cement container.
23. Displace calculated volume to stage collar depth.
24. Slow pump rate to 3 BPM, 5 - 10 bbls prior to total displacement volume.
25. Bump closing plug and increase pressure to 1,000 psi above final circulating pressure.
26. Hold pressure for 5 minutes.
27. Release pressure to zero.
28. If excessive bleed back volume is observed, pump closing plug back down and bump closing plug at a higher pressure and/or flow rate. This procedure may be repeated, but do not exceed casing string or running equipment pressure or load ratings when bumping plugs.
29. With no flow back, Job is now complete.

OTT #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 1:
Running in set up.





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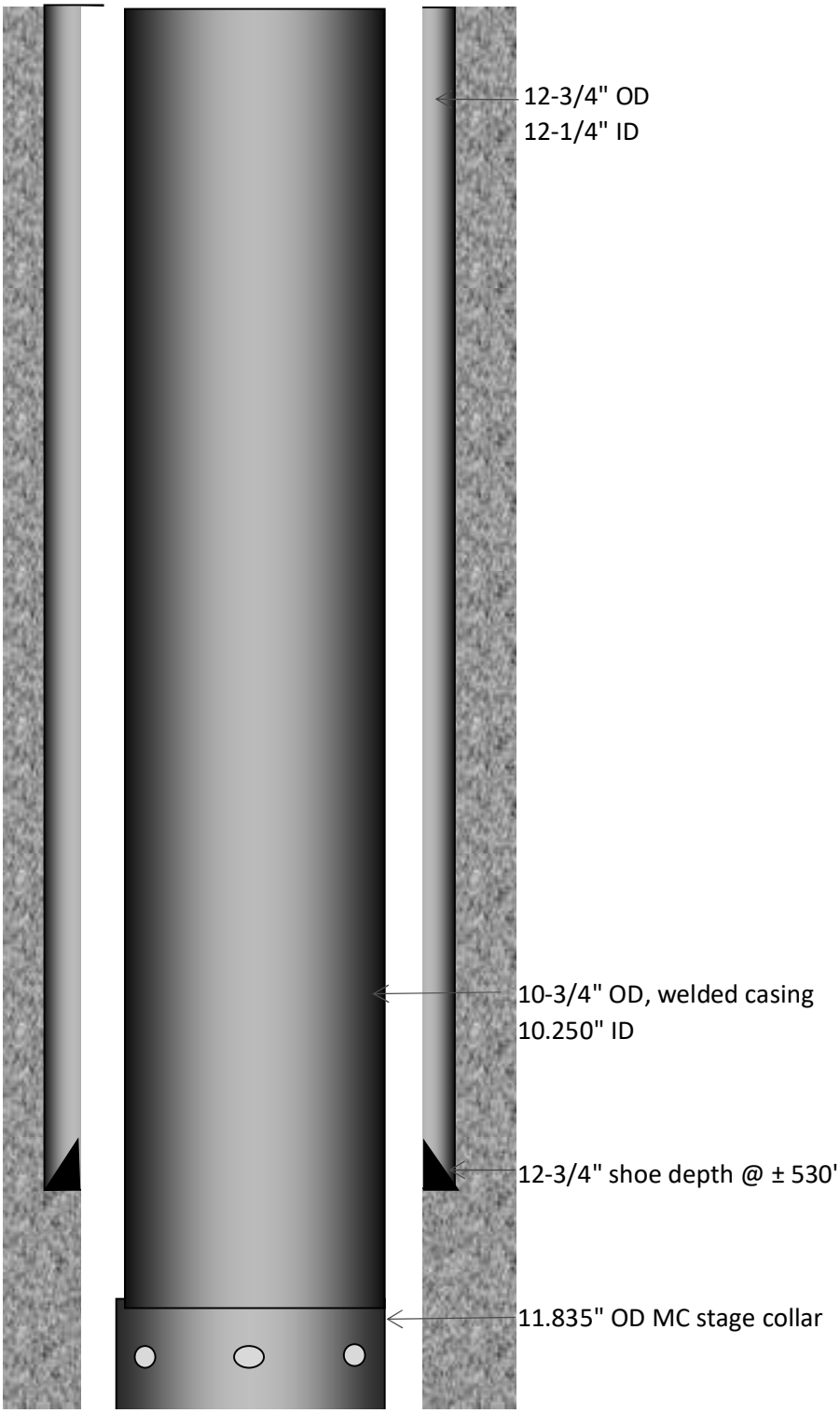
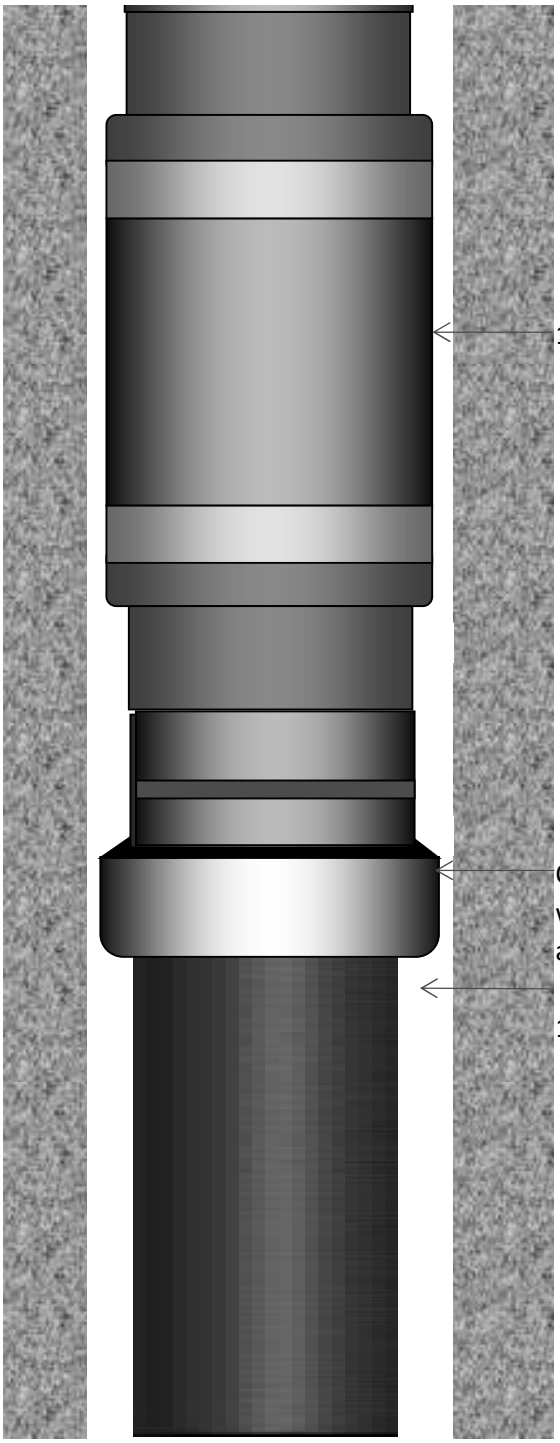
OTT #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 2:
Engage 10-3/4" casing stump with 10k pounds of down weight and right turn for proper Engagement.



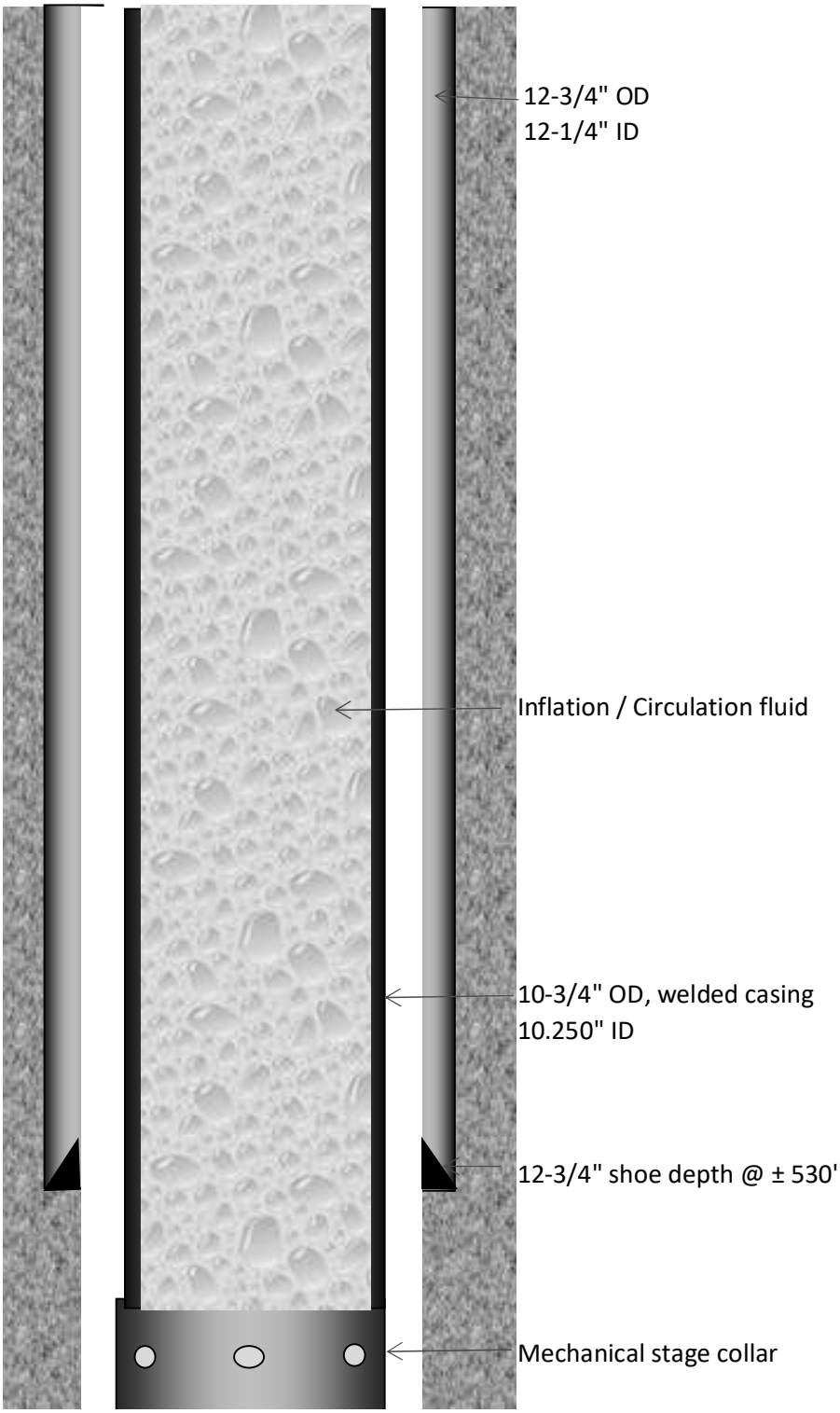


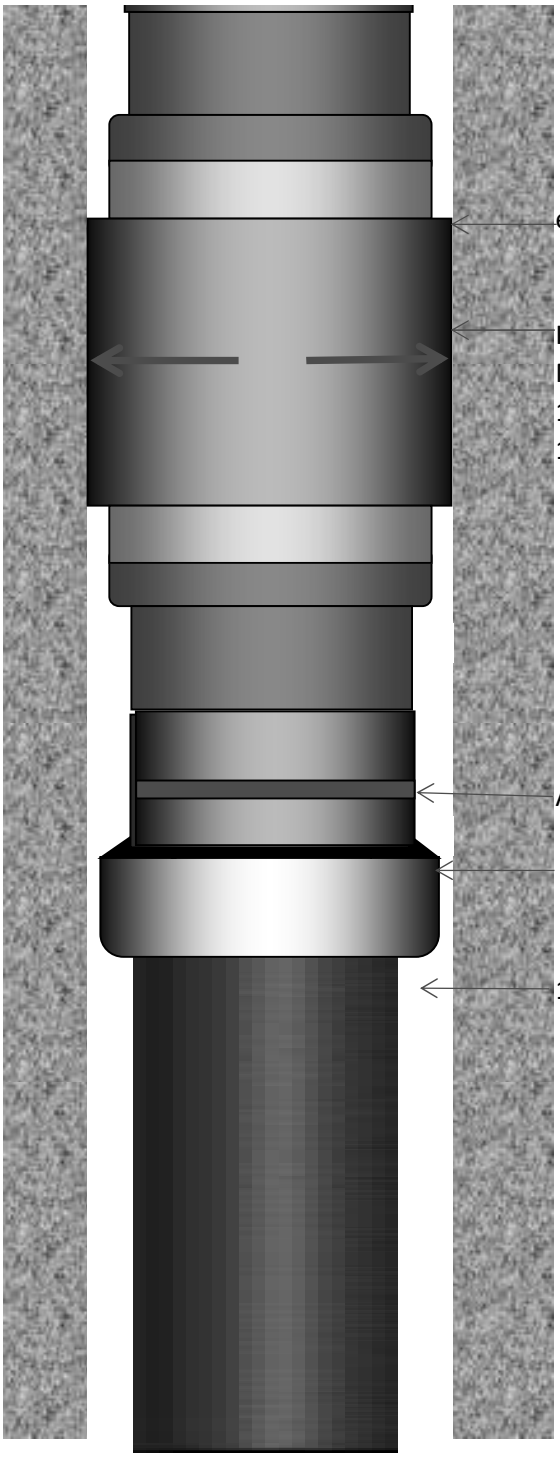
PROJECT ENGINEERING
USA Corporation

Oil #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 3:
Inflate HY ICP, see inflation procedure.





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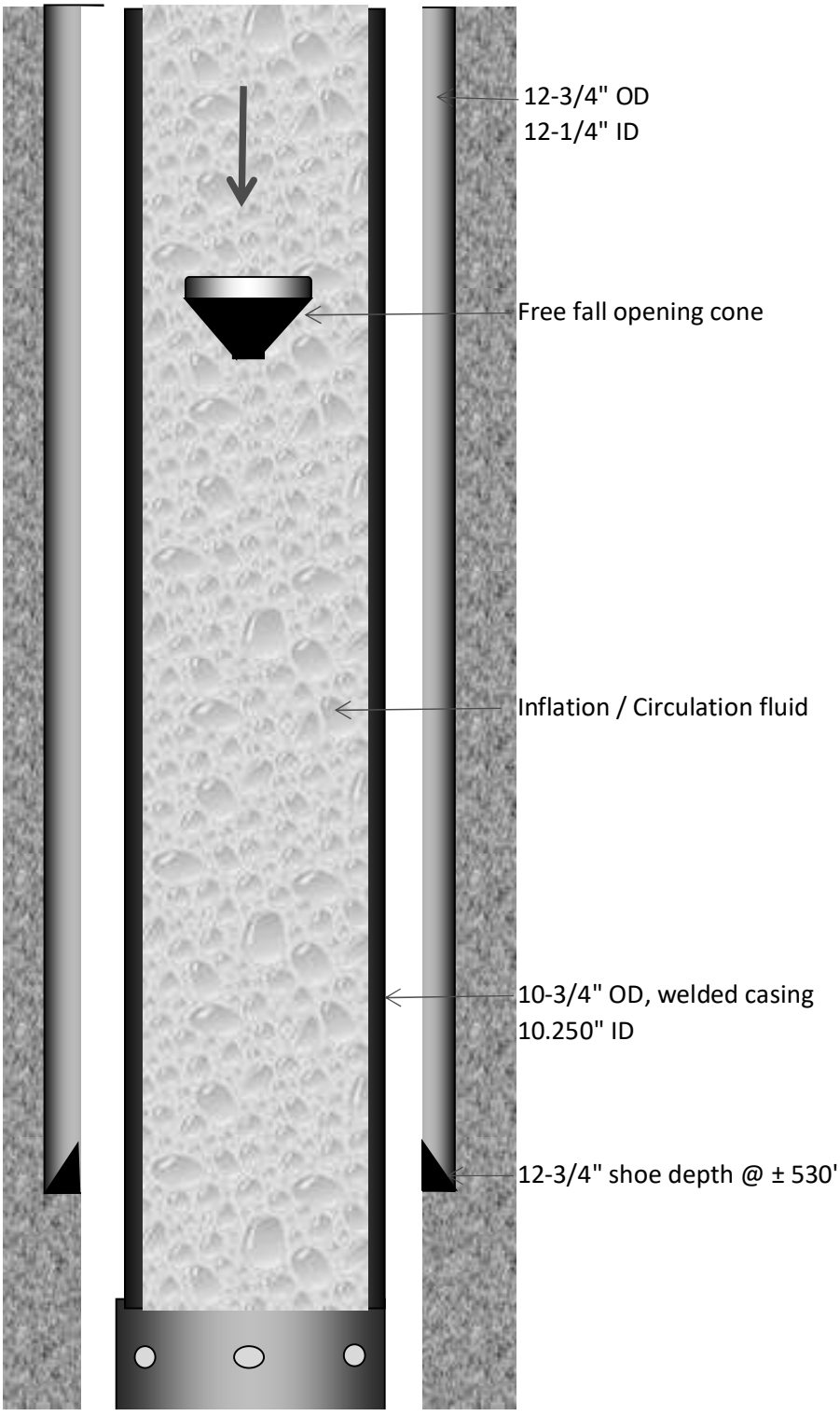
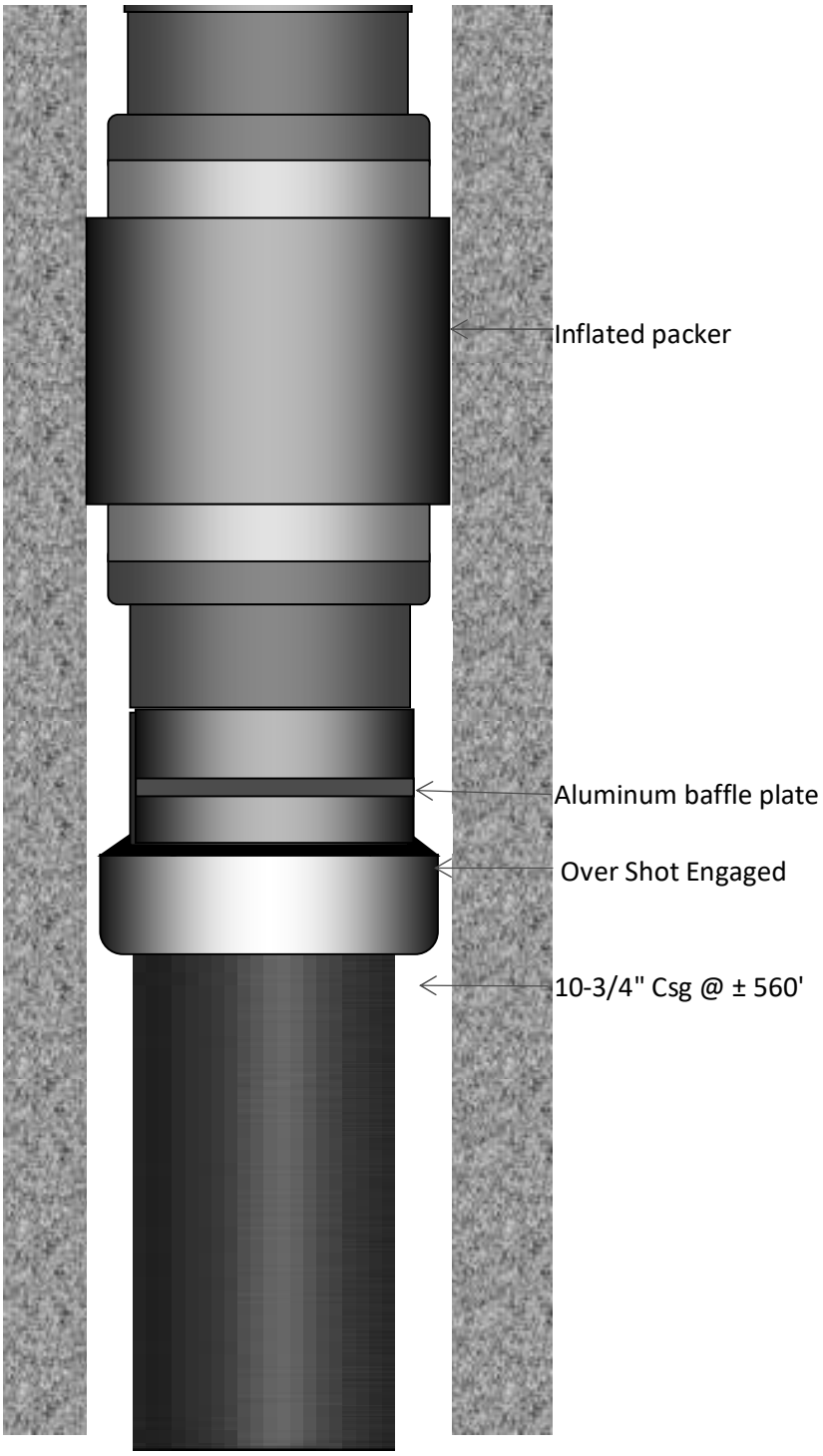
OIT #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 4:
Launch Free fall opening device to stage collar opening seat depth.





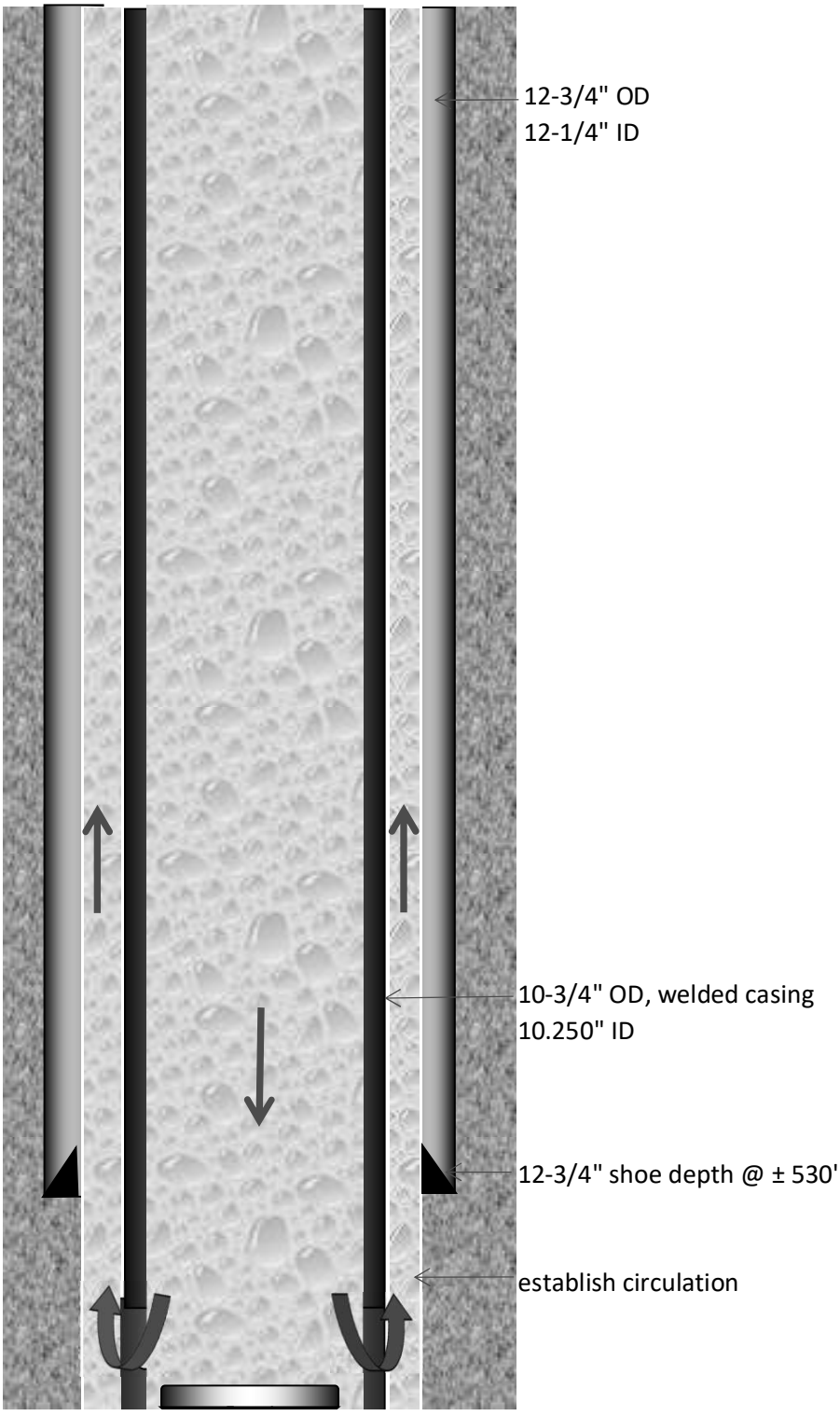
PROJECT ENGINEERING USA Corporation

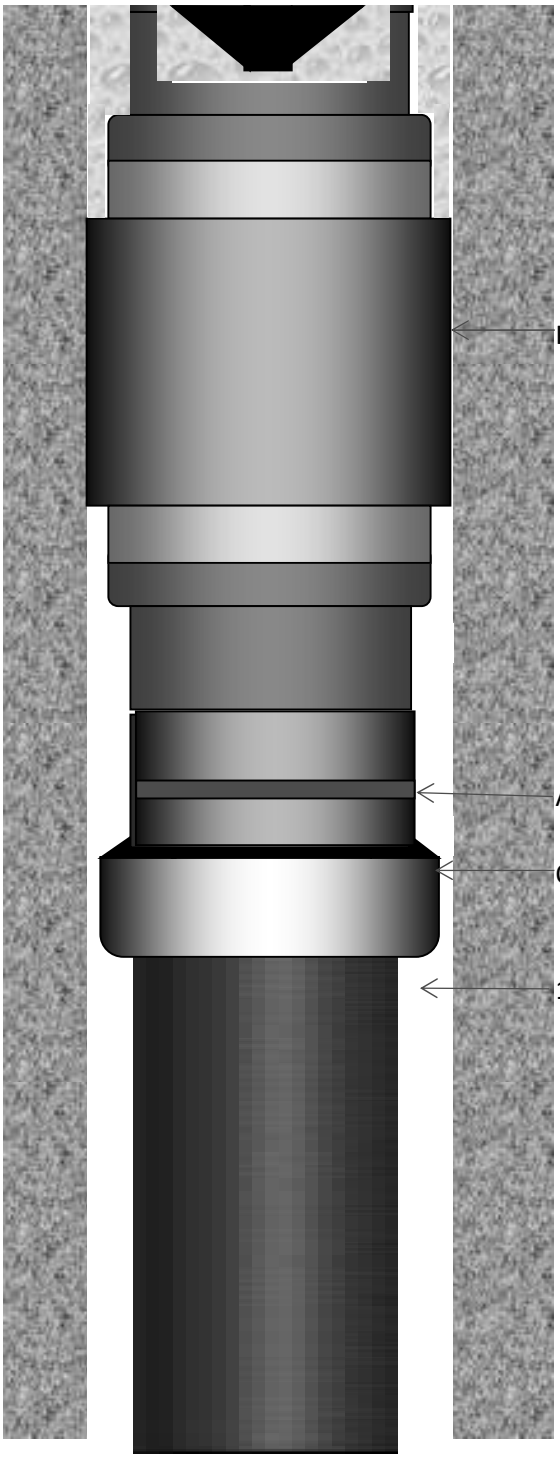
OIT #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 5:
Shift seat open, See MC stage collar opening procedure.

Establish circulation, condition well for cement job.





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OIT #5

Date: 2 - 1 - 2022
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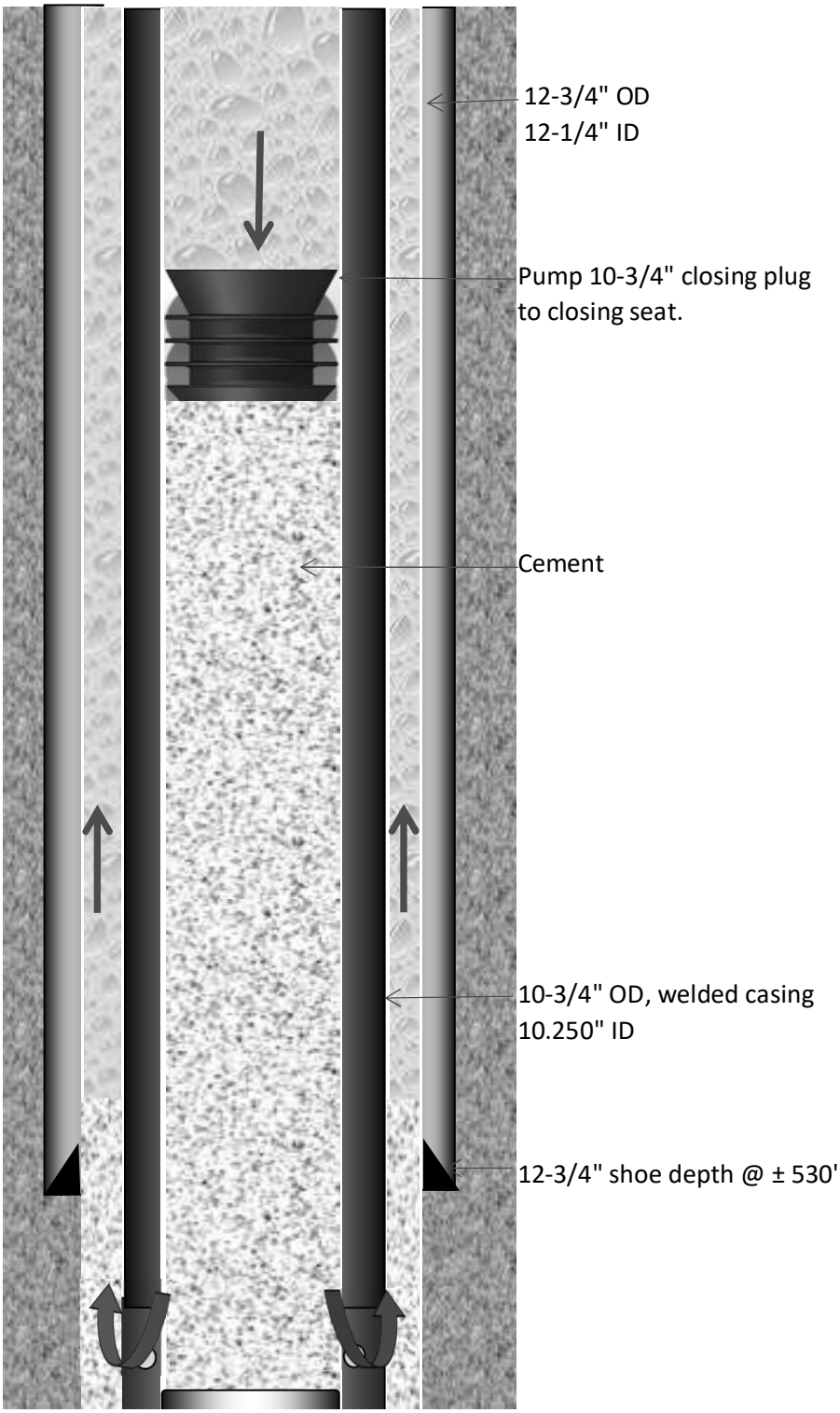
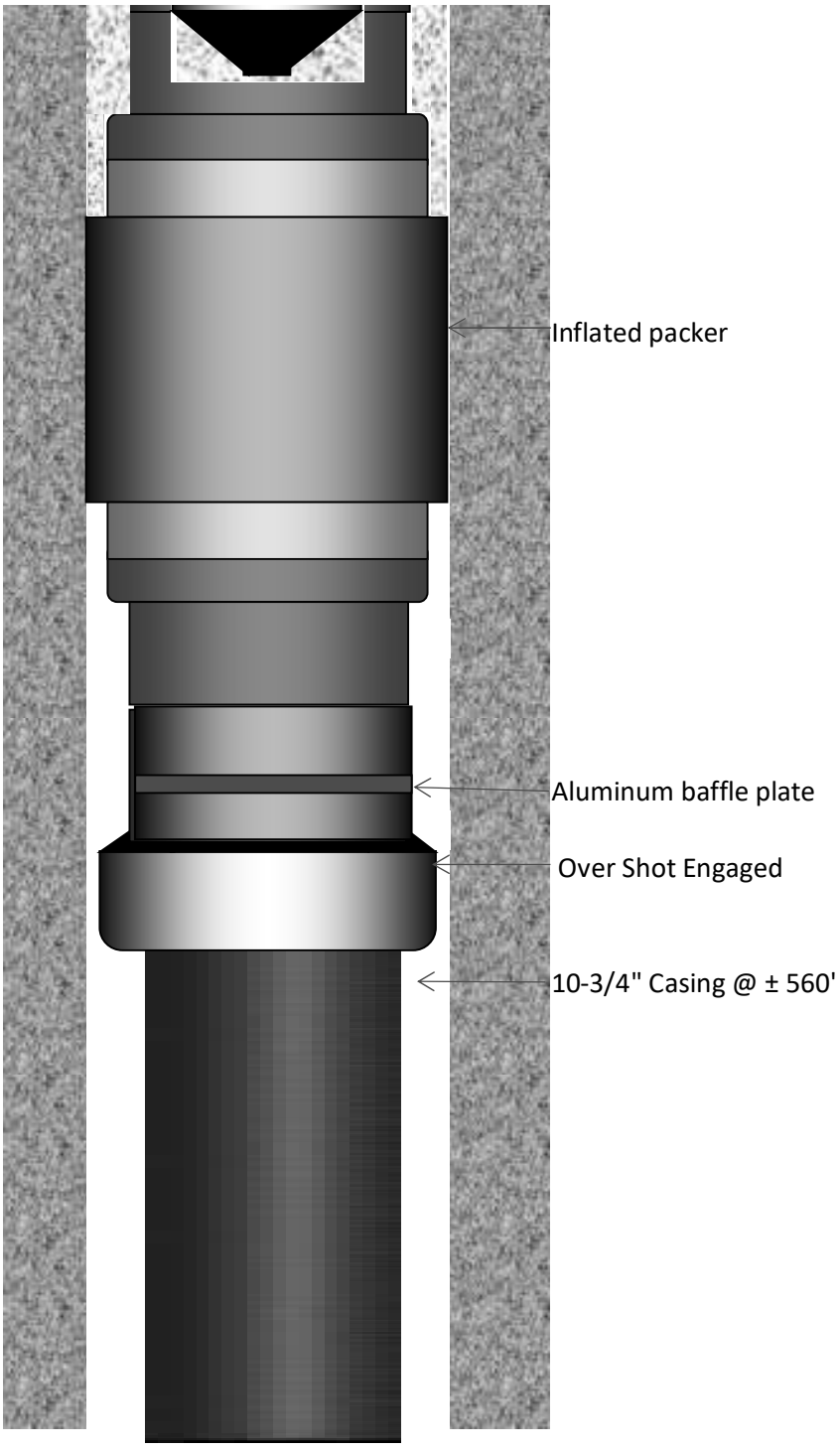
Attn: Virgil Welch
By: Ismael, A.

Figure 6:
Pump cement job,
Launch closing plug.





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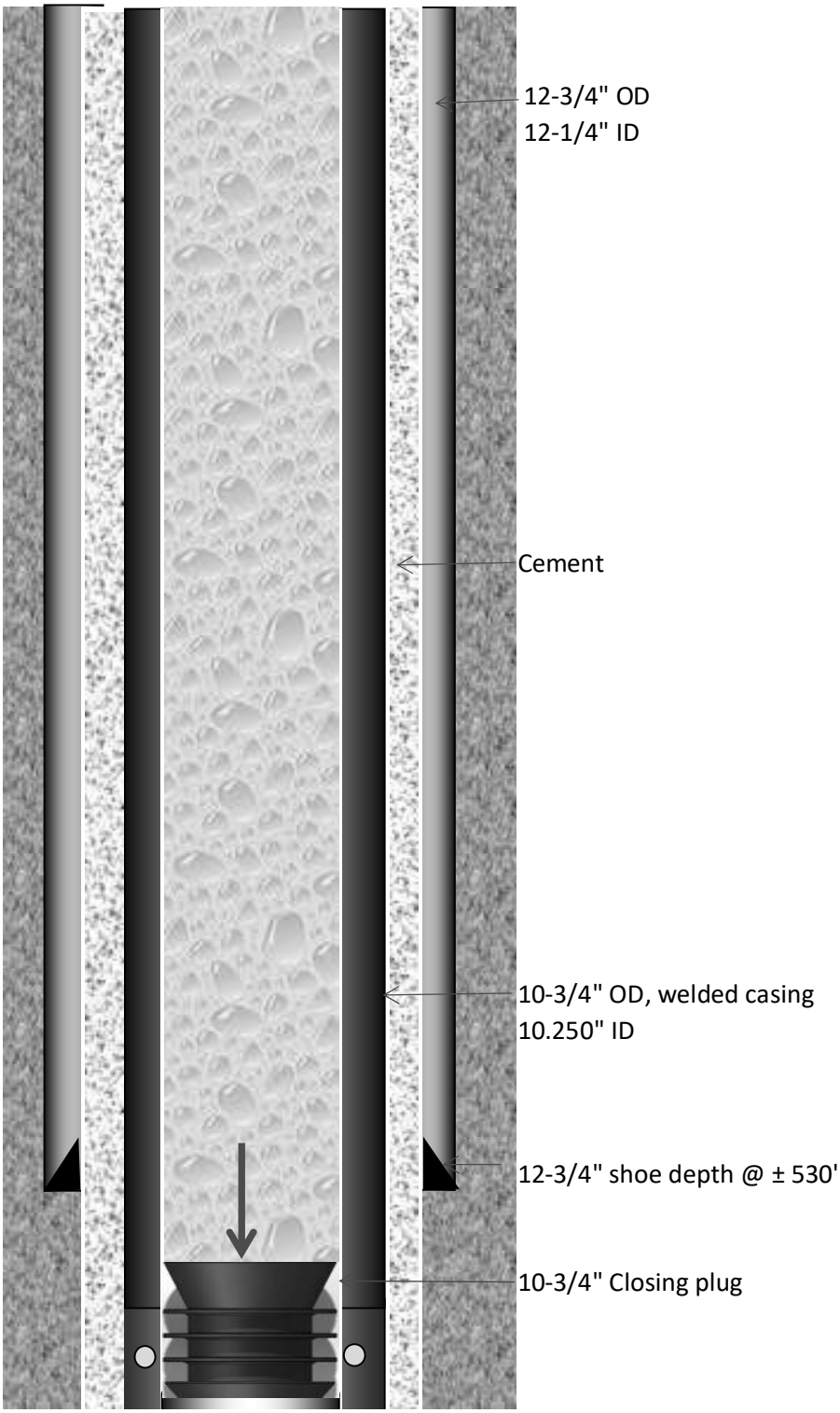
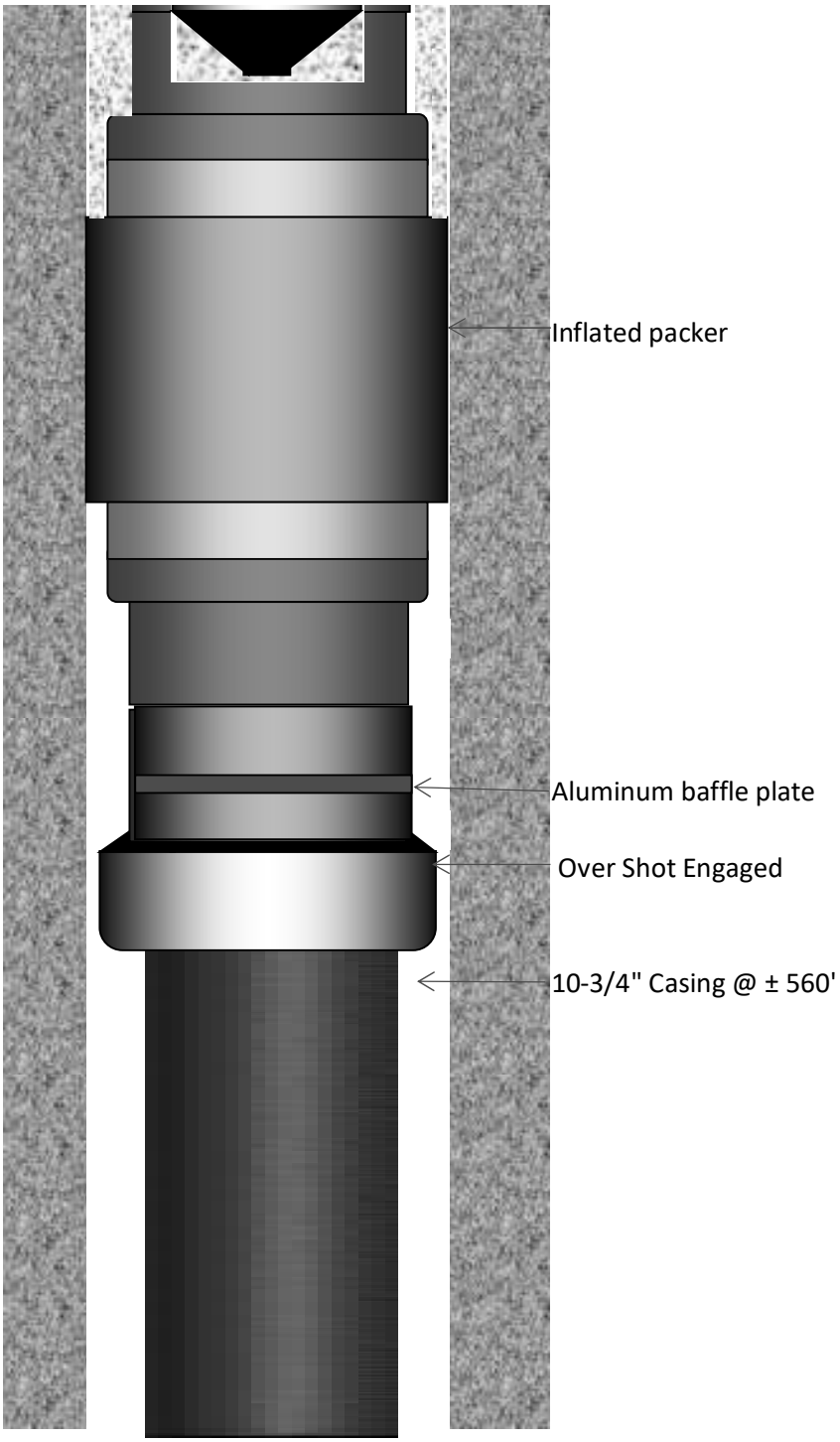
OIT #5

Date: 2 - 1 - 2022
Cust: Welch Energy
Attn: Virgil Welch
By: Ismael, A.

Figure 7:
Apply closing pressure, hold for 5 minutes. See stage collar closing procedure.

Bleed back, with no fluid rushing back, stage collar is closed. Job complete.

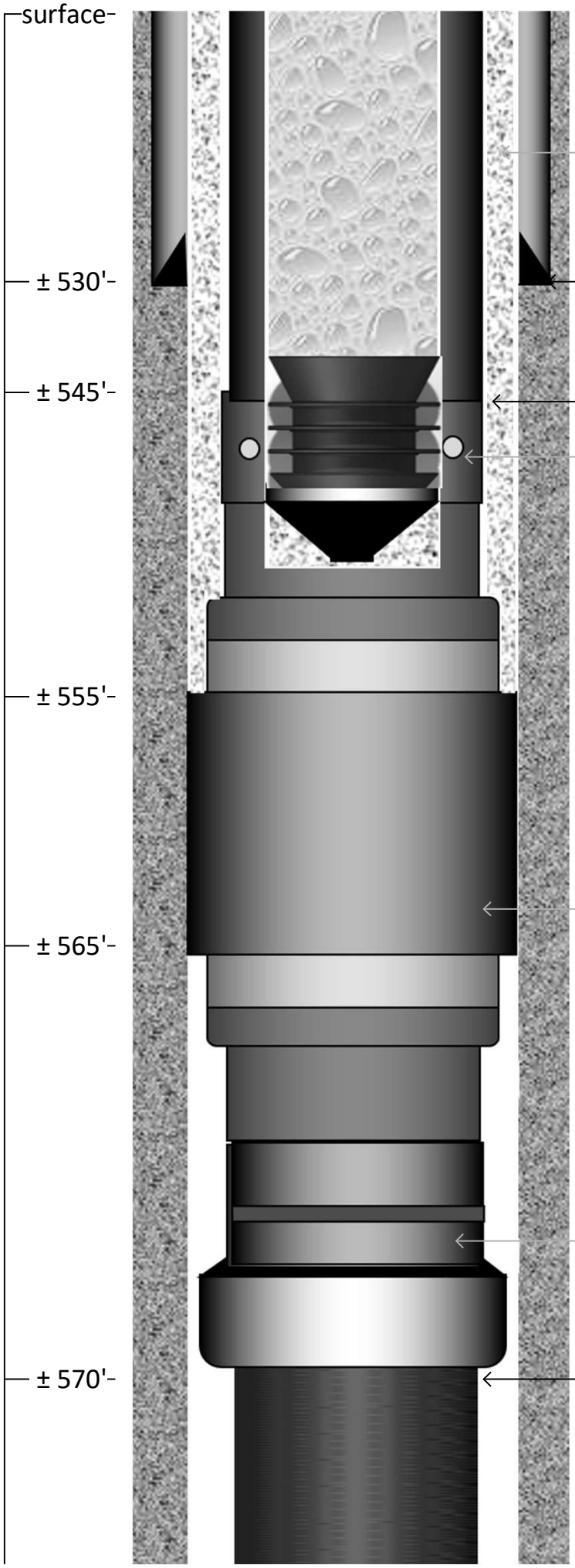




PROJECT ENGINEERING USA Corporation

OIT #5 – *Tieback/Cementing Assembly*

Drawing Not to Scale



<u>±25' total length Tieback/Cementing Assembly composed of:</u>

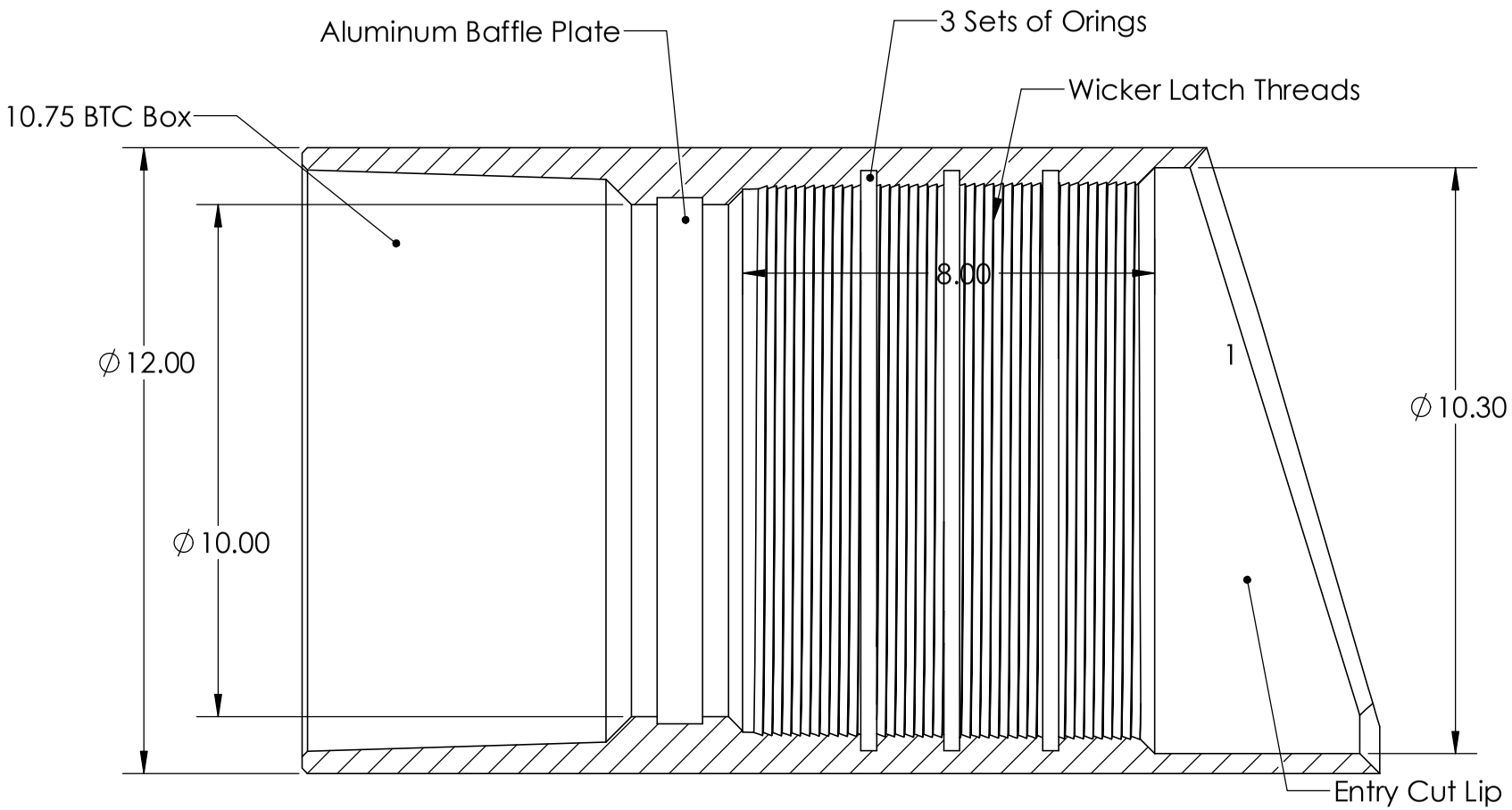
Stage Cementing Collar (top: welded, bottom: threaded)

Inflatable Casing Packer (top: threaded, bottom: threaded)

Casing patch overshot (top: threaded, bottom: wicker threaded)

GeothermEx

A Schlumberger Company



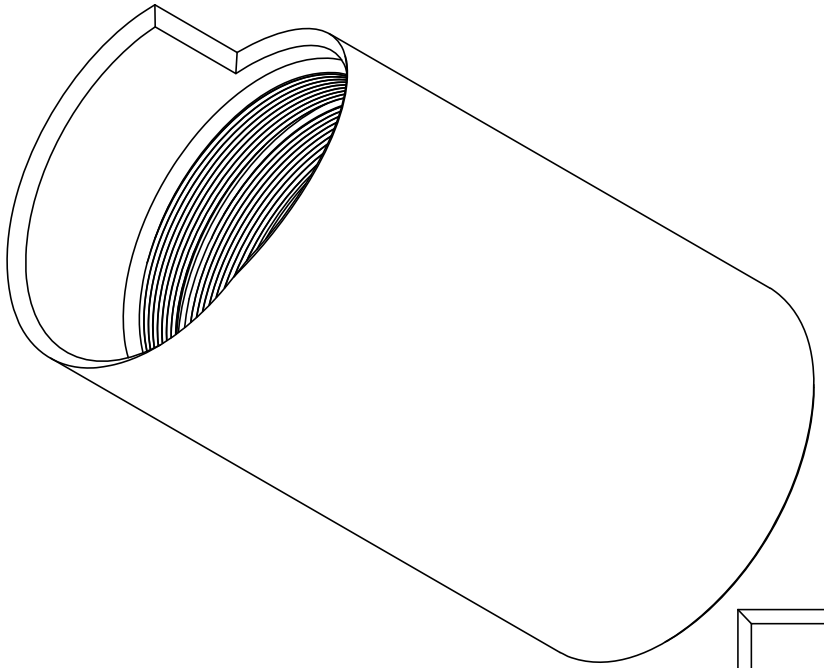
SECTION A-A
SCALE 1 : 3

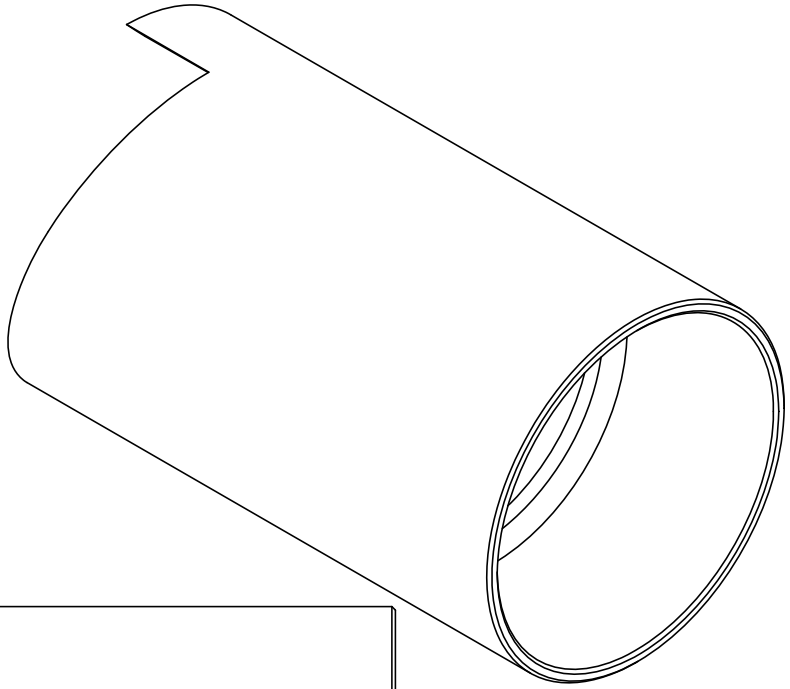
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	Ray L.	7/24/2017
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:
DRIVEOVER HEAD 12.0 X 10.75 w Oring and Baffle

SIZE	DWG. NO.	REV
A	DOBPSO12X10	1

SCALE: 1:8	WEIGHT:	SHEET 1 OF 2





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	Ray L.	7/24/2017
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

DRIVEOVER HEAD 12.0 X 10.75 w Oring and Baffle

SIZE	DWG. NO.	REV
A	DOBPSO12X10	1

SCALE: 1:8	WEIGHT:	SHEET 2 OF 2

WORK INSTRUCTION – OPERATING PROCEDURE FOR

MECHANICAL 2-STAGE TOOL

Document Control Number:	GR.ENG.PROC.29
Version:	6
Created by:	TYLER TINNIN
Approved by:	BRENT LIRETTE
Date of version:	April 29TH, 2020
Signature:	

Change history

Date	Version	Created by	Description of change
9/24/2019	4	Tyler Tinnin	Added parameters for drill out with directional assembly with mud motor and PDC bit
11/01/2019	5	Brent Lirette	Added tool specific recommendations for drilling with PDC and Roller Cone bits
04/29/2020	6	Tyler Tinnin	Modified WOB parameters and application for drilling with PDC bits

SERIES 500 – MECHANICAL 2-STAGE COLLAR

Series 500 Mechanical Stage Collar allows for cementing casing in two stages. Incorporating state of the art design provides for a robust tool that ensures optimal performance in even the harshest environments. Years of experience has enabled Antelope engineers to develop a tool that takes into account every possible variable that may affect the performance of the tool.

Applications

- Cementing long casing strings.
- Where a low hydrostatic pressure is required due to weak formations.
- Zonal isolation.

Features & Benefits

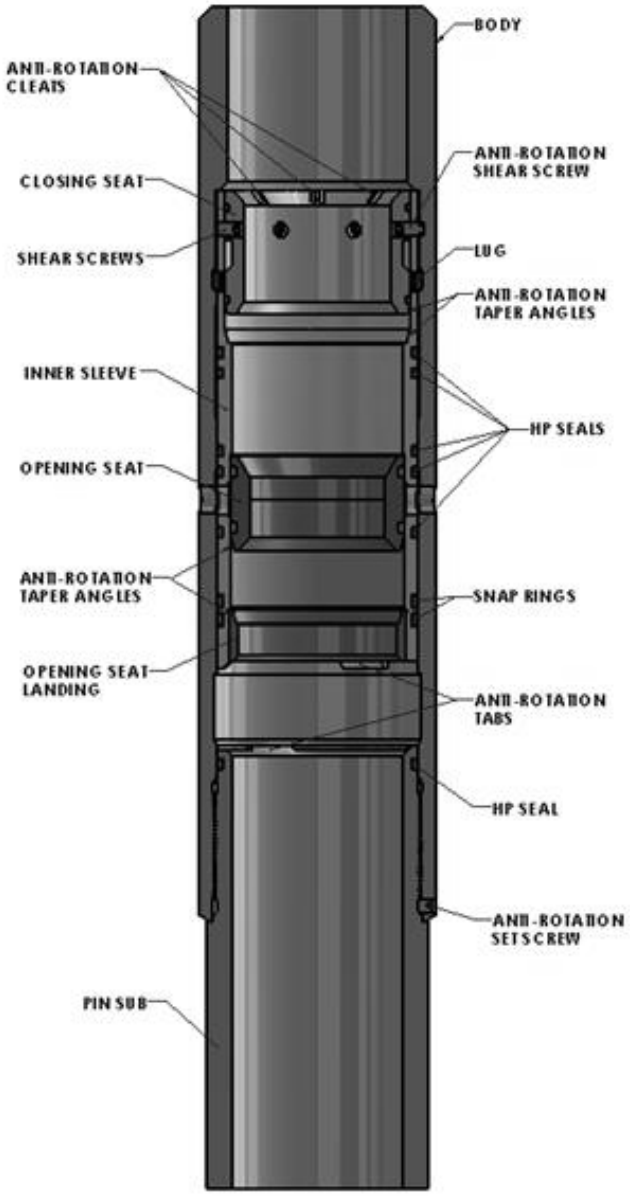
- Minimal moving parts reduces chances of failures.
- Large pump through diameters allows for wiper plugs and drop balls to pass through without affecting tool operation.
- High burst and collapse pressure after closure of tool (see data sheet for values).
- Robust snap ring locking mechanism ensures the tool does not open after closure and is able to withstand 100,000 lbs minimum upward force.
- Well protected components ensures the tool is able to withstand drill out without damage or leakage.
- One sleeve design eliminates pressure traps and increases reliability.
- Box sub is integrated into the body of the stage tool and is capable of withstanding makeup torque of all connections without damage.
- Can be operated within well curvatures with dog leg severity (DLS) up to 12°/100 feet.
- Multiple HNBR O-rings ensures against pressure leakage.
- Standard stage collar materials are suitable for sour service applications.
- Suitable for operating at temperatures up to 300°F.
- Opening cone made from composite material to allow for easy drill out.
- All internal components are PDC and Tri-cone drillable.

Options

- Available in three stage configurations. (Series 503 Mechanical Stage Collar)
- High temperature version rated to 400°F.

Equipment

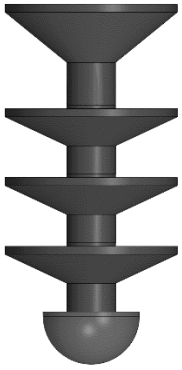
Series 500 Mechanical 2-Stage Collar



Equipment

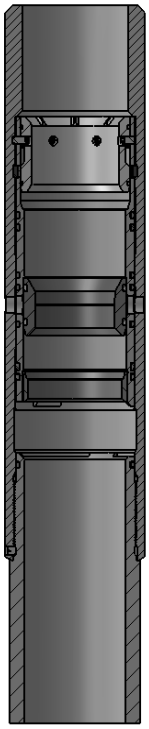
Innovex's Series 500 Mechanical Stage Collar is normally run as the upper tool in 3-stage cementing with the following plug set:

1. Flexible first stage plug
2. 2-Stage Free fall opening cone
3. 2-Stage Closing plug

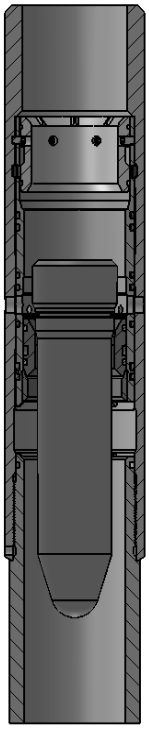
		
Flexible first stage plug	2-Stage Free fall opening cone	2-Stage Closing plug

Note: A free-fall opening cone is not recommended if the inclination above the stage collar is greater than 27°. A pump-down opening plug system is recommended for opening the stage collar at inclinations above 27°or at depths where cement pumped in the annulus above the stage tool may set before the opening cone reaches the stage collar.

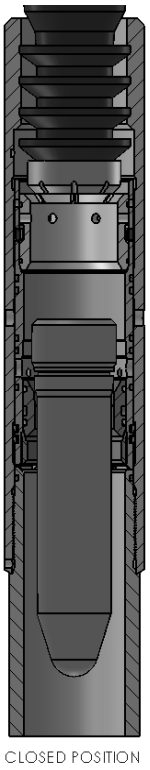
Operational Sequence



RUN-IN
POSITION



OPEN
POSITION



CLOSED
POSITION

Inspection

1) Inspect/verify stage collar and auxiliary equipment upon arrival at location:
a) Check for dents, damaged threads, debris, cuttings, etc.
b) Verify description on assembled tool and/or box matches with delivery ticket.
2) Check opening cone and closing plug to verify that they will seat properly by conducting a simple fit test or dimensional check.
3) Verify that the first stage flex plug nose OD is smaller than both top and bottom seats. Also, verify that the plug nose is compatible with the landing collar, baffle plate, or float equipment upon which it will land. The plug nose OD should be at least ¼" larger than the ID of the surface on which it will land.
4) Verify that the cementing head contains no foreign plugs or objects.
5) If the closing plug is to be pre-load in the cementing head, verify that the plug release mechanism is operable and that the retaining mechanism is sufficient to retain the plug. A shut-off plug and baffle (or landing collar) may be substituted for the first stage plug if preloading of the first stage displacement plug is required.
6) Verify that the nose of the closing plug with pass through the ID of the cement head or any joints or tools between the cement head and the stage collar.
7) Verify cementing head has pressure equalizing channels beside and above the plug to ensure plugs don't get hydraulically locked, which would prevent them from launching.
8) Check stage collar, casing string and running equipment pressure and load ratings to insure that ratings will not be exceeded during operating procedures.

Screw-In Shut-Off Baffle (for BC or 8rd threads) Installation

NOTE: Applicable only if a shut-off plug and baffle are substituted for the first stage plug

1) Visually inspect threads on screw-in baffle plate, checking for any damaged threads.
2) Verify the threads on the baffle plate match that of the float equipment box or casing coupling in which it will be installed. Verification can be visual and/or by checking product description on the documentation provided.
3) Clean box end of float equipment with a clean brush ensuring all debris is removed.
4) Apply thread lock compound to the lower 1/2" of threads in the box end of the float equipment or above the center of the coupling in which the baffle will be installed. Take care not to let thread lock compound drip into the valve inlet of float equipment.
5) Gently screw-in the baffle plate into the box end of the float equipment until it bottoms out at the end of the box thread or the center of the coupling. Clean excess thread lock compound from the box thread above the shut-off baffle.

Stage Collar Installation

1) Install stage collar at desired location on casing string, making sure **tongs are not placed on the body of the stage collar**.
2) Thread lock compound should only be applied to the pin end of the stage collar or casing joint.
3) During make up, do not exceed the torque limit of the stage collar threads.

Stage Collar Operating Procedure

1) Once casing has landed at target depth and circulation to condition well is completed, mix and pump first stage cement.

2) Load first stage plug in cement head, ensuring it fits in the cement head, and replace cap.

3) Release first stage plug behind cement (cement lines can be washed before displacement).

4) Pump calculated amount of displacement fluid to bump first stage plug.

a) It is recommended to slow down pump rate to a rate in BPM that is approximately half the diameter of the casing in inches, but not less than 3 BPM, when first stage plug passes through stage collar.

b) Regular circulating rates can commence once plug has passed stage collar.

5) Pressure up to 500 PSI above circulating pressure to bump and seal the plug, noting the flow rate and pressure before bumping. Also note the increase in pressure and related volume of fluid pumped after bumping the plug. This ratio of pressure increase per bbl pumped can be used to determine the expected amount of flow back when checking the floats.

6) Release pressure to check float valves for flow back and note bleed back volume. If excessive flow back is observed, pump first stage plug back down until it bumps and recheck floats. If floats do not hold after several attempts, pressure can be held at the surface until the first stage cement sets.

7) With floats holding and pressure released, open plug container and launch free-fall opening cone. Note: Closing plug can be pre-installed in plug container after launching opening cone.

8) Reinstall plug container cap and allow free-fall opening cone to drop through the casing string, usually about 200 feet per minute. Allow additional time for heavier fluids.

9) Once opening cone seats in the stage collar, pressure up to 700 – 1000 PSI to open stage collar (always verify opening pressure for larger tools as per specification table). If the opening cone is seated, the pressure increase per bbl pumped should be lower than the ratio noted when the first stage plug was bumped in proportion to the measured depth of the stage collar to the measured depth of the landing collar for the first stage plug.

10) Once the stage collar is open, establish circulation to condition the hole. If the stage collar does not open, release pressure and allow additional time for opening cone to reach the opening seat on the collar, then repeat pressure build.

a) If the stage collar does not open at set pressure, determine if the opening cone is seated in the tool by comparing the ratio of the pressure increase per bbl pumped and / or the ratio of bump pressure to bleed-back volume recorded earlier when bumping first stage plug and checking floats.

b) If the bleed back volume or ratio is less than for the first stage plug bump, it is an indication that the opening cone is seated and circulating pressure can be increased (do not exceed safe limits of stage collar, cement head or casing).

c) If the volume is the same, it may be an indication that the opening cone did not seat and the following actions can be used:

i) Surging (applying pressure rapidly).

ii) Move casing.

iii) Using sinker bar, tubing, or drill pipe with tail pipe smaller than closing seat ID to push the opening cone further down the string to the opening seat. (Consult with Innovex engineering for tail pipe design.)

11) After conditioning the hole and allowing first stage cement to set, decrease pump rates but continue circulation to prevent any solids build up.

12) Mix and pump second stage cement.

13) Release closing plug once second stage cement has been pumped, verifying that the closing plug has left the cement container (lines can be washed before displacement).

14) Pump calculated displacement volume to seat closing plug. A flow rate of 2 to 3 BPM is recommended for landing the closing plug.

15) Once surface indications show the plug has landed, continue pumping and increase pressure to closing pressure listed on stage collar (see Table A) + final displacement pressure to close the stage collar.

16) Hold pressure for 5 minutes to ensure the stage collar has closed properly.

17) Release pressure and note bleed back volume.

18) If excessive bleed back volume is observed, pump closing plug back down and bump closing plug at a higher pressure and/or flow rate. This procedure may be repeated, but do not exceed casing string or running equipment pressure or load ratings when bumping plugs.

19) Job completed.

Table A

Stage Tool Size (in.)	Opening Pressure +/-200psi	Closing Pressure +/-100psi
4.500	900	1500
5.500	900	1500
7.000	900	1500
7.625	900	1500
7.625-CI	450	1200
8.625	900	1500
8.625-CI	450	1200
9.625	900	1500
9.625-CI	450	1000
10.750	900	1200
10.750-CI	450	1000
11.750-CI	450	1000
13.375	900	1200
13.375-CI	450	1000

Stage Collar Cancellation Procedure

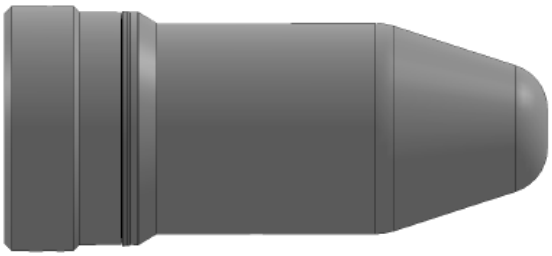
A free-fall cancellation cone can be used to permanently close a stage tool if an opening cone has not been dropped and permanent closure of the stage collar (without opening) is desired.

1) Inspect both cancellation ring and free fall opening cone and verify that the part numbers and sizes match the tool being run. This can also be done by correlating the opening cone OD to the cancellation ring ID and the cancellation ring OD to the closing seat ID.
2) Install cancellation ring on to free-fall opening cone and ensure the cancellation ring is fully seated before installing set screws to hold in place.
3) Tighten set screws in a criss-cross pattern until fully secured and centered.
4) With floats holding, open plug container and release free fall cancellation cone.
5) Reinstall plug container cap and allow free-fall cancellation cone to drop through the casing string, usually about 200 feet per minute. Allow additional time for heavier fluids.
6) Apply pressure above tool until reaching closing pressure listed on stage tool (see Table A) and hold for 5 minutes, watching for a slight pressure drop, casing movement, or weight indicator change as a signal that the tool has shifted to the closed position.
7) Note pressure pumped for closing as well as volume bled back. Compare this to the pressure and volume bled back when the first stage plug was bumped. If a lower volume is bled back this will indicate that the cancellation cone is seated.
8) If no indication of tool closure is observed, allow additional time for the cancellation cone to reach the stage tool, then repeat pressure application.

Note:

- **Do not open stage tool before cancellation.**
- **If the well inclination is greater than 27° above the stage collar, the cancellation cone may not reach the closing seat. The cancellation cone can be pushed into position with drill pipe or a sinker bar on wireline. Pressure can then be applied to close the tool.**
- **<u>Only steps 4-8 are necessary for fully composite cancellation cones which are identifiable by their yellow color.</u>**

Standard Cancellation Cone



Fully Composite Cancelation Cone

SECTION VIEW OF CANCELLATION RING AND FREE-FALL OPENING CONE (NOT TO SCALE)

Stage Collar Drill Out Procedure

Preparation:

1. Check diameter of bit and stage collar drill out diameters to verify clearances.
2. Manual control of drilling operation recommended.
3. Reamers and stabilizers installed close to the bit are recommended to ensure bit is centralized.
4. Spot cement above closing plug if allowable help prevent rotation during drill out.
5. Convex bits tend to drill better than concave PDC bits when drilling out plugs, float, and stage cementing equipment, since convex bits are less likely to trap materials under the bit.

Drill Out with PDC Bit:

Drilling with pdc bit is only recommended when running -CI composite seat stage tools

The below procedure can also be applied in applications using composite seat contingency collars

It is recommended to *not* engage any *autodrilling* features while inside the casing and to wait until everything in the casing string including the shoe track is drilled before engaging.

1. Lower bit in casing until approaching location of stage collar. After contacting top of cement or closing plug, raise bit.
2. Establish sufficient flow rate to remove drill cuttings. 40 GPM per inch of bit diameter may be a good starting point. Rotate bit at a rate greater than 25 RPM. When using motor driven bits use optimum weight and RPM that will not stall bit. The following parameters are normally successful when drilling out with a directional assembly which includes a mud motor:

    Bit RPM: 100 +/- 20
    Rotary RPM: 10
    WOB: 1,000 – 10,000 lbs

3. Lower bit slowly and gently tag stage collar closing plug. Set down 1,000 lbs WOB and allow bit to score and build torque slightly. Once torque has smoothed out, allow bit to smoothly cut down through stage collar while ensuring no torque spikes. Increase WOB to 10,000 lbs in 1,000 lb increments and be patient to allow the torque to smooth. If torque issues arise, pick up and start again.

    **Initially setting down too much WOB and not gradually increasing weight can cause heavy vibration and could potentially damage the bit. In addition to lower vibration, gradually increasing weight from 1,000 lbs will also reduce the size of cuttings.

4. If ROP slows excessively, slowly build up to 800 to 1500 lbs WOB per inch of bit diameter. Use no more WOB than is needed to maintain a good rate of penetration, which is normally no more than 5,000 to 10,000 lbs.
5. If ROP stops or torque increases excessively, the bit should be raised while continuing to rotate and circulate before continuing as recommended above. This should help to remove cuttings and cementing plug wiper fins from bit.
6. If ROP stops or torque declines, the bit may be spinning on the cementing plug. Raise the bit, then stop rotating. Reduce the flow rate to two or three BPM, then apply 3000 to 5000 lbs WOB. (High flow rates can decrease the effective WOB.) Slowly begin rotating 25-40 RPM. (When using a turbine or mud motor,

use the lowest RPM that will not stall the motor). Increase WOB to 5,000 to 12,000 lbs and resume normal drilling parameters once normal drilling progress is observed.
7. If the drilling characteristics change, such as excessive vibration or loss of ROP, change either the WOB, RPM, or the circulation rate until the drilling characteristics normalize.
8. If ROP stops and cannot be restarted using the above parameters, retrieve bit for inspection. If no reason for loss of ROP is observed, consider use of a roller cone bit to complete drill out.
9. After drilling through the stage collar, run the bit through it at least three times while rotating.
10. When proceeding to continue running the BHA downhole it is recommended not to rotate the bit or drill pipe unless necessary. To avoid damaging the casing a minimal amount of WOB is recommended before attempting to rotate through any obstruction. If rotating is necessary, rotate only enough to not damage equipment in the BHA.

Drill Out with Roller Cone Bit:
Drilling with roller cone bit is recommended for aluminum seat tools as well as -CI composite seat tools

1. Use of a three-cone, long milled tooth bit that is as large in diameter as possible and below casing drift and stage collar drill out ID is recommended. A bit that is designed for medium to soft formations should provide optimum performance.
2. Lower bit in casing until approaching location of stage collar. After contacting top of cement or closing plug, raise bit.
3. Establish sufficient flow rate to remove drill cuttings. 40 GPM per inch of bit diameter may be a good starting point. Rotate bit at 40 to 60 RPM, never exceeding 100 RPM.
4. Lower bit slowly, applying up to 2000 lbs WOB until the bit pattern is made. When using motor-driven bits use optimum weight and RPM that will not stall bit.
5. Slowly build up to 2000 to 3000 lbs WOB per inch of bit diameter if necessary, but no more than is needed to maintain a good rate of penetration.
6. Maintain at least 2 hhp (hydraulic horsepower) per sq in of bit surface.
7. Raise and lower the bit occasionally while continuing to circulate to clean junk from bit.
8. After drilling through the stage collar, run the bit through it at least three times while rotating.

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ICP TECHNICAL MANUAL

Document Control Number:	TM.01
Version:	1
Created By:	Chris Cuffe
Approved By:	Chris Weaver
Date of Version:	November 8, 2016
Initial Release Date:	November 8, 2016

Change history

Date	Version	Created by	Description of change
02/01/2022	1.0	Chris Cuffe	Updated shear pressure data

PRODUCT DESCRIPTION

The ICP product is an Inflatable Casing Packer used to isolate the annulus between a casing or liner string and the open hole wellbore or previously set casing. The ICP is made up as part of the casing string and will meet all mechanical properties of the casing string.

The ICP incorporates a one-piece mandrel which is available in all standard API casing sizes from 4 ½" (114.3mm) to 20" (508mm) and all standard API casing grades.

The temperature rating of the ICP with standard rubber is 250 F (121 C) and with high temperature rubber is 350 F (176 C)

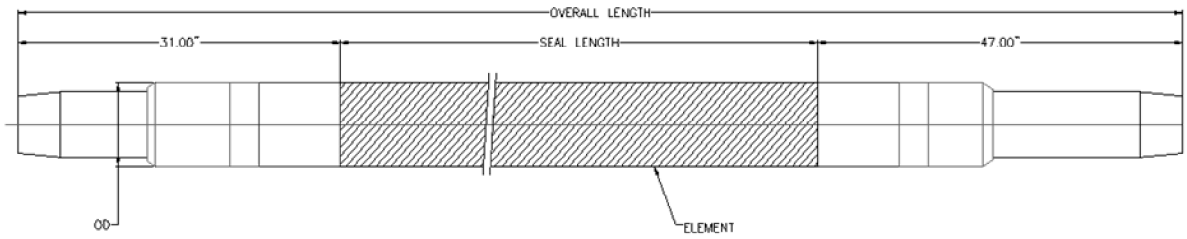
FEATURES

- Patented lock ring design mounts ICP on to casing.
- Available to match all casing weights, grades and threads.
- ICP valve housing and valves rated to full casing burst pressure after operation.
- Valve system fully compatible with cement inflation.

SIZES AVAILABLE

Casing		ICP OD	
in	mm	in	mm
4.50	114.3	5.56	141.2
5.50	139.7	7.00	177.8
6.63	168.4	8.06	204.7
7.00	177.8	8.06	204.7
8.63	219.2	10.25	260.4
9.63	244.6	11.25	285.8
10.75	273.1	11.88	301.8
13.38	339.7	15.25	387.4
16.00	406.4	18.00	457.2
18.63	473.1	20.50	520.7
20.00	508.0	22.00	558.8

ELEMENT SEAL LENGTH SPECIFICATIONS

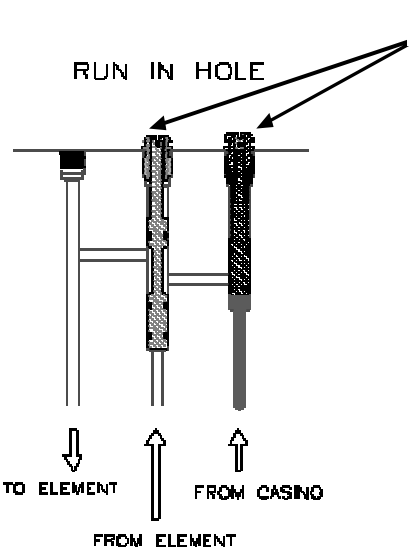


Seal Length			Overall Length		
4 ft	**10 ft**	**20 ft**	**4 ft**	**10 ft**	**20 ft**
ft (m)	ft (m)	ft (m)	ft (m)	ft (m)	ft (m)
4 (1.22)	10 (3.05)	19 (5.79)	10.45 (3.19)	16.45 (5.01)	24.98 (7.61)

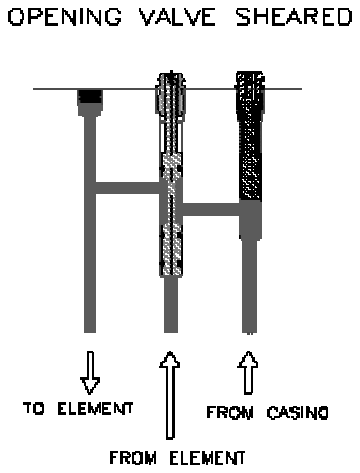
ICP INFLATION CONTROL SYSTEM

The ISOTECH ICP utilizes a dual valve system to control the pressure at which inflation of the element begins as well as controlling the amount of pressure allowed in the element. The opening valve operates on differential pressure between the hydrostatic pressure inside the casing string and the hydrostatic pressure in the annulus at the depth of the ICP. The closing valve operates on a differential pressure between the internal pressure of the element and the hydrostatic pressure in the annulus at the depth of the ICP. Once the closing valve operates, the valve prevents any further fluid being pumped into the ICP element. Once the ICP element inflation is complete, the casing pressure can be released back to 0 psi pressure and the opening valve moves to a position where it also prevents any fluid from entering the element, giving a redundant seal between the casing and the element.

VALVE OPERATION

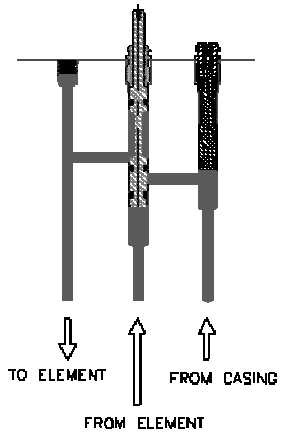


When the valve system is in the run-in position, both the opening and the closing valves are held in place by shear pins. The opening valve is in a position such that casing fluid is prevented from entering the element.



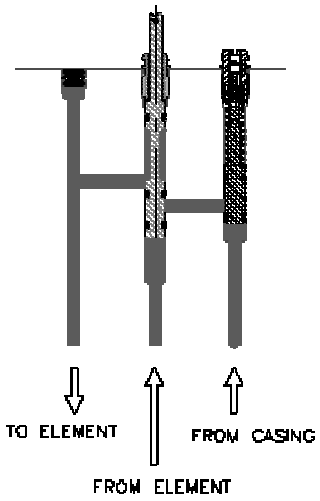
Pressure is increased inside the casing which results in the casing hydrostatic pressure exceeding the annular hydrostatic pressure at the valve. Once this differential in pressure exceeds the shear pin rating, the shear pin shears and the valve moves into a position that allows flow into the ICP element.

CLOSING VALVE SHEARED



When the differential between the ICP element inflation pressure and the annular hydrostatic pressure at the valve exceeds the shear pin rating of the closing valve, the closing valve pin shears and the valve moves to a position that prevents any further flow into the element. This allows the service engineer to set the required pressure in the ICP element and prevents over inflation of the ICP element.

OPENING VALVE LOCKED



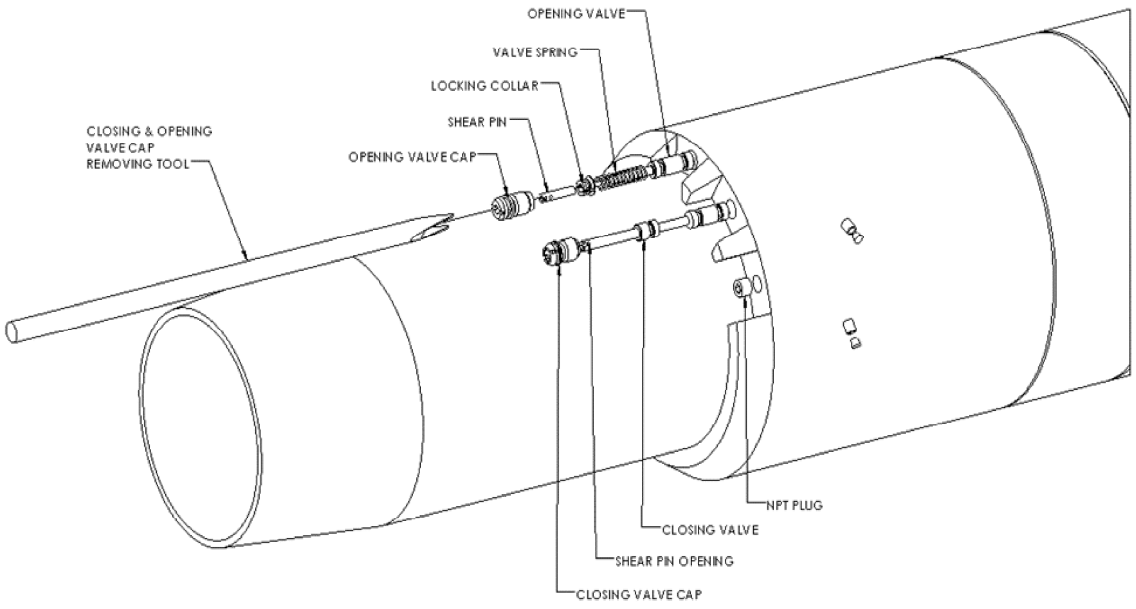
Once inflation of the ICP element is complete, the surface pressure is released back to 0 psi. At this point, the opening valve spring, moves the valve back to its original position and the opening valve lock ring closes over the stem preventing any further movement. This acts as a secondary seal, preventing fluid flow from the casing ID to the ICP element

CHANGING THE OPENING SHEAR PIN (Refer to diagram below for parts descriptions)

1. Select the shear pin to be used from the supplied shear pin card.
2. Using screwdriver, turn opening valve cap and collet assembly one complete turn to the left.
3. Use a needle nose pliers to remove the shear pin from the cap and discard.
4. Insert the selected shear pin into the hole in the cap and install completely so that the shear pin runs through the assembly and out the opposite hole on the cap.
5. Screw the opening valve cap back to the right until the shoulder on the cap bottoms out on the valve housing.
6. Check that shear pin is bent around the cap to prevent slipping out of the cap during run-in

CHANGING THE CLOSING SHEAR PIN (Refer to diagram below for parts descriptions)

1. Select the shear pin to be used from the supplied shear pin card
2. Using screwdriver, turn closing valve cap one complete turn to the left.
3. Use needle nose pliers to remove the shear pin from the cap and discard
4. Insert the selected shear pin into the hole in the cap and install completely so that the shear pin runs through the assembly and out the opposite hole on the cap.
5. Screw the closing valve cap back to the right until the shoulder on the cap bottoms out on the valve housing.
6. Check that shear pin is bent around the cap to prevent slipping out of the cap during run in.



SHEAR WIRE DATA SHEET

Wire Size	Shear PSI	Shear KPA	SHEAR WIRE ATTACHED
0.020 *0.508*	**220**	***1520***	
0.026 *0.660*	**490**	***3380***	
0.029 *0.737*	**540**	***3720***	
0.031 *0.787*	**730**	***5030***	
0.033 *0.838*	**1000**	***6890***	
0.035 *0.889*	**1100**	***7580***	
0.037 *0.940*	**1200**	***8270***	
0.040 *1.016*	**1425**	***9830***	
0.043 *1.092*	**1675**	***11550***	
0.045 *1.143*	**1800**	***12410***	
0.049 *1.245*	**2240**	***15440***	
0.053 *1.346*	**2600**	***17920***	
0.057 *1.448*	**3032**	***20900***	

UNIT KEY: INCH *MM* **PSI** *KPA*

THIS DATA PERTAINS TO ISOTECH EVALUATED BRASS SHEAR WIRE ONLY FLUCTUATION IS DEPENDANT OF MATERIAL AND HANDLING.

ICP STANDARD OPERATING PROCEDURE

The following program begins when the hole has been drilled to TD. These procedures are based upon generally accepted cementing practices, but they may be altered due to the condition of the well at the time of the primary cement job or prior to inflation of the packer.

1. Appropriate logging program is recommended; calipered hole size is critical.
2. From open hole logs determine desired position for the ISOTECH packer.
3. Run casing per normal design considerations with ISOTECH packer positioned as determined in Steps 1 and 2. ISOTECH packers are designed for compatibility with conventional downhole cementing equipment. However, the following is recommended:
   a. To minimize (metal) debris in the wellbore, only high quality centralizers should be run below the packers.
   b. Differential/automatic fill-up shoes are not recommended.
   c. All hydraulically-operated equipment needs to be checked prior to running in order to ensure proper pressure settings, (i.e. number of pins in a hydraulically-operated stage tool or liner hanger). Also proper setting order of all hydraulic equipment must be verified.
   d. Install baffle plate into float collar if applicable.
4. Establish circulation of casing. Pipe may be reciprocated if desired during job. Sufficient fluid should be circulated to ensure proper operation of float equipment.
5. Conduct normal cementing operations as follows:
   a. Test surface lines to 5,000 psi or per safe operating practices.
   b. Pump in spacer/pre-flush fluids.
   c. Pump in normal volume of cement for primary cement job.
   d. Drop shut-off plug.
6. Re-establish circulation of casing. Pipe may be reciprocated if desired during job. Sufficient fluid should be circulated to ensure proper operation of float equipment.
7. If the packer is to be fluid inflated it should be noted that fluid densities of 17#/gal or greater need to be investigated as to flow through the valve system. Loss circulation material should not be in the inflation fluid nor a high solids content. If fluid inflating, continue to displace until within 10 bbls of total displacement and reduce rate to 1-2 bbls/minute. Proceed to step 9.
8. If inflating with cement-- pump required volume of inflation cement, which may be the same high density cement used in the primary cement job, less any lost circulation additives. However, we would like to review specific properties such as fluid loss, pump time, etc. prior to job. Also, all inflation cement must have a maximum consistency of 20 BC units in 30 minutes.

NOTE: Inflation cement volume should be sufficient to fill packer, plus 200 feet of excess in casing above packer after inflation plus 100 feet below.. (Pumping the necessary cement inflation volume is critical. Inflation cement, pre-mixed in a batch mixer, is the most desired method of verifying the volume of inflation cement pumped. However, if a batch mixer is not available, care must be taken to ensure that adequate bulk cement is

held back from the primary job so that the inflation cement volume is not cut short. If possible, loading the inflation cement in its own bulk tank will eliminate much of the room for error. If the packer is positioned more than 600' from float collar a mud spacer should be used between the wiper plug and bottom of inflation cement which can then be followed by another plug as an interface if possible.

Displace cement until the first stage shut-off plug "bumps" down on the landing collar. A cementing pump is recommended for the last 10 bbls of displacement. Slow displacement to 2 bpm prior to landing plug and record surface (balance) pressure.

NOTE: The first stage shut-off plug must be displaced to the landing collar and hold pressure. Since the required displacement volume (as measured from surface tanks) is increased by compressibility and extent of aeration:

1) ***verification that the plug leaves the head on time, and***
2) ***a commitment to displace more than the theoretical volume is essential to success of the installation.***

9. When plug lands, increase surface pressure to 300 psi plus recorded surface (balance) pressure and hold for 2-5 minutes. Check for and repair all surface leaks no matter how small.
10. Bleed pressure to zero and monitor flow back to ensure floats are holding. Record flow back volume from pressures.
11. Increase pressure to 500 psi and record volume in displacement tank.
12. Increase surface pressure in increments of 200 psi to balance pressure plus rated differential shear pin pressure. If no pressure decline, increase pressure by 200 psi or as needed to open valve.
13. Inflate packer and monitor pressure decline as the packer takes fluid. Do not let surface pressure decline below CLOSING VALVE shear pin setting.

NOTE: In small inflation volume installations (less than ¼ bbl.), you may not be able to see a pressure bleed off indicating valve action.

NOTE: When packer is fully inflated, surface pressure will stabilize and not decline.

14. Bleed surface pressure to pressure at Step 11 and record volume in displacement tank for net inflation volume calculation.
15. Hold pressure 5-10 minutes.
16. Bleed surface pressure to zero. Record flow back volume from pressures.

ICP STANDARD OPERATING PROCEDURE WITH MECHANICAL OPERATED STAGE TOOL

FIRST STAGE

The following program begins when the hole has been drilled to TD. These procedures are based upon generally accepted cementing practices, but they may be altered due to the condition of the well at the time of the primary cement job or prior to inflation of the packer.

1. Appropriate logging program is recommended; calipered hole size is critical.
2. From open hole logs determine desired position for the ISOTECH packer.
3. Run casing per normal design considerations with ISOTECH packer positioned as determined in Steps 1 and 2. ISOTECH packers are designed for compatibility with conventional downhole cementing equipment. However, the following is recommended:
   a. To minimize (metal) debris in the wellbore, only high quality centralizers should be run below the packers.
   b. Differential/automatic fill-up shoes are not recommended.
   c. All hydraulically-operated equipment needs to be checked prior to running in order to ensure proper pressure settings, (i.e. number of pins in a hydraulically-operated stage tool or liner hanger). Also proper setting order of all hydraulic equipment must be verified.
   d. Install baffle plate into float collar.
4. Establish circulation of casing. Pipe may be reciprocated if desired during job. Sufficient fluid should be circulated to ensure proper operation of float equipment.
5. Conduct normal first stage cementing operations as follows:
   a. Test surface lines to 5,000 psi or per safe operating practices.
   b. Pump in spacer/pre-flush fluids.
   c. Pump in normal volume of cement for primary cement job.
   d. Drop first stage shut-off plug.
6. Re-establish circulation of casing. Pipe may be reciprocated if desired during job. Sufficient fluid should be circulated to ensure proper operation of float equipment.
7. Pump required volume of inflation cement if applicable, which may be the same high density cement used in the primary cement job, less any lost circulation additives. However, we would like to review specific properties such as fluid loss, pump time, etc. prior to job. Also, all inflation cement must have a maximum consistency of 20 BC units in 30 minutes.

NOTE: Inflation cement volume should be sufficient to fill packer, plus 200 feet of excess in casing above packer after inflation. (Pumping the necessary cement inflation volume is critical. Inflation cement, pre-mixed in a batch mixer, is the most desired method of verifying the volume of inflation cement pumped. However, if a batch mixer is not available, care must be taken to ensure that adequate bulk cement is held back from the

primary job so that the inflation cement volume is not cut short. If possible, loading the inflation cement in its own bulk tank will eliminate much of the room for error).

8. Displace cement, (decrease pump rate to 2 bpm from 10 bbls before and after passing through stage tool) increase rate and continue displacement until the first stage shut-off plug "bumps" down on the landing collar. A cementing pump is recommended for the last 10 bbls of displacement. Slow displacement to 2 bpm prior to landing plug and record surface (balance) pressure.

NOTE: The first stage shut-off plug must be displaced to the landing collar and hold pressure. Since the required displacement volume (as measured from surface tanks) is increased by compressibility and extent of aeration:

1) ***verification that the plug leaves the head on time, and***
2) ***a commitment to displace more than the theoretical volume is essential to success of the installation.***

9. When plug lands, increase surface pressure to 300 psi plus recorded surface (balance) pressure and hold for 2-5 minutes. Check for and repair all surface leaks no matter how small.
10. Bleed pressure to zero and monitor flow back to ensure floats are holding. Record flow back volume from pressures.
11. Increase pressure to 500 psi and record volume in displacement tank.
12. Increase surface pressure in increments of 200 psi to balance pressure plus rated differential shear pin pressure. If no pressure decline, increase pressure by 200 psi or as needed to open valve.
13. Inflate packer and monitor pressure decline as the packer takes fluid. Do not let surface pressure decline below CLOSING VALVE shear pin setting.

NOTE: In small inflation volume installations (less than ¼ bbl.), you may not be able to see a pressure bleed off indicating valve action.

NOTE: When packer is fully inflated, surface pressure will stabilize and not decline.

14. Bleed surface pressure to pressure at Step 11 and record volume in displacement tank for net inflation volume calculation.
15. Hold pressure 5-10 minutes.
16. Bleed surface pressure to zero. Record flow back volume from pressures.

SECOND STAGE

17. Drop opening cone and allow to free fall at a rate of 200 feet per minute.
18. When opening cone lands on seat increase pressures to open stage tool.
19. Establish circulation and circulate at a minimum of 1-2 bottoms up to condition hole and pump out excess cement if applicable.
20. Conduct second stage cement operations as follows:
    a. Test surface lines to 5,000 psi or per safe operating practices.
    b. Pump in spacer/pre-flush fluids.
    c. Pump in normal volume of cement for primary cement job.
    d. Drop second stage closing plug.
21. Displace cement until the second stage closing plug "bumps" down on the stage tool. A cementing pump is recommended for the last 10 bbls of displacement. Slow displacement to half the casing size in bbls per minute prior to landing plug and record surface (balance) pressure.
22. Once closing plug lands, increase surface pressure to 500 psi over recorded surface (balance) pressure plus rated differential shear pin pressure.
23. Hold pressure 5-10 minutes.
24. Record volume in displacement tank.
25. Bleed surface pressure to zero. Record flow back volume from pressures.
26. Monitor displacement tank for 30 minutes for flow back to ensure stage tool is closed.

APPENDIX-C: Well Schematics

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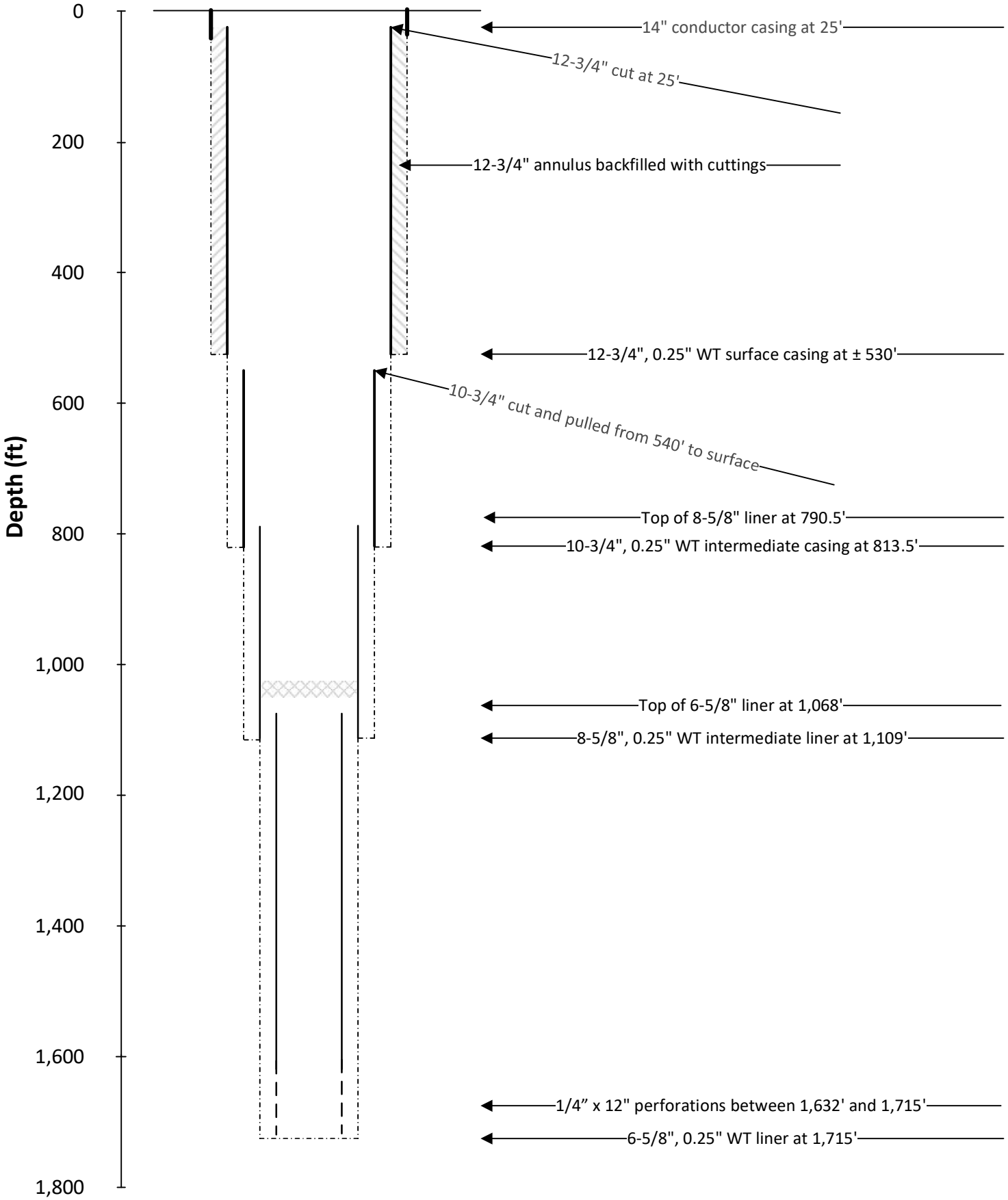
OIT #5 *Well – current*



GeothermEx
A Schlumberger Company

OIT #5 *Well – planned*