RETRIEVABLE PACKERS **Notice:** N728-04

Engineering Change Notice

Bill of Material Change -

Location: Navigation
Product Family: H99501
Product Description: 582-387 ISO - Frac Packer

DESCRIBE CHANGE BEING MADE

Replaced Packing Element, Lower Cylinder, Drift Ring, and Upper Piston.

DESCRIBE REASON CHANGE IS BEING MADE

Field specifications changed and now requires a smaller O.D. (5.820 vs. 5.710)

BILL OF MATERIAL CHANGES

Affected Assembly M/N	Item No.	Old M/N	Qty.	Item No.	New M/N	Qty.
H995015900	3	H036445701	1	3	H036445700	1
H995015900	8	H035521802	2	8	H036465100	2
H995015900	11	H036445901	1	11	H036445900	1
H995015900	25	H036034805	1	25	H035780505	1

DISPOSITION

Work in Progress: Manufacture/Rework To Latest
Plant Inventory -> Parts: Manufacture/Rework To Latest
Plant Inventory -> Assemblies: Manufacture/Rework To Latest
Field Inventory: Use As Is
Ass'y and Test Area -> Parts: Manufacture/Rework To Latest
Ass'y and Test Area -> Assemblies: Manufacture/Rework To Latest

ADDITIONAL INFORMATION

Tech Unit affected: ☐
Assembly/TM Drawing: ☐
Field Notificaton required: ☐

ACCOUNTING INFORMATION

Cost Center / Internal Order No.:
470310317

Account Number:
501600 Scrap
501550 In-House Rework
689300 Outside Rework
500900 Obsolete

WORKFLOW HISTORY

This ECN has not been released from Engineering yet.

Material	H995015900 582	Alt.	Usage 1
	MISC & SPCL PROD, ~~591~~-387 4.5" 8RL P 4.5		Valid 11/18/2004
Reqd qty	1.000 EA	Base Quant	1.000 EA

Level no.	Item	Component no. / Description	Quant	Un	Ict / Ex.
.1	0001	H036445800 PROTO UPR MNDRL F/582 ISO FRAC PKR	1.000	EA	L
.1	0002	HWWG51B0B0 SET SCW,HEX SKT CUP PT 5/16-18X.3125"LG	20.000	EA	L
.1	0003	H036445700 PROTO DRFT RG F/582 MISC & SPCL PROD	1.000	EA	L
.1	0004	H034280400 PEEK B/U RG F/HS HYD SET RTVBL SS PKR	2.000	EA	L
.1	0005	H035676500 THD BK-UP RG F/582 RMVBL PPP	2.000	EA	L
.1	0006	H035459702 END PE F/582 PREM RMVBL PROD PKR	2.000	EA	L
.1	0007	H035459800 PE SPC F/582 PREM RMVBL PROD PKR	2.000	EA	L
.1	0008	H036465100 CNTR PE F/582 MISC & SPCL PROD	2.000	EA	L
.1	0009	H034394600 FLR RG F/582 & 591 WSB WL SET RTVBL SB	2.000	EA	L
.1	0010	H036445600 PROTO CNTR ELEM SPC F/582 MISC & SPCL PR	1.000	EA	L
.1	0011	H036445900 PROTO UPR PSTN F/582 MISC & SPCL PROD	1.000	EA	L
.1	0012	HWWGE180BR SLTD HEADLESS SCW 1/4-20 X 5/16	15.000	EA	L
.1	0013	H035646600 O-RG B/U F/200 SER 5.174 X 4.951	8.000	EA	L
.1	0014	HWWB249P40 ORNG 249 P40 NIT 90 DURO PEROXIDE	4.000	EA	L
.1	0015	H035462500 UPR BK-UP RTNR F/582 & 591 PREM RMVBL	2.000	EA	L
.1	0016	H035466700 B/U F/300 SER 4.773 X 4.417	4.000	EA	L
.1	0017	HWWB348P40 ORNG 348 90 PEROXIDE CURED NIT	2.000	EA	L
.1	0018	H035462600 LWR B/U RTNR F/582 & 591 PREM RMVBL PROD	2.000	EA	L
.1	0019	10067877 SPRL RTNG RG F/PREM RMVBL PROD PKR	2.000	EA	L
.1	0020	H035780605 UP CYLR F/582 RMVBL PPP	1.000	EA	L
.1	0021	H035786206 LWR MNDRL F/582 RMVBL PPP	1.000	EA	L
.1	0022	H035780800 BLR HSG F/582 PREM RMVBL PROD PKR	1.000	EA	L
.1	0023	H035782400 BLR F/582 PREM RMVBL PROD PKR	1.000	EA	L
.1	0024	H035780200 LWR PSTN F/582 PREM RMVBL PROD PKR	1.000	EA	L
.1	0025	H035780505 LWR CYL CUT REL F/582/591/598 RMVBL PP	1.000	EA	L
.1	0026	H036450300 PROTO BTM SUB F/582 ISO FRAC PKR	1.000	EA	L
.1	T001	H035943600 ML CLAMSHL HSG F/7 PREM RMVBL PROD PKR	1.000	EA	L
.1	T002	H035943500 CLAMSHL QUARTERS F/7 PREM RMVBL PROD PKR	0.000	EA	L
.1	T003	H035943700	0.000	EA	L

Material	H995015900	Alt.	Usage 1
	MISC & SPCL PROD, 591-387 4.5" 8RL P 4.5		Valid 11/18/2004
Reqd qty	1.000 EA	Base Quant	1.000 EA

Level no.	Item	Component no. / Description	Quant	Un	Ict Ex.
		FML CLAMSHL HSG F/7 PREM RMVBL PROD PKR			
.1	T004	H035906700 ASSY TL F/598 PREM RMVBL PROD PKR	0.000	EA	L
.1	T005	H469504510 SPEC TBLR, BULL PLG 4.5"8RL B X.5"NPT	0.000	EA	L
.1	T006	HDRIFTT10922 DRFT BARS 3.833"OD 42"LG NYL	0.000	EA	L
.1	T007	HPRESSTEST08 STANDARD PRESSURE TESTING	0.000	EA	L

ENGINEERING JOB CONTROL CARD

Estimated Cost: ~~$179,579~~ 248,359	Job No.: 4Z9-140
Estimated Hrs: ~~1,384~~ 1784	Internal Order No.: 13005140
Planned Gate 3C Date: 03/05	Project Type: 3
Estimated Completion Date: 05/05	Revenue Class: R
Job Name: Iso Frac Packer for 7" Liner System	

Job Instructions: Develop an 18 in. packing element for the open hole frac. system. Two designs will be developed per the attached Brainstorming Meeting Minutes. Ball and sleeve development is also included in this job card.

1. Maximum packer OD: 5.820" for up to 6.250" open hole desired; 5.820" for 6.00 in. open hole and 5.910" for 6.250" open hole acceptable
2. Designed to deploy in 6.500" ID open hole
3. Minimum ID: 3.875"
4. Operating temperature of 100°F-250°F
5. Differential pressure rating of 10,000 psi desired; 8,500 psi acceptable
6. Torque rating through mandrel: 15,000 ft-lbf
7. Burst & collapse rating of 10,000 psi
8. Non-NACE service
9. Setting pressure: 4,000 psi
10. Desirable to have pistons below element; acceptable to have pistons above the element
11. Maximum packer cost: $4,000
12. See attached test plan for acceptance criteria

12. Test balls to 8,500 psi acceptable, 10,000psi desired @250°F

Packer

Milestone Dates:

Prototype Chassis Available to Order: 1/24/05
Commence Prototype Testing: 2/1/05
First Packer Acceptance Test: 2/22/05
Test Plan Completion: 3/31/05
Estimated Ship Date: Week of 4/4/05

Written By: Gus Weinig	Date Written: 12/21/2004
Assigned To: Gary Anderson	Manager Assigned To: Gus Weinig
Cost Center: 470310317	Date Job Closed:
Approved By: (Engineering Director)	Approved By: (District Manager or designee)

Design Team

Name	Department	Core/Peripheral
Gary Anderson	Packer Engineering	Core
Craig Whitler	Region Manager	Core
Greg Badke	Wellbore Construction Engineering	Peripheral
Erick Peterson	Region Engineer	Peripheral

(Form: JOB CARD)

18. Use an atmospheric chamber continuously energize the element
19. Place a piston between the elements and cover it with rubber
20. Use a steel accordion with variable waves
21. Use a rubber accordion with variable waves
22. Make the center element thinner to reduce friction loss
23. Use a solid core ECP with a secondary setting piston
24. Undercut the element along its length

Each idea was reviewed and several were eliminated. The following two ideas were candidates for future development:

- Use an expandable element similar to the new Big Bore Permanent packers
- Use a solid core ECP with a secondary setting piston

After the review, each person voted for the three best designs. The results were:

Six votes for:

- Set the element system from both ends
- Six votes for: Taper the ID of the element and fill the void with Teflon, steel, another durometer rubber, or a flexible filler
- Six votes for: Use an MPAS sleeve under the element

Four votes for:

- Add multiple grooves with varying lengths and diameters

Three votes for:

- Mold varying thicknesses of continuous strand matting into the element

Two votes for:

- Use multiple elements with spacer rings between, but cover the spacers with a thin sheet of rubber
- Two votes for: Extend a long sleeve under the element and shear pin it to the gage rings
- Two votes for: Vary the durometer with each element, such as 70-80-90

4. Add another 500 psi and hold for 15 minutes
5. Continue applying pressure in 500 psi increments until failure

Brainstorming Meeting Minutes
Iso Frac Packer Packing Element System

Meeting Date: December 7th, 2004

Attendees: Doug Murray, Chuck Pleasants, Jim Doane, Mike Evans, Cliff Mills, Hector Mireles, Gary Anderson, Greg Badke, Amy Farrar

Purpose: Choose three packing element concepts to pursue for the Iso Frac packer. The following constraints were placed on the designs:

- Compatible with the threaded backup rings off the 7" Premier packer
- Able to hold 10,000 psi water at 250°F in 6.250 in. ID casing
- Element Length: 18 in. continuous (run-in position)
- Maximum Element OD: 5.780 in.
- Mandrel OD: 5.525 in.
- Gage Ring OD: 5.890 in.
- Setting Force: 45,000 lbs.

The meeting began with a review of the constraints and a brief description of the application. It was agreed that the main challenge was to transfer enough force through the element to set the upper threaded backup ring and set the element in sequence to reduce voids and gaps.

Each person at the table presented a design. The following list was generated after several rounds of ideas.

1. Set the element system from both ends
2. Add multiple grooves with varying lengths and diameters
3. Use multiple elements with spacer rings between, but cover the spacers with a sheet of rubber
4. Use two, 6 in. elements with a 6 in. metal spacer covered with rubber
5. Extend a long sleeve under the element and shear pin it to the gage rings
6. Push the element over a metal or Teflon cone
7. Taper the ID of the element and fill the void with Teflon, steel, another durometer rubber, or a flexible filler
8. Use an MPAS sleeve under the element
9. Use an MPAS sleeve on the OD of the element
10. Make the backup rings out of wire mesh
11. Use an expandable element similar to the new Big Bore Permanent packers
12. Push through a long ZXP element
13. Use a double-piston with a tapered element
14. Shear pin spacers together or to an intermediate mandrel
15. Vary the durometer with each element, such as 70-80-90
16. Mold varying thicknesses of continuous strand matting into the element
17. Design a multiple-ramped ZXP element on a helix (similar to a Fishing spear)

Iso Frac Packer Test Plan

Test 1: Simulates loads on lower packer

Casing ID: 6.250"
Elastomer: Nitrile

Setting Temperature: 250°F
Test Medium: Water

Acceptance Criteria: Able to maintain the hold pressure with the Sprague pump.

Steps:
1. Heat fixture to 250°F
2. Set with 4,000 psi
3. Pressure below element with 8,500 psi and hold for 30 minutes
4. Cool down to 100°F with 8,500 psi below and hold for 30 minutes
5. Reverse to top at 100°F and hold 8,500 psi for 30 minutes
6. Reverse pressure to below and repeat steps 3 and 5 at 10,000 psi

Test 2: Simulates loads on upper packers

Casing ID: 6.250"
Elastomer: Nitrile

Setting Temperature: 250°F
Test Medium: Water

Acceptance Criteria: Able to maintain the hold pressure with the Sprague pump.

Steps:
1. Heat fixture to 250°F
2. Set with 8,500 psi
3. Cool to 100°F
4. Pressure below element with 8,500 psi and hold for 30 minutes
5. Reverse to top at 100°F and hold 8,500 psi for 30 minutes
6. Reverse pressure to below and repeat steps 4 and 5 at 10,000 psi

Test 3: Determine pressure rating in larger ID hole with pressure from below

Casing ID: 6.500"
Elastomer: Nitrile

Setting Temperature: 250°F
Test Medium: Water

Acceptance Criteria: Able to maintain the hold pressure with the Sprague pump.

Steps:
1. Set with 4,000 psi
2. Pressure below element with 4,000 psi and hold for 15 minutes
3. Add another 500 psi and hold for 15 minutes
4. Continue applying pressure in 500 psi increments until failure

Test 4: Determine pressure rating in larger ID hole with pressure from above

Casing ID: 6.500"
Elastomer: Nitrile

Setting Temperature: 250°F
Test Medium: Water

Acceptance Criteria: Able to maintain the hold pressure with the Sprague pump.

Steps:
1. Set with 4,000 psi
2. Pressure below element with 1,000 psi less than the failure pressure from test #3
3. Reverse pressure to above at 4,000 psi and hold for 15 minutes

PROJECT PLAN

JOB NUMBER: 4Z9-140 Hourly Rate: $71.95

Project Steps	Hours Reqd	Prototype Expenses	Completion Date	Comments	Reqd Steps	Documentation Verified
FEASIBILITY						
Identify Technological Obstacles						
Marketing Feasibility						
Manufacturing Feasibility						
Conceptual Layout/Sketch						
Preliminary Calculations						
PROJECT DEFINITION						
JOB CONTROL CARD	8				Yes	
Form Design Team						
Project Schedule	8					
Predesign						
CONCEPTUAL DEVELOPMENT						
Conceptual Layout/Sketch						
Patent Disclosure						
Preliminary Calculations						
Conceptual Testing						
Conceptual Design Review						
DESIGN						
DESIGN LAYOUT	~~160~~ 200				Yes	
Preliminary Calculations	~~60~~ 80				Yes	
Manufacturing Feasibility						
Cost Estimate	60					
DESIGN REVIEW	16				Yes	
DESIGN DOCUMENTATION						
DETAIL & ASSY DRAWINGS	~~160~~ 200				Yes	
CHECK LAYOUT	~~80~~ 100				Yes	
FINAL DESIGN CALCULATIONS	~~40~~ 60				Yes	
ANALYSIS VERIFICATION						
Tolerance Study	40					
Mfg/VA Review						
MANUFACTURE/ASSEMBLY						
MANUFACTURE PRODUCT	16				Yes	
ASSEMBLE PRODUCT	16				Yes	
Mfg/Assy Evaluation						
First Article Inspection Assy Instruction Draft						
TEST	40	100,000				
TESTING	~~800~~	~~$80,000~~			Yes	
TEST REPORT	80 ~~40~~				Yes	
DOCUMENTATION						
Verify Standard Cost						
Update Drawings/Calculations						
Predesign Details/Assys						
FIELD EVALUATION						
Interim Field Runs						
Interim Tech Unit						

PROJECT PLAN

Project Steps	Hours Reqd	Prototype Expenses	Completion Date	Comments	Reqd Steps	Documentation Verified
PROJECT WRAP-UP						
Release for Production						
TECH UNIT	40					
CLOSE JOB CONTROL FILE	40				Yes	

PROJECT TOTAL - HOURS	1,384
PROJECT TOTAL - PROTOTYPE	$80,000
TOTAL ENGR EXPENSE	$179,579

ENGINEERING JOB EST. ATTACHED: _____ YES

IF FOR SOME REASON, MANDATORY PHASES OR STEPS DO NOT APPLY, APPROVAL MUST BE GIVEN BY AN ENGINEERING MANAGER TO OMIT. PROOF OF APPROVAL MUST BE INSERTED INTO THE ENGINEERING JOB CONTROL FILE DOCUMENTING THE REASON FOR DISCREPANCY

PROJ. PLAN PREPARED BY: _____ **DATE:** _____

PROJ. PLAN APPROVED BY: _____ **DATE:** _____
(Manager)

PROJ. PLAN APPROVED BY: _____ **DATE:** _____
(Engineering Director)

Outputs Verified: _____ **DATE:** _____
(District Manager or designee)

JOB CLOSURE APPROVED: _____ **DATE:** _____
(Engineering Director)

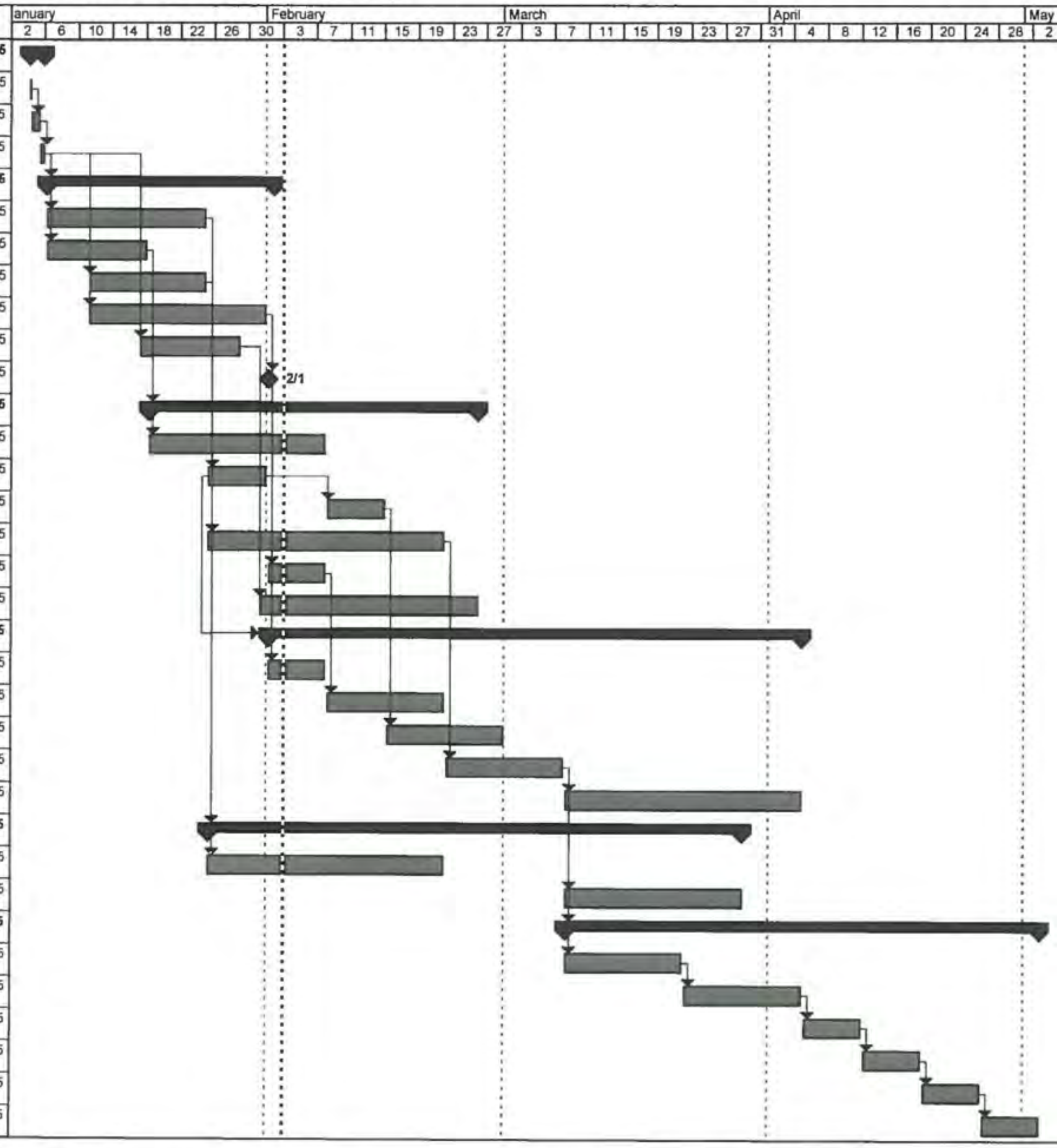
(DOCUMENTATION OF MANDATORY STEPS MUST BE VERIFIED BY APPROVERS AT JOB CLOSURE)

FORM: PROJ PLAN (02/02)
Ref: Eng Unit 201

Iso Frac Packer 18 in. Element Design

ID	Task Name	Duration	Start	Finish
1	**Project Definition**	**2 days**	**Tue 1/4/05**	**Wed 1/5/05**
2	Form Design Team	0.5 days	Tue 1/4/05	Tue 1/4/05
3	Write Job Card	1 day	Tue 1/4/05	Wed 1/5/05
4	Project Schedule	0.5 days	Wed 1/5/05	Wed 1/5/05
5	**Design**	**19 days**	**Thu 1/6/05**	**Tue 2/1/05**
6	MPAS Design and Details	13 days	Thu 1/6/05	Mon 1/24/05
7	Press Test Fixture D & D	8 days	Thu 1/6/05	Mon 1/17/05
8	Production Chassis D & D	2 wks	Tue 1/11/05	Mon 1/24/05
9	Conventional Elements D & D	3 wks	Tue 1/11/05	Mon 1/31/05
10	Piston Above Chassis D & D	2 wks	Mon 1/17/05	Fri 1/28/05
11	*Design Review*	1 day	Tue 2/1/05	Tue 2/1/05
12	**Prototype Manufacture**	**29 days**	**Tue 1/18/05**	**Fri 2/25/05**
13	Press Test Fixture	3 wks	Tue 1/18/05	Mon 2/7/05
14	Crush Sleeve	1 wk	Tue 1/25/05	Mon 1/31/05
15	MPAS Element	1 wk	Tue 2/8/05	Mon 2/14/05
16	Acceptance Test Chassis	4 wks	Tue 1/25/05	Mon 2/21/05
17	Conventional Elements	1 wk	Tue 2/1/05	Mon 2/7/05
18	Piston Above Chassis	4 wks	Mon 1/31/05	Fri 2/25/05
19	**Testing**	**45 days**	**Tue 2/1/05**	**Mon 4/4/05**
20	Crush Sleeve	1 wk	Tue 2/1/05	Mon 2/7/05
21	Conventional Element Press Test	2 wks	Tue 2/8/05	Mon 2/21/05
22	MPAS Press Testing	2 wks	Tue 2/15/05	Mon 2/28/05
23	First Acceptance Tests	2 wks	Tue 2/22/05	Mon 3/7/05
24	Acceptance Tests 2 - 4	4 wks	Tue 3/8/05	Mon 4/4/05
25	**Production Manufacturing**	**45 days**	**Tue 1/25/05**	**Mon 3/28/05**
26	Chassis	4 wks	Tue 1/25/05	Mon 2/21/05
27	Element	3 wks	Tue 3/8/05	Mon 3/28/05
28	**Project Wrap-up**	**40 days**	**Tue 3/8/05**	**Mon 5/2/05**
29	Tolerance Study	2 wks	Tue 3/8/05	Mon 3/21/05
30	Optimize Design for Cost	2 wks	Tue 3/22/05	Mon 4/4/05
31	ECN's	1 wk	Tue 4/5/05	Mon 4/11/05
32	Tech Unit	1 wk	Tue 4/12/05	Mon 4/18/05
33	Finalize Calculations	1 wk	Tue 4/19/05	Mon 4/25/05
34	Close Job Card	1 wk	Tue 4/26/05	Mon 5/2/05

add ball testing - offset 2 weeks from des. rev.



Project: New Dual
Date: Thu 2/3/05

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary

RESTRICTED - OUTSIDE ATTORNEYS' EYES ONLY - TECHNICAL

BH00363817

Ex. 2052
IPR2016-01506

Opportunity Profile 8.0

4DH-5

Submitted By:	Erick Peterson	Date Submitted:	11/5/2004	Requested Reply Date:	
Location:	Oklahoma City	Phone:	(405) 842-4005	Requested Ship Date:	12/6/2004
Is this request for an SAP Quote ?				Reference SAP Quote #	

Request Type-make a selection in both boxes:

Action: Order

Type: New Material Number

Orders Only: Reference PO or STO:

Number to Reinstate:

Number of New Products covered by this Opportunity: 1 ☐ See Attachment for additional item requiremnts

Which items in the attachment require action for this Opportunity:

Actions Requested (check all that apply)

- ☑ SAP Material Number
- ☐ Special QA-Include Attachment with Requirements
- ☐ SAP Order Acknowledgement---Orders only---Non-SAP Districts only
- ☑ Extend to Operations District Plant-Include all SAP data for District:
- ☑ Delivery
- ☑ Standard Cost
- Sales Price:
- ☐ Transfer Price

District Plant #	0073	Profit Center	170125400	Sales/Rental	
Storage location		Pur.Group			

Other Requirements, Please Describe:

PROJECT DESCRIPTION

Project / Well Name: 582-387 Open Hole Premier Packer

Customer: Multiple Customers

Estimated Total Project Value: $500,000

Project Summary:

Manufacture 6 qty 582-387 Open Hole Premier Packers for use in the Iso-Frac horizontal frac isolation hookups

Brief Well Description

Drill Pipe / Tubing?		Casing / Liner?	Liner	Open Hole Diameter:	6" & 6-1/4"
Size:		Size:	4-1/2"	Temperature Range:	250F
Grade:		Grade:	P-110	Pressure Range:	8500psi
Weight:		Weight:	11.60 & 13.50		

Operations Approval Use Only:

Originator: Recommended: Approved:

Tool Description

- o Max O.D. 5.820 / Min I.D. 3.844 (blanking dimension for 4-1/2" 13.5 ppf Atlas-Bradford ST-L thread)
- o 100°F – 250°F temperature rating, Open hole range 6.00 to 6.25, Non-NACE service

Baker Equivalent Threads Acceptable?

Threads up:	4-1/2" 13.50 Flush Joint	Threads down:	4-1/2" 13.50 Flush Joint		
Thread Size:		Thread Size:			
Thread Weight:		Thread Weight:			
Tool O.D. Max.:		Tool I.D. Max.:		Tool I.D. Min.:	
Elastomer:		Material:			

Similar to Material Number: Order/Quote Quantity:

The Difference:

Plant Use Only Weight: Volume: I.D./O.D./Length:

Opportunity Profile #		Delivery ARO:	
PDM Proejct Type		Cost Each:	
SAP Material #:		Price Each:	

Test: try 8,500, then 10 ksi

Open Hole Pin Point Frac System

Greg Bodke - layout

Information Provided By:_____
Original Date: 10/15/04 Revision Date:_____ Rev. Level:____
Size & Model/Name: Open Hole Pin Point Frac System

ITEM	DESCRIPTION	REV LEVEL	PREFFERRED SPECIFICATIONS	MINIMUM ACCEPTABLE SPECIFICATIONS
1	**General**			
1.1	Model / Name		Open Hole Pin Point Frac System	
1.2	Maximum OD		5.75 inch can live w/ 5.875	
1.3	Minimum ID		3.80 inch	
1.4	Anchor		Anchor on packer is preferred	
1.5	Stabilizer OD (if required)		5.81 inch	
1.6	Wellbore Fluid		Water based mud / completion brine	
1.7	Seal Longevity		Need to seal only during frac job	
1.8	Dog Leg		Need to pass through 15º/100 ft doglegs	
2	**Performance**		3,500 psi setting P	
2.1	Burst Rating of System		12,410 psi (equivalent to 4.5 13.50# P-110)	10,690 psi (equivalent to 4.5 11.60# P-110)
2.2	Collapse Rating of System		10,000 psi (not required to exceed maximum frac pressures)	
2.3	**Setting ID**			
2.3.1	Gauged Hole		6.00 to 6.25 inch	
2.3.2	Oval Hole		N/A	
2.4	Bottom hole operating temperature		275 F	250 F
2.5	**Differential Pressures**			
2.5.1	In gauged hole after set		10,000 psi	8,000 psi
2.5.2	In oval hole after set		N/A	N/A
2.6	Torqued Connections		15,000 ft-lbs 16,250 act.	10,000 ft-lbs
3	**Basic Type Materials**			
3.1	Elastomers		Compatible with bottom hole temperature, pressures and temperature	
3.1	Material		Non Corrosion Resistant Alloy (Non CRA)	
4	**Market / Economic Factors**			
4.1	Target Factory Cost of seal device		$5,000 US	
4.2	Target Factory Cost of frac sleeve		$2,500 US (already designed by Eric Peterson)	
4.2	EOQ		10	
4.3	Time to Market		End of November 2004	

PLM Approval:_____ **Date:**_____

PED Approval:_____ **Date:**_____

Document Printed: October 21, 2004

Iso-Frac System *Competitor Equivalent*

CONFIDENTIAL

Final Installation

Prepared for: Matt Rees | Company: Petro-Canada | Date: Aug.10/03

Well Name: Shaw | Location: 14-21-49-22W5 | Type of Installation: High Rate Acid Frac

Depth	Drawing	Description	OD(mm)	ID(mm)	Length
	Vertical Section	177.8mm Casing 47.16Kg/m L-80 set at 3995m			
		Picked up for tubing compression			-2.20
		KBD			5.57
		Hanger			0.23
		Pin to pin hanger cross over			0.30
		4 PH-6 pups lengths-1.25, 1.71, 2.33, 2.97.			8.26
		114.3mm 23.10 kg/m PH-6 Hydril premium connection tubing 407 jts			3932.77
3945.19		114.30mm PH-6 Hydril 403 Box 88.90mm EUE Pin L-80 X-Over Sub			0.34
		7" 3.5			
3945.77	Build Section	177.8mm x 88.9mm PL on-off tool with LH release c/w Otis 'X' Profile w/ 69.85mm ID (API Modified)	149.23	69.85	0.58
element 3945.77		177.8mm x 88.9mm EUE Plus-6 mechanical retrievable double grip 10K packer c/w P-110 mandrel RH set and release and emergency shear safety release (API Modified)	149.23 5.91	72.00 2.83	2.44
		88.9mm EUE High Pressure 10K sealed Tubing swivel c/w HSN Elastomer (API Modified) P-110 Material			0.31
		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Bevelled Collars			9.60
3958.12	Horizontal Section	88.90mm EUE Profile Nipple Otis Original 'XN' w/ 69.85mm Seal Bore ID & 66.93mm NoGo ID (API Modified) P-110 Landing Nipple to be Halliburton original		66.93 2.63	0.44
		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			115.02
4073.58		177.8mm x 88.9mm RockSeal II packer with HPHT packing element - hydraulic set shear release Heavy Wall P-110 Mandrel Material (Approximate setting pressure 15.5mpa)	146.05	69.85 2.75	1.27
		Rockseal centralizer P-110 Material	147.62		0.28
116M 4147.11		88.90mm EUE 13.84 kg/m P-110 Tubing c/w Bevelled Collars			71.98
		Ball activated frac port assembly P-110 Material 2 1/2" ball for 2 1/4" Seat		57.15	0.55
		88.90mm EUE 13.84 kg/m P-110 Tubing c/w Bevelled Collars			41.48
		Rockseal centralizer P-110 Material	5.81 147.62		0.28
4189.42		177.8mm x 88.9mm RockSeal II packer with HPHT packing element - hydraulic set shear release Heavy Wall P-110 Mandrel Material (Approximate setting pressure 15.5mpa)	146.05 5.75	69.85	1.27
		Rockseal centralizer P-110 Material	147.62		0.28
91M 4248.44		88.90mm EUE 13.84 kg/m P-110 Tubing c/w Bevelled Collars			57.47
		Ball activated frac port assembly P-110 Material 2 1/4" ball for 2" Seat		50.80	0.55
4280.85		88.90mm EUE 13.84 kg/m P-110 Tubing c/w Bevelled Collars			31.86
		Ball activated frac port assembly P-110 Material 2" Ball for 1 3/4" Seat		44.45	0.55
		88.90mm EUE 13.84 kg/m P-110 Tubing c/w Bevelled Collars			41.11
		Rockseal centralizer P-110 Material	147.62		0.28
4322.79		177.8mm x 88.9mm RockSeal II packer with HPHT packing element - hydraulic set shear release Heavy Wall P-110 Mandrel Material (Approximate setting pressure 14mpa)	146.05	69.85	1.27
		Rockseal centralizer P-110 Material	147.62		0.28
167M 4381.07		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			56.73
		Ball activated frac port assembly P-110 Material 1 3/4" Ball for 1 1/2" Seat		38.10	0.55
		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			67.40
		Rockseal centralizer P-110 Material	147.62		0.28
4449.3		177.8mm x 88.9mm RockSeal II packer with HPHT packing element - hydraulic set shear release Heavy Wall P-110 Mandrel Material (Approximate setting pressure 14mpa)	146.05	69.85	1.27
		Rockseal centralizer P-110 Material	147.62		0.28
98M 4489.32		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			38.47
		High Pressure P-110 Internal Hydraulic Activated Frac Port Tool (Opening Pressure 27MPA) P-110 Material		69.85	0.51
		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			57.76
		Rockseal centralizer P-110 Material	147.62		0.28
4547.59		7" x 3 1/2			
		177.8mm x 88.9mm RockSeal II packer with HPHT packing element - hydraulic set shear release Heavy Wall P-110 Mandrel Material (Approximate setting pressure 14mpa)	146.05	69.85	1.27
		Rockseal centralizer P-110 Material	147.62		0.28
		88.90mm EUE 13.84 kg/m L-80 Tubing c/w Regular Collars			9.64
4559.06		88.90mm EUE Reverse Frac Port Tool P-110 Material (Hydraulic Closing Circulating Sleeve) (1 1/2" Ball for 1 1/4" Ball Seat) Set to close at 5-6 MPA)			0.45
		Rockseal centralizer P-110 Material	147.62		0.28
4560.00		88.9mm EUE P-110 Material Bull Plug			0.21
		152.40mm Open Hole 6" O.H.			

Service Center: Red Deer | Telephone: 403-340-0735 | Contact: Woody Randell | Telephone: Bruce Bond 253-7587

Open Hole Pin Point Frac System

mention sealing after movement on [redacted] WS/WSB tomorrow

setting @ 2,000 psi ??? centralization tomorrow

Information Provided By:_____
Original Date: 10/15/04 Revision Date:_____ Rev. Level:____
Size & Model/Name: Open Hole Pin Point Frac System

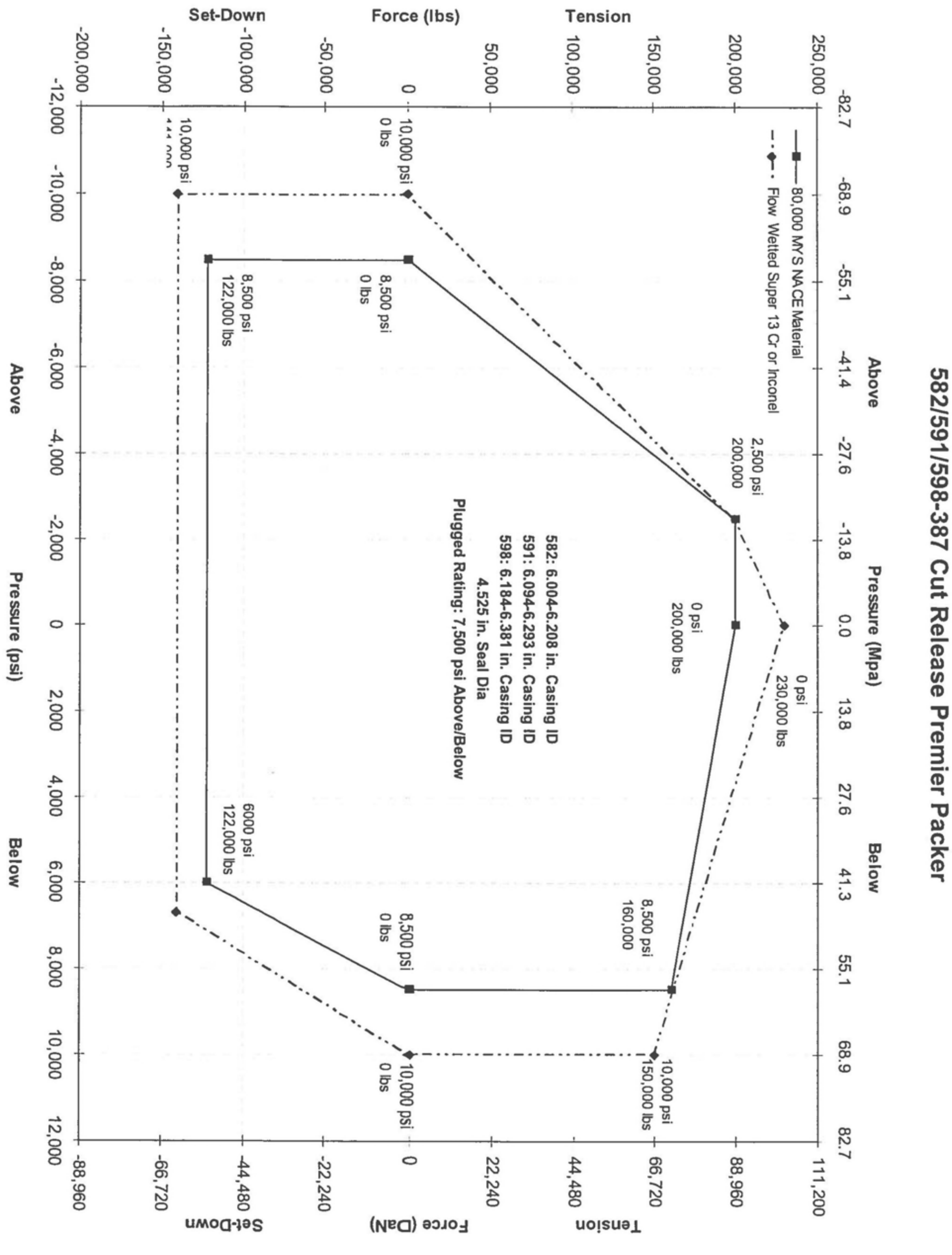
ITEM	DESCRIPTION	REV LEVEL	PREFFERRED SPECIFICATIONS	MINIMUM ACCEPTABLE SPECIFICATIONS
1	**General**			
1.1	Model / Name		Open Hole Pin Point Frac System	
1.2	Maximum OD		5.75 inch	
1.3	Minimum ID		3.80 inch	
1.4	Anchor		Anchor on packer is preferred	
1.5	Stabilizer OD (if required)		5.81 inch	
1.6	Wellbore Fluid		Water based mud / completion brine	
1.7	Seal Longevity		Need to seal only during frac job	
1.8	Dog Leg		Need to pass through 15º/100 ft doglegs Chuck will check	
2	**Performance**			
2.1	Burst Rating of System		12,410 psi West Texas (equivalent to 4.5 13.50# P-110)	10,690 psi (equivalent to 4.5 11.60# P-110)
2.2	Collapse Rating of System		10,000 psi (not required to exceed maximum frac pressures)	
2.3	**Setting ID**			
2.3.1	Gauged Hole		6.00 to 6.25 inch	
2.3.2	Oval Hole		N/A	
2.4	Bottom hole operating temperature		275 F	250 F
2.5	**Differential Pressures**			
2.5.1	In gauged hole after set		10,000 psi	8,000 psi
2.5.2	In oval hole after set		good for 16,500 N/A	N/A
2.6	Torqued Connections		15,000 ft-lbs Gary will check	10,000 ft-lbs
3	**Basic Type Materials**		.12 safety factor	
3.1	Elastomers		Compatible with bottom hole temperature, pressures and temperature	
3.1	Material		Non Corrosion Resistant Alloy (Non CRA)	
4	**Market / Economic Factors**			
4.1	Target Factory Cost of seal device		$5,000 US	
4.2	Target Factory Cost of frac sleeve		$2,500 US (already designed by Eric Peterson)	
4.2	EOQ		10	
4.3	Time to Market		End of November 2004	

PLM Approval:_____ **Date:**_____

PED Approval:_____ **Date:**_____

Add a torque shoulder
Add Burst, collapse, Piston areas, Torque

Document Printed: October 21, 2004



Premier™ Cut Release Removable Production Packer, Size 7" x 4-1/2"

Unit No. 10244	1-21-04
Rev. B	Page 24 of 24

ESN: 8, Rev. 51G			Page 1 of 2
Spreadsheet Prepared By: Eddie Hixson			Calc. Prepared By: GLA
Spreadsheet Checked By: Kurt Hickey			Date Prepared: 10/21/04
Spreadsheet Approved By: Steve Shirk		Job Number: None	Calc. Approved By:
Date Approved: 6-11-92		Reference:	Date Approved:
		Ref. 357-806-00	

COMBINED STRESS ANALYSIS

COMPONENT NAME:	Cylinder			**SECTION OD:**	5.790
WORKING TEMPERATURE:	275°F	**YIELD STR:**	106,000 PSI	**SECTION ID:**	5.179
TEST TEMPERATURE:	275°F	**YIELD STR:**	106,000 PSI	**REF: BMS-**	A098

D/t= 19.0 **(Use the "Thick Section" Analysis for all D/t cases.)**

CASE *	YIELD STRENGTH AT TEMP	APPLIED INTERNAL PRESSURE	APPLIED EXTERNAL PRESSURE	Applied Tensile Load	Major Dia. of "piston" area ++	Minor Dia. of "piston" area	STRESS CALCULATED AT OD or ID	TOTAL TENSILE LOAD	RADIAL STRESS THICK	TANGENTIAL STRESS THICK	AXIAL STRESS	EQUIVALENT STRESS THICK	REFERENCE SAFETY FACTOR
UNIT	psi	psi	psi	lbs	in	in	(OD or ID)	lbs	psi	psi	psi	psi	per case
A	110,000	10,690	0	0	0.000	0.000	ID	0	-10,690	96,254	0	102,020	1.08
B	110,000	0	10,000	0	0.000	0.000	ID	0	0	-100,041	0	100,041	1.10
C	106,000	10,690	0	0	0.000	0.000	ID	0	-10,690	96,254	0	102,020	1.04
D	106,000	0	10,000	0	0.000	0.000	ID	0	0	-100,041	0	100,041	1.06
E	110,000	11,526	0	0	0.000	0.000	ID	0	-11,526	103,783	0	110,000	1.00
F	110,000	0	10,995	0	0.000	0.000	ID	0	0	-110,000	0	110,000	1.00
G	106,000	11,107	0	0	0.000	0.000	ID	0	-11,107	100,009	0	106,000	1.00
H	106,000	0	10,596	0	0.000	0.000	ID	0	0	-106,000	0	106,000	1.00
	0	0	0	0	0.000	0.000	ID	0	0	0	0	0	N/A
												Safety Factor(worst case, Seq):	1.00

As = Cross Sectional area of component = 5.264in^2

++ Use negative sign for compressive load

EQUATIONS

Thick Section Analysis

Description	Symbol	Equation
Tangential Stress (Pi & Po)	St	$St = ((Pi*ri^2)-(Po*ro^2)-(ri^2*ro^2*(Po-Pi)/r^2))/(ro^2-ri^2)$
Radial Stress (Pi & Po)	Sr	$Sr = ((Pi*ri^2)-(Po*ro^2)+(ri^2*ro^2*(Po-Pi)/r^2))/(ro^2-ri^2)$
Axial Stress	Sz	$Sz=(Pi-Po)*D^2/(OD^2-ID^2)$
Equivalent Stress	Seq	$Seq=[((Sr-St)^2+(St-Sz)^2+(Sz-Sr)^2)/2]^{1/2}$

Where:
Po=External Pressure
Pi=Internal Pressure
ri=inside radius
ro=outside radius
r=radius at which stresses are to be calculated
D=Diameter which pressure creating load is applied
ID=Inside Diameter of cross section being analyzed
OD=Outside Diameter of cross section being analyzed

* For description of loading cases, see SSQPM unit D001-2, section 6.0

Definitions, assumptions, derivations, and references are as per:

API Specification 5C3, "Bulletin on Formulas and Calculations for Casing, Tubing, Drill Pipe and Line Pipe Properties", 5th Edition, July 1989, p. 5-14 & 16-17.
Shigley, J. and Mischke C.: "Mechanical Engineering Design",5th Edition, McGraw-Hill, New York, 1989, p. 58-60.
Roark, R. and Young, W.: "Formulas for Stress and Strain", 5th Edition, McGraw-Hill, New York, 1975, p. 446.
Bednar, Henry H.: "Pressure Vessel Design Handbook", Van Nostrand Reinhold Co. Inc., New York, 1981, p. 39.

ESN: 8, Rev. 51G	Page 1 of 2
Spreadsheet Prepared By: Eddie Hixson	Calc. Prepared By: GLA
Spreadsheet Checked By: Kurt Hickey	Date Prepared: 10/21/04
Spreadsheet Approved By: Steve Shirk	Calc. Approved By:
Date Approved: 6-11-92	Date Approved:

COMBINED STRESS ANALYSIS

Job Number: None
Reference:
Ref. 358-503-00

COMPONENT NAME:	Upper Mandrel		**SECTION OD:** 4.412
WORKING TEMPERATURE:	275°F	**YIELD STR:** 106,000 PSI	**SECTION ID:** 3.900
TEST TEMPERATURE:	275°F	**YIELD STR:** 106,000 PSI	**REF: BMS-** A098

D/t= 17.2 **(Use the "Thick Section" Analysis for all D/t cases.)**

CASE *	YIELD STRENGTH AT TEMP	APPLIED INTERNAL PRESSURE	APPLIED EXTERNAL PRESSURE	Applied Tensile Load	Major Dia. of "piston" area ++	Minor Dia. of "piston" area	STRESS CALCULATED AT OD or ID	TOTAL TENSILE LOAD	RADIAL STRESS THICK	TANGENTIAL STRESS THICK	AXIAL STRESS	EQUIVALENT STRESS THICK	REFERENCE SAFETY FACTOR
UNIT	psi	psi	psi	lbs	in	in	(OD or ID)	lbs	psi	psi	psi	psi	per case
A	110,000	10,690	0	0	0.000	0.000	ID	0	-10,690	87,102	0	92,909	1.18
B	110,000	0	10,000	0	0.000	0.000	ID	0	0	-91,480	0	91,480	1.20
C	106,000	10,690	0	0	0.000	0.000	ID	0	-10,690	87,102	0	92,909	1.14
D	106,000	0	10,000	0	0.000	0.000	ID	0	0	-91,480	0	91,480	1.16
E	110,000	12,656	0	0	0.000	0.000	ID	0	-12,656	103,124	0	110,000	1.00
F	110,000	0	12,025	0	0.000	0.000	ID	0	0	-110,000	0	110,000	1.00
G	106,000	12,196	0	0	0.000	0.000	ID	0	-12,196	99,374	0	106,000	1.00
H	106,000	0	11,587	0	0.000	0.000	ID	0	0	-106,000	0	106,000	1.00
	0	0	0	0	0.000	0.000	ID	0	0	0	0	0	N/A
												Safety Factor(worst case, Seq):	1.00

As = Cross Sectional area of component = 3.342in^2

++ Use negative sign for compressive load

EQUATIONS

Thick Section Analysis

Description	Symbol	Equation
Tangential Stress (Pi & Po)	St	$St = ((Pi*ri^2)-(Po*ro^2)-(ri^2*ro^2*(Po-Pi)/r^2))/(ro^2-ri^2)$
Radial Stress (Pi & Po)	Sr	$Sr = ((Pi*ri^2)-(Po*ro^2)+(ri^2*ro^2*(Po-Pi)/r^2))/(ro^2-ri^2)$
Axial Stress	Sz	$Sz=(Pi-Po)*D^2/(OD^2-ID^2)$
Equivalent Stress	Seq	$Seq=[((Sr-St)^2+(St-Sz)^2+(Sz-Sr)^2)/2]^{1/2}$

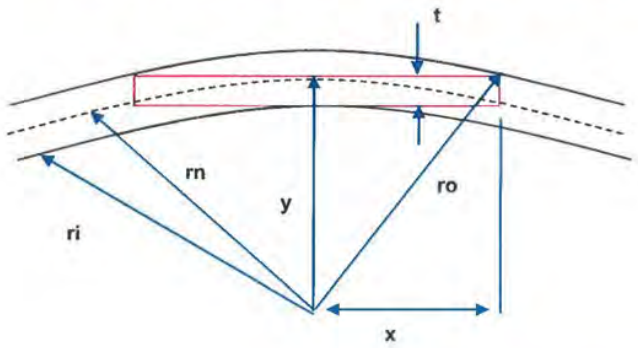
Where:
Po=External Pressure
Pi=Internal Pressure
ri=inside radius
ro=outside radius
r=radius at which stresses are to be calculated
D=Diameter which pressure creating load is applied
ID=Inside Diameter of cross section being analyzed
OD=Outside Diameter of cross section being analyzed

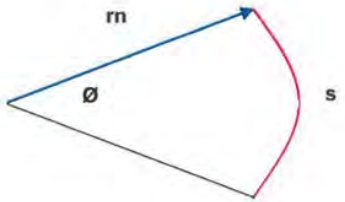
* For description of loading cases, see SSQPM unit D001-2, section 6.0

Definitions, assumptions, derivations, and references are as per:

API Specification 5C3, "Bulletin on Formulas and Calculations for Casing, Tubing, Drill Pipe and Line Pipe Properties", 5th Edition, July 1989, p. 5-14 & 16-17.
Shigley, J. and Mischke C.: "Mechanical Engineering Design",5th Edition, McGraw-Hill, New York, 1989, p. 58-60.
Roark, R. and Young, W.: "Formulas for Stress and Strain", 5th Edition, McGraw-Hill, New York, 1975, p. 446.
Bednar, Henry H.: "Pressure Vessel Design Handbook", Van Nostrand Reinhold Co. Inc., New York, 1981, p. 39.

MAX TOOL LENGTH - ASSUMES TOOL OD CONSISTENT THROUGHOUT LENGTH





Comments:	Open Hole Pin Point Frac System, 6.00-6.25 open hole ID

	INPUT INFORMATION										
Case Number	s, Arc Lgh (ft)	Ø, Angle (degrees)	t, Max Tool OD, (in)	Csg ID min. (in)	rn, nom wellbore radius of curvature (ft)	(in)	ro (in)	ri (in)	y (in)	x (in)	Tool Lgh (2*x) (in)
1	100.00	15.00	5.875	6.000	381.97	4,583.66	4,586.66	4,580.66	4,586.54	33.86	67.72
2	100.00	15.00	5.875	6.250	381.97	4,583.66	4,586.79	4,580.54	4,586.41	58.65	117.30
3	100.00	15.00	5.750	6.000	381.97	4,583.66	4,586.66	4,580.66	4,586.41	47.89	95.78
4	100.00	15.00	5.750	6.250	381.97	4,583.66	4,586.79	4,580.54	4,586.29	67.72	135.45
5					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
6					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
7					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
8					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
9					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
10					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
11					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
12					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
13					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
14					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
15					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Open Hole Pin Point Frac System

Eric Peterson

Information Provided By:_____
Original Date: 10/15/04 Revision Date:_____ Rev. Level:____
Size & Model/Name: Open Hole Pin Point Frac System

H 64629 - Inverted Lock Set
1 reversal

ITEM	DESCRIPTION	REV LEVEL	PREFFERRED SPECIFICATIONS	MINIMUM ACCEPTABLE SPECIFICATIONS
1	**General**			
1.1	Model / Name		Open Hole Pin Point Frac System	
1.2	Maximum OD		5.75 inch	5 7/8 max, 6" 4/6.25 hole
1.3	Minimum ID		3.80 inch	3.8 min
1.4	Anchor		Anchor on packer is preferred	
1.5	Stabilizer OD (if required)		5.81 inch	
1.6	Wellbore Fluid		Water based mud / completion brine	
1.7	Seal Longevity		Need to seal only during frac job	
1.8	Dog Leg		Need to pass through 15º/100 ft doglegs	
2	**Performance**		3,500 psi setting P	
2.1	Burst Rating of System		12,410 psi (equivalent to 4.5 13.50# P-110)	10,690 psi (equivalent to 4.5 11.60# P-110)
2.2	Collapse Rating of System		10,000 psi (not required to exceed maximum frac pressures)	
2.3	**Setting ID**			
2.3.1	Gauged Hole		6.00 to 6.25 inch	
2.3.2	Oval Hole		N/A	
2.4	Bottom hole operating temperature		275 F	250 F
2.5	**Differential Pressures**			
2.5.1	In gauged hole after set		10,000 psi	8,000 psi
2.5.2	In oval hole after set		N/A	N/A
2.6	Torqued Connections		15,000 ft-lbs	10,000 ft-lbs
3	**Basic Type Materials**			
3.1	Elastomers		Compatible with bottom hole temperature, pressures and temperature	
3.1	Material		Non Corrosion Resistant Alloy (Non CRA)	
4	**Market / Economic Factors**			
4.1	Target Factory Cost of seal device		$5,000 US	
4.2	Target Factory Cost of frac sleeve		$2,500 US (already designed by Eric Peterson)	
4.2	EOQ		10	
4.3	Time to Market		End of November 2004	

PLM Approval:_____ **Date:**_____

PED Approval:_____ **Date:**_____

Document Printed: October 19, 2004

fracturing @ 10ksi but bottom hole is 8ksi;
Craig Whitter suggested Premier - length would be nice

off-the-shelf as much as possible

4½ needed

Radoil, Inc.

12251 FM 529, HOUSTON, TEXAS 77041 (713) 937-4494, FAX 937-4624, E-MAIL bbaugh@radoil.com

August 10, 2004

QUOTATION NO. 040802-01

Baker Oil tools
P.O. Box 3048
Houston, Texas 77243-3048

ATTENTION: **John Fothergill, Manager - Cased Hole Market Developoment**

Subject: **DEVELOPMENT PROGRAM - 2 7/8" ISOLATION PACKER & PACKER ANCHOR**

ITEM	QTY	DESCRIPTION	ITEM COSTS	TOTAL COSTS
1	1	**ENGINEERING DESIGN - ANCHOR PACKER - 2 7/8"** * Collect design information, including: 1. 2 7/8" API Upset tubing thread 2. 10,000 p.s.i. minimum burst pressure 3. 80,000 lbs. minimum tensile load 4. 50,000 lbs. minimum compressive load 5. 4140 28-36 Roc C material specification 6. 3.90" min I.D. 7. 5.91" max. O.D. * Prepare Acad manufacturing detail drawings * Prepare Acad assembly drawing * Prepare design calculation package	$3,200.00	$3,200.00
2	1	**PROTOTYPE MANUFACTURE - ANCHOR PACKER - 2 7/8"** * To be estimated based on actual drawings * Prototype testing will be as follows: * 1. Mechanical functioning * 2. Internally pressure test to 10,000 p.s.i. * 3. Set in 6.50" I.D. pipe & pull to 80,000 lbs.	$18,000.00	$18,000.00
3	1	**ENGINEERING DESIGN - FRAC PACKER - 2 7/8"** * Collect design information, including: 1. 2 7/8" API Upset tubing thread 2. 10,000 p.s.i. minimum burst pressure 3. 80,000 lbs. minimum tensile load 4. 50,000 lbs. minimum compressive load 5. 4140 28-36 Roc C material specification 6. 3.90" min I.D. 7. 5.91" max. O.D. * Prepare Acad manufacturing detail drawings * Prepare Acad assembly drawing * Prepare design calculation package	$3,200.00	$3,200.00
4	1	**PROTOTYPE MANUFACTURE - FRAC PACKER - 2 7/8"** * To be estimated based on actual drawings * Prototype testing will be as follows: * 1. Mechanical functioning * 2. Internally pressure test to 10,000 p.s.i. * 3. Set in 6.50" I.D. pipe & pull to 80,000 lbs.	$18,000.00	$18,000.00
1	1	**ENGINEERING DESIGN - FRAC SLEEVE** * Collect design information, including: 1. 2 7/8" API Upset tubing thread	$3,200.00	$3,200.00

2. 10,000 p.s.i. minimum burst pressure
3. 80,000 lbs. minimum tensile load (100,000 preferred)
4. 50,000 lbs. minimum compressive load (75,000 preferred)
5. 4140 28-36 Roc C material specification
6. 3.90" min I.D.
7. 5.91" max. O.D.

* Prepare Acad design layouts
* Prepare Acad manufacturing detail drawings
* Prepare Acad assembly drawing
* Prepare design calculation package

2	1	**PROTOTYPE MANUFACTURE - FRAC SLEEVE**	$14,000.00	$14,000.00

* To be estimated based on actual drawings
* Prototype testing will be as follows:
* 1. Mechanical functioning
* 2. Internally pressure test to 12,500 p.s.i., 2 times

TOTAL FOR THIS QUOTATION $59,600.00

Notes:
1. Terms: Net 30 days
2. Delivery: Item 1 & 3 in 3 weeks, item 2 & 4 due 6 weeks after approval of item 1
3. Past due invoices will be subject to a charge of 1 1/2% per month
4. Quotation is valid for 90 days
5. Warranted to be free of manufacturing defects for one year

We appreciate the opportunity of providing this quotation.

Regards,

Benton F. Baugh, Ph.D., P.E.
President

Iso-Frac System Component Project Specifications for Quotation 7-23-04

Tool	Reference Size	Tool OD	Tool ID	Heaviest Intermediate Casing Size	Production String or Liner Size	Gaged Hole Size	QualifyingTest ID Size
Packer	591-390	5.91"	3.90"	7" (32#)	4-1/2" (11.6-13.5#)	6-1/4"	6-1/2"
	770-490	7.70"	4.90"	8-5/8" (32#)	5-1/2" (14-20#)	7-7/8"	8-1/8"
	448-287	4.48"	2.87"	5-1/2" (23#)	3-1/2"(9.3#)	4-3/4"	5"
	375-238	3.75"	2.38"	4-1/2" (13.5#)	2-7/8" (6.50#)	3-7/8"	4-1/8"
Frac Sleeve	591-390	5.91"	3.90"	7" (32#)	4-1/2" (11.6-13.5#)	6-1/4"	
	770-490	7.70"	4.90"	8-5/8" (32#)	5-1/2" (14-20#)	7-7/8"	
	448-287	4.48"	2.87"	5-1/2" (23#)	3-1/2"(9.3#)	4-3/4"	
	375-238	3.75"	2.38"	4-1/2" (13.5#)	2-7/8" (6.50#)	3-7/8"	
Hyd Anchor Packer	591-275	5.91"	2.75"	7" (32#)	4-1/2" (11.6-13.5#)	6-1/4"	6-1/2"
	770-450	7.70"	4.50"	8-5/8" (32#)	5-1/2" (14-20#)	7-7/8"	8-1/8"
	448-200	4.48"	2.00"	5-1/2" (23#)	3-1/2"(9.3#)	4-3/4"	5"
	375-188	3.75"	1.88"	4-1/2" (13.5#)	2-7/8" (6.50#)	3-7/8"	4-1/8"

	Materials		Differential Pressure Rating	Initiating Setting Pressure	Comments
	Metallurgy	Elastomer			
Packer	110ky 4140	Nitrile 80D	10,000 psi	3,500 psi	Setting psi target can adjust to meet ID requirement. Preset protection (interlock mechanism) must be engaged to the packer body and outer housing.
Frac Sleeve	110ky 4140	Non-Elastomeric	10,000 psi	3,000 psi	Flow Area ≥ Tubular
Hyd Anchor	110ky 4140	Nitrile 80D o'rings		2,500 psi	Slip Hardness HT 56rc to .030 depth in wickers

All dimensional references are subject to change, to the extent OD remains at least .060 below drift of the restrictive Casing ID, and ID of packer and sleeves (assumes ball seat drilled out) is ≥ drift of its mating tubular's drift ID.

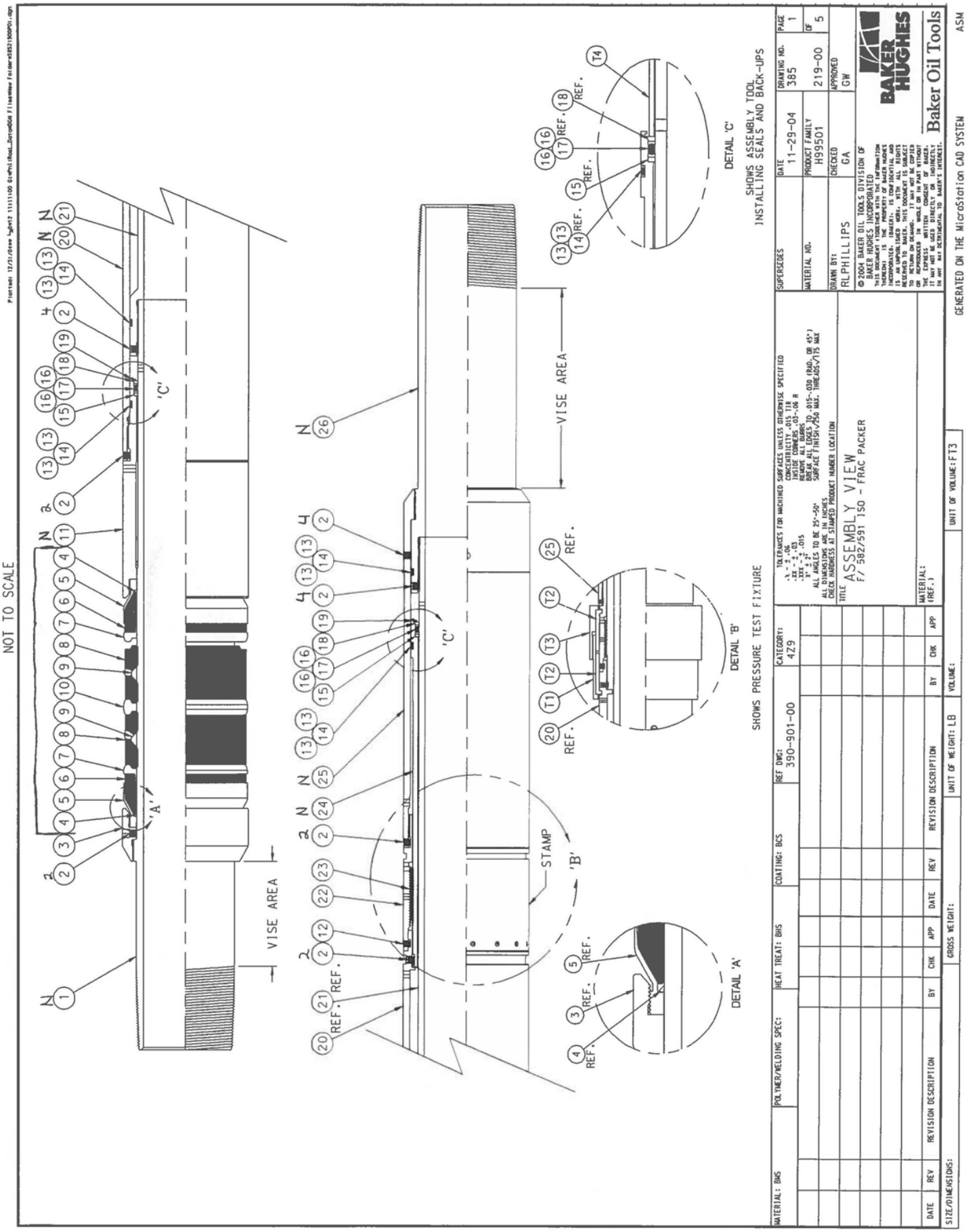
chassis only; sent 1-20-05

Parts List

582-387 Iso-Frac

w/ 4.5" 13.5 lb/ft Buttress Casing Thread, Box x Pin

ITEM	MATERIAL	DESCRIPTION	QTY
1	H036474700	Upper Mandrel	1
2	HWWG51B0B0	5/16-18x3.125 Set Screw	20
3	H036445700	Drift Ring	1
4-10	TBD	Element System	1
11	H036474800	Upper Piston	1
12	HWWGE180BR	1/4-20x5/16 Shear Screw	15
13	H035646600	O-Ring Back Up	8
14	HWWB249P40	O-Ring, Peroxide Nitrile 90 Duro	4
15	H035462500	Upper Back-Up Retainer	2
16	H035466700	O-Ring Back Up	4
17	HWWB348P40	O-Ring, Peroxide Nitrile 90 Duro	2
18	H035462600	Lower Back-Up Retainer	2
19	10067877	Spiral Retainer Ring	2
20	H036474900	Upper Cylinder	1
21	H036475000	Lower Mandrel	1
22	H035780800	Body Lock Ring Housing	1
23	H035782400	Body Lock Ring	1
24	H036475100	Lower Piston	1
25	~~H036475200~~ H036477900	Lower Cylinder	1
26	H036475300	Bottom Sub	1


NOT TO SCALE
VISE AREA
VISE AREA
STAMP
'A'
'B'
'C'
DETAIL 'A'
DETAIL 'B'
DETAIL 'C'
SHOWS PRESSURE TEST FIXTURE
SHOWS ASSEMBLY TOOL INSTALLING SEALS AND BACK-UPS
ASSEMBLY VIEW
F/ 582/591 ISO - FRAC PACKER
Baker Oil Tools
BAKER HUGHES
GENERATED ON THE MicroStation CAD SYSTEM

IsoFrac – Generation 1

- Generation 1
  - System Status (Testing and Development)?
    - Packer
      - Design Requirements – Hold 8,500 psi at 250F in 6.250 in. open hole
      - Packer Testing Results – Held 8,500 psi consistently, able to achieve 10,000 psi
    - Frac Sleeve
      - Design Requirements – Reference Job Card
      - Ball Testing Time Line and Results
    - Equipment Delivery
      - Status of Equipment
    - System Issues

Baker Oil Tools

Packer Length = 76"
Gage-to-Gage = 55"
PE Length = 7¼"

H99501 5910

IsoFrac – Generation 2

- Generation 2
  - System Status (Testing and Development)?
    - Packer
      - Design Requirements – Hold 8,500 psi at 250F in 6.250 in. open hole using an 18 in. element
      - Packer Testing Time Line and Results – Preliminary testing underway, initial packer testing March 1st
    - Delays or Roadblocks to Development – Setting sequence and force transfer of long element, centralization

Baker Oil Tools

Packer Length = 104"
Gage-to-Gage = 82"
PE Length = 19"

IsoFrac – Generation 3

- Generation 3 Drivers
  - General Design Specifications
    - 10,000 PSI / 350F
    - Generation 2 System Chassis
    - Multiple Cycle Frac Sleeves
    - Additional Open Hole Sizes
  - Technical Road Blocks – Setting sequence and force transfer of long element at higher temperature, centralization, higher pressures

Baker Oil Tools

Generation 3 Requirements

- MALT Area
  - Freestone Area:
    - 6 1/8" to 6 ¼" Hole ID
    - 10K / 320F
    - Horizontal – 4 to 5 Zones
  - Vernon/Bossier Area:
    - 6 1/8" to 6 ¼" Hole ID
    - 10K / 350 to 375F
    - Horizontal – 4 to 5 Zones
  - Haley Area:
    - 6 1/8" to 6 ¼" Hole ID
    - 10K / 280F
    - Vertical 7 to 9 Zones

BAKER HUGHES Baker Oil Tools

Market Drivers & Opportunities

- Competition:
  - Packers Plus
    - Proven System
- Opportunities
  - Mid Con
    - Generation 1 and Generation 2
      - 6 1/4" Open Hole, 8,500PSI, &250F
  - MALT
    - Generation 3
      - 6 ¼" Open Hole, 10,000PSI, & 375F

BAKER HUGHES Baker Oil Tools

Iso Frac Packer Testing Update

Test #1: Simulate loads on lower packer

Casing ID: 6.250" Setting Temperature: 250°F
Elastomer: HNBR Test Medium: Water

Acceptance Criteria: Able to maintain the hold pressure with the Sprague pump.

Steps:
1. Heat fixture to 250°F
2. Set with 4,000 psi
3. Pressure below element with 5,000 psi and hold for 30 minutes
4. Cool down to 100°F with 5,000 psi below and hold for 30 minutes
5. Reverse to top at 100°F and hold 5,000 psi for 30 minutes
6. Heat back up to 250°F with 5,000 psi above and hold for 30 minutes
7. Reverse pressure to below and repeat steps 3-6 at 8,500 psi, then at 10,000 psi

Results: Passed 5,000 psi cycle. Passed with 8,500 psi below. Leaked when 8,500 psi was reversed to above at 100°F. Setting force was re-applied and the packer held 10,000 psi. There was a leak but 10 ksi was maintained with the Sprague pump. Packing element had evidence of trapped fluid between center elements.

Test #2: Repeat test #1 but start at 8,500 psi. Center elements were re-worked to eliminate trapped fluid problem.

Results: Passed with 8,500 psi below the element. Got to 8,500 psi above the element at 100°F (further than last test), and the crossover to the push/pull device zippered out. Packing element did not show evidence of trapped fluid between the center elements.

Next Test: Repeat test #2 with the test packer, which has stronger threads that connect to the push/pull device. Start test on Monday (12/20/04).

Written by: Gus Weinig 12/15/04

Opportunity Profile 8.0

Submitted By:	Erick Peterson	Date Submitted	11/5/2004	Requested Reply Date	
Location:	Oklahoma City	Phone:	(405) 842-4005	Requested Ship Date	12/6/2004
Is this request for an SAP Quote				Reference SAP Quote #	

Request Type-make a selection in both boxes:

Action: Order

Type: New Material Number

Orders Only: Reference PO or STO:

Number to Reinstate:

Number of New Products covered by this Opportunity: 1 ☐ See Attachment for additional item requiremnts

Which items in the attachment require action for this Opportuni:

Actions Requested (check all that apply)

- ☑ SAP Material Number
- ☐ Special QA-Include Attachment with Requirements
- ☐ SAP Order Acknowledgement---Orders only---Non-SAP Districts only
- ☑ Extend to Operations District Plant-Include all SAP data for District:
- ☑ Delivery
- ☑ Standard Cost
- Sales Price:
- ☐ Transfer Price

District Plant #	0073	Profit Center	170125400	Sales/Renta	
Storage location		Pur.Group			

Other Requirements, Please Describe:

PROJECT DESCRIPTION

Project / Well Name: 582-387 Open Hole Premier Packer

Customer: Multiple Customers

Estimated Total Project Value: $500,000

Project Summary:

Manufacture 6 qty 582-387 Open Hole Premier Packers for use in the Iso-Frac horizontal frac isolation hookups

Brief Well Description

Drill Pipe / Tubing?		Casing / Liner?	Liner	Open Hole Diameter:	6" & 6-1/4"
Size:		Size:	4-1/2"	Temperature Range:	250F
Grade:		Grade:	P-110	Pressure Range:	8500psi
Weight:		Weight:	11.60 & 13.50		

Operations Approval Use Only:

Originator: Recommended: Approved:

Tool Description

- o Max O.D. 5.820 / Min I.D. 3.844 (blanking dimension for 4-1/2" 13.5 ppf Atlas-Bradford ST-L thread)
- o 100°F – 250°F temperature rating, Open hole range 6.00 to 6.25, Non-NACE service

Baker Equivalent Threads Acceptable:

Threads up:	4-1/2" 13.50 Flush Joint		Threads down:	4-1/2" 13.50 Flush Joint	
Thread Size:			Thread Size:		
Thread Weight:			Thread Weight:		
Tool O.D. Max.:			Tool I.D. Max.		Tool I.D. Min.:
Elastomer:			Material:		

Similar to Material Number:

Order/Quote Quantity:

The Difference:

Plant Use Only

Weight: Volume: I.D./O.D./Length:

Opportunity Profile #		Delivery ARO:	
PDM Proejct Type		Cost Each:	
SAP Material #		Price Each:	

Iso-Frac Design and Testing
01/14/05

Requirement--design a packing element system with the following characteristics:

- Utilizes metal Back-up Rings similar to those of the 7" Premier packer
- Has at least 18 inches of uninterrupted rubber visible
- Withstand pressure differentials up to 8,500 psi with minimal leakage
- Must seal in open-hole of up to 6.25" ID, possibly more 6.500" work in

Technical Challenges:

- Transferring sufficient force through the long element to expand the uppermost metal Back-up Ring
- Controlling the expansion shape of the long Packing Element in such a way that it creates a seal without the aid of boost
- Storing sufficient energy in the packing element system with limited setting force to maintain a seal if temperature decreases

Methods of Controlling Packing Element Properties to Meet Technical Challenges (singularly or in combination):

- Rubber Durometer
- Geometrical Features (ID Grooves)
- Shaped Spacer Rings (secondary) teflon
- Impregnated materials (crush sleeve, fiberglass mesh, helical spring)

Design Evaluation and Verification:

1. Start with simplest design (closest to existing, most predictable designs).
2. Confirm desired shape of packing element system components with only setting force applied using one of the following methods:
    - Set in slotted casing
    - Set in transparent tube
    - Set in casing and then retrieve
3. Change existing design to improve shape of set packing element system components **OR** move to a different design, **OR** run a functional pressure test in a solid piece of casing or use a piston above

When Gary is done w FEA things, talk to Jim Goodson about FEA

Design Review Minutes
Iso-Frac Packing Element

IWO #: 13005140
Meeting Date: January 26, 2005
Meeting Location: BOT-Navigation

Attendees: Gary Anderson, Dale Cockrell, Jim Doane, Mike Evans, Frank Maenza, Hector Mireles, Gus Weinig

Minutes:

- Listed requirements: 18" Center Packing Element, 8,500 psi at 250°F, compatible with current Premier End Packing Elements and Threaded Back-up Ring system, March delivery.
- Highlighted the anticipated challenges of developing a working system.
- Gave a tentative test plan: Test prototype in transparent acrylic tube or slotted casing, evaluate, then repeat with another concept or move on to a functional test.
- Introduced four concepts.
- Opened question and answer session. ← answer these

1. Will an asymmetrical element seal from both sides? -Frank M. — test
2. Can we use two 9" elements? -Jim D. — no
3. For concept #4, is the spacing between the spacers practical (i.e. 0.1" difference)? –Hector M. — buy to get FEA → test
4. Does setting time matter? Is the setting sequence in our test environment realistic enough, or do we need to try to set it faster? –Dale C. — module designed → test
5. Does the whole element have to contact the casing, i.e. could the spacers in concept #4 be a continuous piece as long as the element system seals in one spot? –Dale C. — another concept
6. Do you have to get the fluid out if it becomes trapped in the element? Dale C. — test
7. Have we ever tried the glass fiber mesh? –Jim D. — no
8. Can the Upper Packing Element be wrapped in Kevlar? -Mike E. — maybe
9. Do you have to seal with the center element [or every element]? -Frank M.
10. Is it possible to test concept #4 by testing a series of conventional 80 hd. short elements without wrapping the OD to cover them up? –Mike E. — test → yes
11. Could we use petal metal back-ups to reduce the amount of force needed to set the back-up system? –Jim D. — none designed ⇒ too long
12. Could we wrap metal back-up rings into the rubber to control the setting? -Frank M. — ?
13. What assumptions can we make of a good element design? What would we need to know to model the problem mathematically or with FEA? -Dale C. — try a couple different lengths
14. What is the critical buckling length of rubber? -Hector M. — Jim to get info
15. Are there other back-up options, i.e. garter springs? -Jim D. — no time

Action Items:

1. For testing, contact Sean Calahan to find leads on sourcing clear acrylic tube. -Gary A.

2. Research buckling calculations to determine a critical buckling length for the rubber element. -Jim D.
3. Design and order parts to test a "short" version of concept #4 on the existing test packer, with multiple elements but without the outer sheath. –Gary A.

Minutes written by Gary Anderson, Jan. 28, 2005

Questions to ask search software elastomeric
- what is the buckling force of a cylindrical - shaped piece of rubber

elastomer
- what is calc. for V of change with applied force
- what is the force/deflection curve for elastomer

Features vs. Cost – Premier Packer

Feature Removed	Benefit of Removal	Relative Cost	Survey Conclusions from PLM
Chemical Cut	Eliminate packing stack with backup retainers	Low	Yes (needed)
No Body Movement	Less complicated cones and cages, calibrated shear screws unnecessary	Medium	Yes, but Al feels they don't do much stacked
Large ID	Reduce number of pistons, use as-rolled or as-drilled material	Medium (High in conjunction with other changes)	Yes
Low Setting Pressure	Reduce number of pistons	Medium	~~No, std is fine~~ Yes, 4ksi needed
Rotationally Locked Bottom Sub	Combine two parts into one	Low	No. How will this affect the interface with the LC Striker? — Different FM x-over, so keep the same
High pressure and load ratings/gas tight rating/high temperature ratings	Less complicated cages (no staged release), same slips above and below, looser tolerances, larger setting piston, no element backups required, O-ring back-ups may be Teflon instead of PEEK	High need to test w/gas to determine slip retrievability, but the gas test could leak I said 2-3 weeks feasability to do design something (experienced person)	7,500 psi with current loads ISO 14310 V1 acceptable 6Ksi plugged — V0 300 F okay
Reliability	More cast parts	~~High~~ > Med.	Yes ??
Locked upper slips	Less complicated parts	Low	Yes
Rotational lock	Less mill work	~~Medium~~ > Low	Yes
Piston pre-set protection	Fewer parts and less complicated cylinder	Medium	Don't understand, what changes on the packer? Yes — would require a new strike
Premium end connections	Less expensive Mandrel, Bottom Sub, and coupling	Medium	Yes New Vam - cost?? #50/thd ∫/ EOQ=5
Easily retrievable	Fewer parts, shorter less complicated Mandrel	Medium	Need Removability
Aflas available	No PEEK back-ups required for elements, less expensive elements	Low Med. to go to Nitrile	HNBR
Box x pin	Eliminates coupling or Alt. Seal Bore	Medium	Pin x Pin okay
Debris Barrier			

want to run through Benny w/ notched elements

*would need to quantify cost savings of non-staged slips to justify cost of testing

Parts List

582-387 Iso-Frac

w/ 4.5" 13.5 lb/ft Buttress Casing Thread, Pin x Pin

See Drawing No. 385-219-00

ITEM	MATERIAL	DESCRIPTION	QTY
1	H036474700	Upper Mandrel	1
2	HWWG51B0B0	5/16-18x3.125 Set Screw	20
3	H036445700	Drift Ring	1
4-10	TBD	Element System	1
11	H036474800	Upper Piston	1
12	HWWGE180BR	1/4-20x5/16 Shear Screw	15
13	H035646600	O-Ring Back Up	8
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16	H035466700	O-Ring Back Up	4
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18	H035462600	Lower Back-Up Retainer	2
19	10067877	Spiral Retainer Ring	2
20	H036474900	Upper Cylinder	1
21	H036475000	Lower Mandrel	1
22	H035780800	Body Lock Ring Housing	1
23	H035782400	Body Lock Ring	1
24	H036475100	Lower Piston	1
25	H036477900	Lower Cylinder	1
26	H036475300	Bottom Sub	1

Iso-Frac Packer Availability

	Packer OD	Packer ID	Hole ID	Initiation Pressure	Setting Pressure	Maximum Temperature	Maximum Torque	Maximum Pressure	Failure Mode
Size 582-387 High Pressure (Available)	5.820"	3.875"	6.250"	2,500 psi	4,000 psi	250°F	16,500 ft-lbs	10,000 psi	Packing Element
Size 582-387 Medium Duty (Available)	5.820"	3.875"	6.250"	2,500 psi	4,000 psi	250°F	12,000 ft-lbs	8,300 psi	Mandrel Tension
Size 365-237 (Not Available*)	3.650"	2.375"	4.000"	2,200 psi	3,500 psi	200°F	3,500 ft-lbs	8,500 psi	Mandrel Tension

* The size 365-237 Iso-Frac packer will be available 6 months after approval of the specifications