GEODynamics®

TUBING-CONVEYED PERFORATING CATALOG

ISSUE 1 – February 10, 2025

About GEODynamics

GEODynamics, Inc. is the global technology and manufacturing leader in perforating, downhole completion, intervention, and wireline-conveyed solutions. GEODynamics creates and delivers downhole solutions that enable unsurpassed well economics, performance, and lifespan.

Patents

www.oilstatesintl.com/patents

Terms and Conditions

www.perf.com/terms-and-conditions

Revisions

ISSUE	DATE	NOTES
1	March 25, 2022	Initial release of Tubing Conveyed Perforating products catalog.
2	November 17, 2022	Updates to Lifting Equipment and Support Plates.
1	February 10, 2025	New products added: - 3.125" Firing and Venting System, TC-FHAV-0314-0000 - Auto-Release Firing Assembly for Eline, TC-AR203-E000 - Hydraulic-Actuated Auto-Release Firing Assembly, TC-ARHA350-HP00 - Centralizing Break-Apart Tandem Sub (Booster to Booster) for 4.50" to 4.75" Gun Systems, GN-R45BA21-ZR - Underbalance Surge Tool, TC-UB287-0000 and TC-UB287-BC00 - 2.03" Pyrotechnic Delay Firing Head, TC-FHPD-20-A100 Removed Centralizing Gun Connectors pages. Going forward, this content will be maintained in the Conventional Perforating Catalog. Additional edits/minor clarifications throughout for consistency with operating manuals and marketing brochures.

Table of Contents

Safety Mechanical Firing Heads
1.690” Standard- and High-Pressure Applications

GEODynamics

GEODynamics’ Safety Mechanical Firing Heads (FHSM) provide safe and reliable drop bar firing systems for TCP applications. These firing heads are designed and tested according to API RP-67 guidelines.

To initiate firing, the FHSM requires a minimum hydrostatic pressure on the firing piston when the drop bar impacts the firing head. This operating requirement provides maximum safety to personnel and equipment at surface during make-up and retrieval. When the drop bar impacts the release rod on the firing head, it shears the retaining pin, moves the rod down, and releases the firing piston. Hydrostatic pressure on the firing piston drives the firing pin into the percussion detonator to initiate detonation of the gun system.

FEATURES/BENEFITS

- Surface Safe—Cannot be detonated accidentally at surface
- Surface Safe—Requires a minimum hydrostatic pressure at the firing head to operate
- Surface Safe—Cannot be detonated accidentally by electrical sources
- Can be used in deviated wells
- Can be run with low hydrostatic pressure conditions, providing a high underbalanced environment when guns are fired
- Available in extended model to allow for tubing fill

Mechanical Specifications		
Tool Size/ Max. OD	1.68 in	42.67 mm
Makeup Length	Varies with handling sub	
Calculated Tensile	Determined by size and grade of API Tubing Sub	

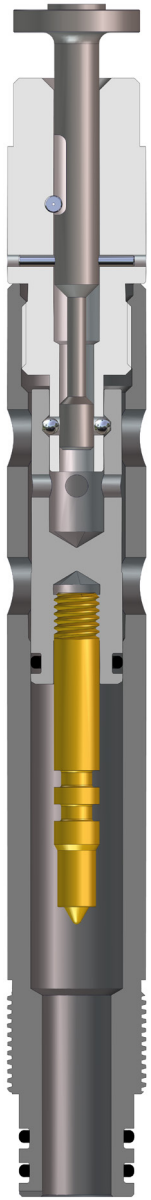
Pressure Specifications		
Min. Operating Pressure (LP)	500 psi	3.45 MPa
Max. Operating Pressure (LP)	7,500 psi	51.71 MPa
Min. Operating Pressure (HP)	2,000 psi	13.79 MPa
Max. Operating Pressure (HP)	20,000 psi	137.90 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

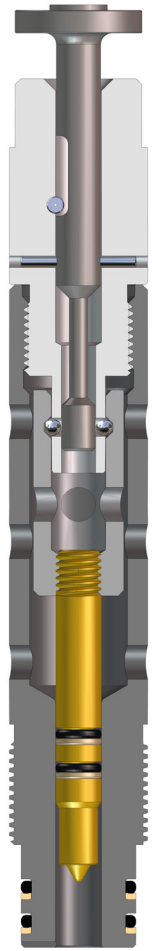
†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Mechanical (Drop Bar)

Tubing Thread Connections
1.900 EU 10 RD or 2-3/8”, 2-7/8”, and 3-1/2” EU 8 RD (Handling Sub), see next page for adapter assemblies



TC-FHSM-LP-0000
Standard Pressure Applications



TC-FHSM-HP-0000
High Pressure Applications

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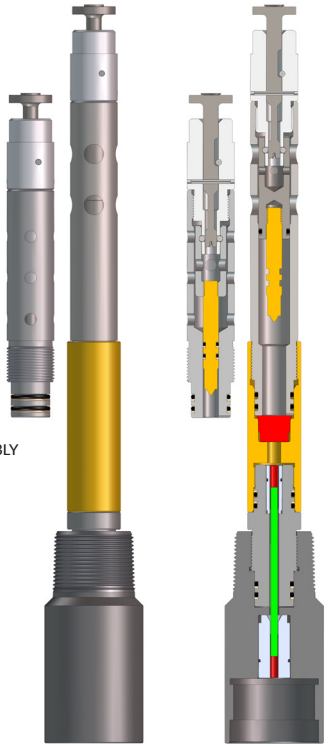
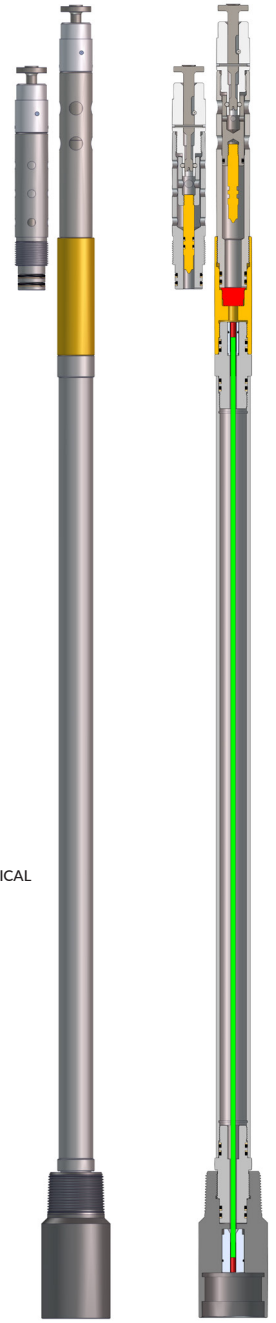
Safety Mechanical Firing Heads
Adapter Assemblies

Assembly P/N	TC-FHSM-C000 Compact Safety Mechanical	TC-FHSM-N000 Safety Mechanical Assembly	TC-FHSM-EX00 Extended Safety Mechanical
Tubing Thread Connection	1.900 EU 10 RD or 2-3/8", 2-7/8", and 3-1/2" EU 8 RD (Handling Sub)		
Diameter	Determined by API Handling Sub Diameter		
Tensile Strength	Determined by size and grade of API Tubing Sub (Handling Sub)		
Temperature Rating	Determined by explosive package used		

Compact Safety Mechanical
TC-FHSM-C000



Safety Mechanical Assembly
TC-FHSM-N000



Extended Safety Mechanical Assembly
TC-FHSM-EX00

Revised: February 10, 2025 5:21 PM

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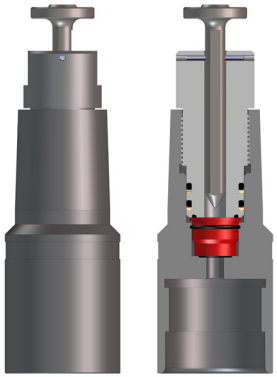
Standard Mechanical Firing Heads
Bar Drop Adapter Assemblies

The Standard Mechanical Firing Head Assembly is used primarily for completions which require virtually dry tubing to perforate at the required underbalance pressure. This device uses a percussion detonator which meets the safety requirements specified by API RP-67, Recommended Practice for Oilfield Explosives Safety.

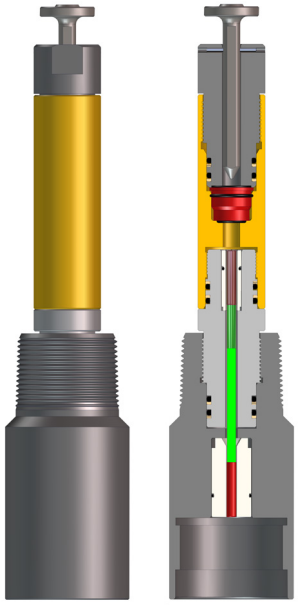
As with all GEODynamics designs, no primary explosives are exposed during assembly, make-up, or installation. Nevertheless, when adequate hydrostatic pressure is present in the tubing, GEODynamics Engineering recommends the use of either the Low- or High-Pressure Safety Mechanical Firing systems due to the inherent safety advantages afforded by these systems. The devices are available for use on guns 2-1/2 inches in diameter and larger and can be readily adapted with or without an extension housing as required to meet the bottom hole well conditions.

Assembly P/N	**TC-FHBD-C000** Compact Standard Mechanical	**TC-FHBD-N000** Standard Mechanical Assembly	**TC-FHBD-EX00** Extended Mechanical Assembly
Tubing Thread Connection	2-3/8", 2-7/8", or 3-1/2" EU 8 RD (Handling Sub)		
Diameter	Determined by API Handling Sub Diameter		
Min. Operating Pressure	0 psi / 0 MPa		
Max. Operating Pressure	20,000 psi / 137.90 MPa		
Seal Ratings	10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		
Tensile Strength	Determined by size and grade of API Tubing Sub (Handling Sub)		
Temperature Rating	Determined by explosive package used		

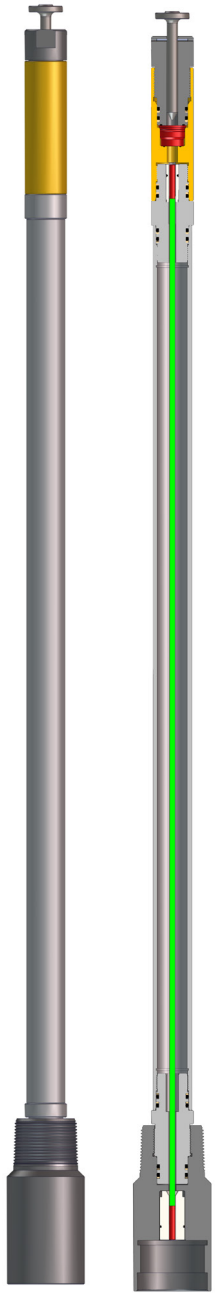
Standard Mechanical Firing Head
TC-FHBD-0000



Compact Standard Mechanical
TC-FHBD-C000



Standard Mechanical Assembly
TC-FHBD-N000



Extended Mechanical Assembly
TC-FHBD-EX00

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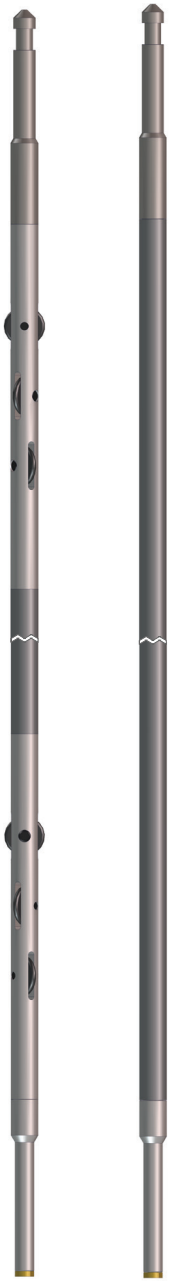
Drop Bars
Standard and Roller Drop Bar Options

GEODynamics' Drop Bar is predominately used to detonate bar-actuated firing heads but is also used to open certain types of production vents during TCP operations. The drop bar is available in a standard straight bar configuration and with roller bar sections for highly deviated wells.



ROLLER BAR CONFIGURATION

- Fishing Neck
- Roller Center Sections (2) w/Pins & Rollers
- 4' Extension (6' Extension Available)
- Bottom Drop Bar
- Insert (optional)

STANDARD CONFIGURATION

- Fishing Neck
- 4' Extension (2)
- Bottom Drop Bar
- Insert (optional)

FEATURES/BENEFITS

- Machined from single piece of material.
- Integral fishing neck allows retrieval from well if required.
- Brass insert may provide indication that the drop bar has engaged the firing head.
- Roller version designed for use in highly deviated wells.
- Can be used in heavy mud environments where downward jarring may be required.
- Unaffected by hydrostatic pressure conditions in well, providing a high underbalanced environment when guns are fired.
- Available in an extended version if required.

DROP BAR COMPONENTS

Part Number	OD		Total Length		Weight		Description
	(in.)	*(cm)*	*(in.)*	*(cm)*	*(lbs.)*	*(kg)*	
TC-DB1-0002	N/A		N/A		0.04 ea.	0.02	Roller Bar Pin
TC-DB1-0003	0.88	2.24	1.00	2.54	N/A		Drop Bar Insert
TC-DB1-0004	1.84	4.67	N/A		0.17 ea.	0.08	Roller Bar Steel Roller
TC-DB1-0019	1.25	3.18	9.00	22.86	1.79	0.81	Bottom Drop Bar, 1.25" OD
TC-DB1-0020	1.25	3.18	10.00	25.40	2.35	1.07	Drop Bar Fishing Neck
TC-DB1-0021	1.25	3.18	18.00	45.72	5.09	2.31	Roller Drop Bar Center Section
TC-DB1-0022	1.25	3.18	48.00	121.92	16.37	7.43	Drop Bar 4' Extension
TC-DB1-0023	1.25	3.18	72.00	182.88	24.72	11.21	Drop Bar 6' Extension
TC-DB1-0008	1.25	3.18	120.00	304.80	39.70	18.01	Drop Bar 10' with Fishing Neck

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Pressure-Actuated Firing Heads
1.690” for 1-11/16” through 7” Perforating Systems

GEODynamics

GEODynamics’ 1-11/16” FHPA uses precision shear pins to provide a desired actuating pressure (± 5%) for a perforating assembly. An appropriate actuating pressure will be a function of hydrostatic pressure, auxiliary pressure-actuated tools, casing pressure limits, and a safety factor. All pressure constraints and variables must be considered when determining an appropriate actuating pressure.

The 1-11/16” FHPA assemblies are designed for use with 1-11/16” through 7” perforating gun systems when no pyrotechnic delay is required. The FHPA is available with a 1.315 NU 10 RD PIN up for use on coiled tubing or snubbing operations, and it can be obtained with or without an automatic venting system. For use with guns larger than 2” OD, the FHPA is housed within a standard API tubing sub for tensile integrity.

FEATURES/BENEFITS

- Minimum recommended operating pressure of *4,875 psi
- Cannot be detonated at surface without applying pressure
- Must apply the required pressure at the tool to actuate firing heads
- Ideal for highly deviated and horizontal wells
- Can be run on top or bottom of GEODynamics TCP guns
- Can be used to detonate multiple gun systems
- Can be used to actuate perforating assemblies, setting tools, and cutters
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	1.69 in	42.93 mm
Calculated Tensile	30,000 lbs min. or API Handling Sub	

Pressure Specifications		
Min. Operating Pressure*	*4,875 psi	33.61 MPa
Collapse Pressure (-P000 and -T000)	20,000 psi	137.90 MPa
Collapse Pressure (-P250)	25,000 psi	172.40 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings 25,000 psi @ 375°F with PEEK back-up rings for -P250		
Shear Pin Value @ 70°F (0.100 dia. GEODynamics shear pin only)	975 psi/pin	6.72 MPa

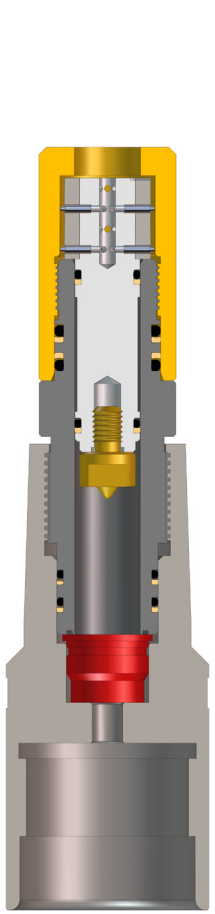
** Minimum of five (5) pins required to survive an RP-67 drop test.*

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

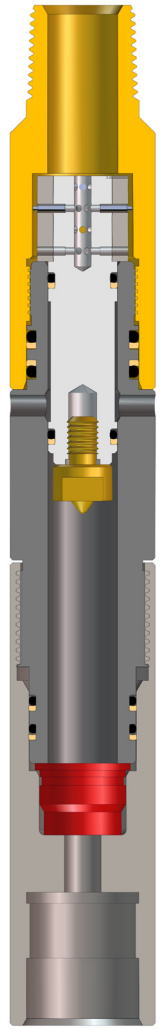
†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Pressure-Actuated

Thread Connections
2-3/8” EU, 2-7/8” EU, or 3-1/2” EU 8 RD Pin Up
1.315 NU10 RD Pin up available



TC-FHPA-16-P000
TC-FHPA-16-P250
ALSO AVAILABLE (RATED TO 25K)



TC-FHPA-16-T000

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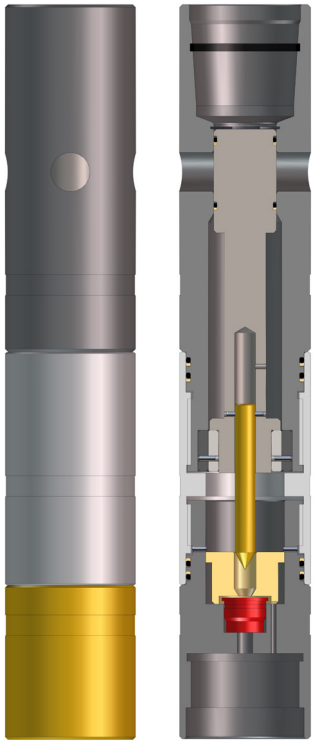
Pressure-Actuated Firing Heads
3.125” Firing and Venting System

GEODynamics

GEODynamics’ 3-1/8” Pressure-Operated Firing and Venting System combines the utility of a pressure responsive firing and venting mechanism with the simplicity and precision of a single pressure-operated device. The benefits afforded by this design improve the overall system reliability by:

- Providing simultaneous operation of both the firing and venting mechanism, and
- Eliminating the need to actuate an independent venting device above the operating pressure of a firing mechanism.

When used in extreme overbalanced conditions, the production casing is not subjected to high tubing pressures until the instant that the guns are detonated. For use in conjunction with under-balanced perforating, this system can be equipped with a delay module that will allow the tubing pressure to be adjusted to the desired value prior to gun detonation.



TC-FHAV-0314-0000

FEATURES/BENEFITS

- Minimum pinning recommendation of *3,760 psi
- Cannot be detonated at surface without applying pressure
- Can be run on top of GEODynamics TCP guns
- Suitable for numerous bottomhole conditions
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	3.125 in	79.30 mm
Makeup Length	17.69 in	0.45 m
Calculated Tensile	140,000 lbs / 622.75 kN	
Ported Flow Area	2.75 sq. in.	

Pressure Specifications		
Min. Operating Pressure	3,760 psi	25.92 MPa
Max. Differential Pressure	10,000 psi	68.95 MPa
Collapse Pressure	20,000 psi	137.90 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		
Shear Pin Value @ 75°F (0.130 dia. GEODynamics shear pin only)	470 psi/pin	3.24 MPa/pin

** Minimum of eight (8) pins required.*

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Pressure-Actuated

Thread Connections
2-3/8” EU 8 RD API Box Up

Pyrotechnic Delay Firing Heads
1.750” Pressure-Actuated

The 1-3/4” Pyrotechnic Delay Firing Head provides a detonation system for TCP applications requiring hydraulic pressure to fire the guns. This firing head assembly is designed for well conditions that are not suitable for detonating bars.

The firing head uses precision shear pins to provide a desired actuating pressure (± 5%) for a perforating assembly. An appropriate actuating pressure will be a function of hydrostatic pressure, auxiliary pressure actuated tools, casing pressure limits, and a safety factor. All pressure constraints and variables must be considered when determining an appropriate actuating pressure. When actuated, the firing head initiates a 1” CAD pyrotechnic delay fuse. The fuse provides a 6-minute delay before detonating the gun system.

FEATURES/BENEFITS

- Minimum recommended operating pressure of *4,875 psi
- Cannot be detonated at surface without applying pressure
- Must apply the required pressure at the tool to actuate firing heads
- Ideal for vertical, deviated, and horizontal wells
- Can be run on top or bottom of GEODynamics TCP guns
- Can be used to detonate multiple gun systems
- Can be used on work string, coiled tubing, and sucker rod conveyance methods
- Can be used to actuate perforating assemblies, setting tools, and cutters
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	1.75 in	44.45 mm
Overall Length	25.64 in	65.13 cm
Calculated Tensile	50,000 lbs min. or API Handling Sub	

Pressure Specifications		
Min. Operating Pressure*	4,875 psi	33.61 MPa
Max. Operating Pressure TC-FHPD-17-A100 and -A100C TC-FHPD-17-A2500	 20,000 psi 25,000 psi	 137.90 MPa 172.37 MPa
Collapse Pressure TC-FHPD-17-A100 -and -A100C TC-FHPD-17-A2500	 20,000 psi 25,000 psi	 137.90 MPa 172.37 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings 25,000 psi @ 375°F with PEEK back-up rings for -A2500		
Shear Pin Value (0.100 dia. GEODynamics shear pin only)	975 psi	6.72 MPa

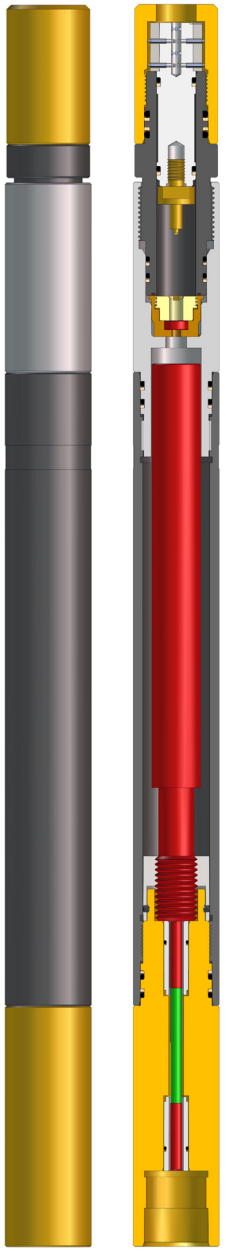
Temperature Specifications		
Seal Temperature Ratings† 90 Duro Buna Nitrile 90 Duro HNBR 90 Duro Viton	 275°F 350°F 375°F	 135°C 177°C 191°C
Operating Temperature Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Pressure-Actuated
Delay Time	Six (6) -minute pyrotechnic delay

Thread Connections	
1-9/16” Gun Box (Downhole)	1.315 NU10 RD Pin up available

** Minimum of five (5) pins required to survive an RP-67 drop test.*



TC-FHPD-17-A100

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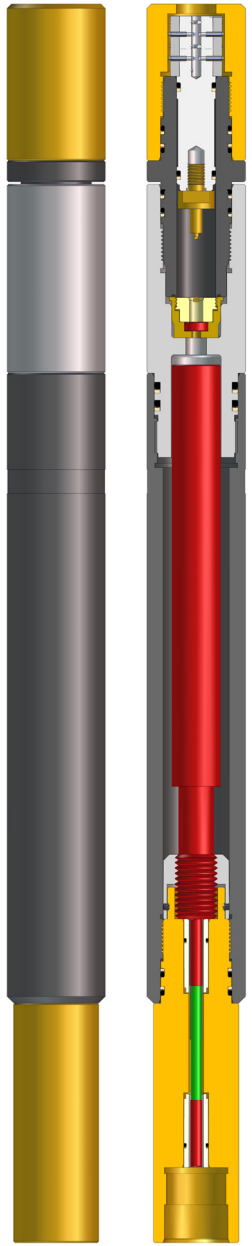
Pyrotechnic Delay Firing Heads
2.030” Pressure-Actuated, HP

The 2.03” Pyrotechnic Delay Firing Head provides a detonation system for TCP applications requiring hydraulic pressure to fire the guns. This firing head assembly is designed for well conditions that are not suitable for detonating bars.

The firing head uses precision shear pins to provide a desired actuating pressure (± 5%) for a perforating assembly. An appropriate actuating pressure will be a function of hydrostatic pressure, auxiliary pressure actuated tools, casing pressure limits, and a safety factor. All pressure constraints and variables must be considered when determining an appropriate actuating pressure. When actuated, the firing head initiates a 1” CAD pyrotechnic delay fuse. The fuse provides a 6-minute delay before detonating the gun system.



TC-FHPD-20-A100

FEATURES/BENEFITS

- Minimum recommended operating pressure of *4,875 psi
- Cannot be detonated at surface without applying pressure
- Must apply the required pressure at the tool to actuate firing heads
- Ideal for vertical, deviated, and horizontal wells
- Can be run on top or bottom of GEODynamics TCP guns
- Can be used to detonate multiple gun systems
- Can be used on work string, coiled tubing, and sucker rod conveyance methods
- Can be used to actuate perforating assemblies, setting tools, and cutters
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	2.03 in	51.60 mm
Overall Length	25.71 in	65.30 cm
Calculated Tensile	100,000 lbs min. or API Handling Sub	

Pressure Specifications		
Min. Operating Pressure*	4,875 psi	33.61 MPa
Max. Operating Pressure	30,000 psi	206.84 MPa
Collapse Pressure	30,000 psi	206.84 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 30,000 psi @ 375°F with PEEK back-up rings		
Shear Pin Value (0.100 dia. GEODynamics shear pin only)	975 psi/pin	6.72 MPa

** Minimum of five (5) pins required to survive an RP-67 drop test.*

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Pressure-Actuated
Delay Time	Six (6) -minute pyrotechnic delay

Thread Connections	
1-9/16” Gun Box (Downhole)	1.315 NU10 RD Pin up available

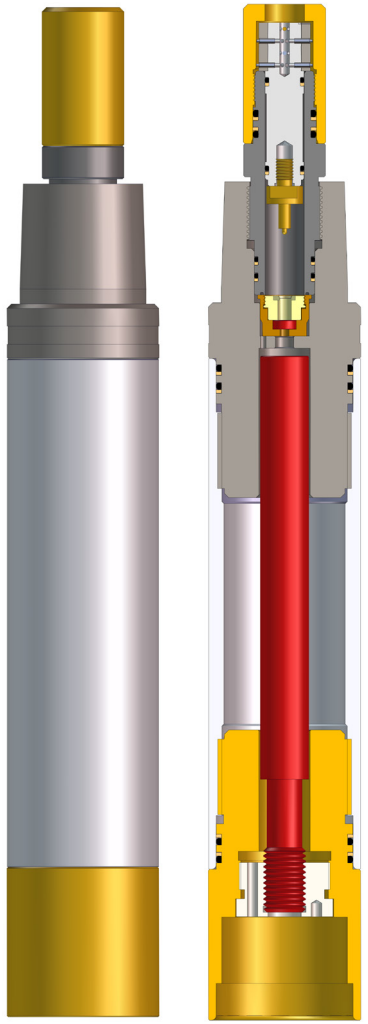
Revised: February 10, 2025 5:21 PM

Patents: www.oilstatesintl.com/patents

Pyrotechnic Delay Firing Heads
3.125” and 3.500” Pressure-Actuated

The 3-1/8” Pyrotechnic Delay Firing Head assembly utilizes the 1-11/16” Pressure Actuated Firing Head to initiate the detonation sequence. This firing head assembly is designed for well conditions that are not suitable for detonating bars.

The firing head uses precision shear pins to provide a desired actuating pressure (± 5%) for a perforating assembly. An appropriate actuating pressure will be a function of hydrostatic pressure, auxiliary pressure actuated tools, casing pressure limits, and a safety factor. All pressure constraints and variables must be considered when determining an appropriate actuating pressure. When actuated, the firing head initiates a 1” CAD pyrotechnic delay fuse. The fuse provides a 6-minute delay before detonating the gun system.



TC-FHPD-31-A238

FEATURES/BENEFITS

- Minimum recommended operating pressure of *4,875 psi
- Cannot be detonated at surface without applying pressure
- Must apply the required pressure at the tool to actuate firing heads
- Ideal for vertical, deviated, and horizontal wells
- Can be run on top or bottom of GEODynamics TCP guns
- Can be used to detonate multiple gun systems
- Can be used on work string, coiled tubing, and sucker rod conveyance methods
- Can be used to actuate perforating assemblies, setting tools, and cutters
- Not affected by electrical sources or radio frequencies; radio silence not required

Assembly P/N	TC-FHPD-31-A238	TC-FHPD-31-A288	TC-FHPD-35-A350
Firing Head Type	Pressure-Actuated		
Diameter	3.125 in / 79.4 mm	3.125 in / 79.4 mm	3.50 in / 88.9 mm
Overall Length	21.00 in / 53.34 cm	21.00 in / 53.34 cm	21.00 in / 53.34 cm
Minimum Operating Pressure	*4,875 psi / 33.61 MPa		
Maximum Operating Pressure	20,000 psi / 137.90 MPa	20,000 psi / 137.90 MPa	**25,000 psi / 172.37 MPa
Temperature Rating	Determined by explosive package used		
Collapse Pressure	20,000 psi / 137.90 MPa	20,000 psi / 137.90 MPa	27,500 psi / 189.61 MPa
Tensile Strength	150,000 lbs. maximum or rating of API Handling Sub	150,000 lbs. maximum or rating of API Handling Sub	350,000 lbs. maximum or rating of API Handling Sub
Shear Pin Value @ 70° F	975 psi / 6.72 MPa (per pin), 0.100 dia. GEODynamics shear pin only		
Seal Ratings	10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings *Contact GEODynamics Engineering for operations in higher pressures.*		
Thread Connections *(uphole)*	2-3/8” EU 8 RD Pin	2-7/8” EU 8 RD Pin	3-1/2” EU 8 RD Pin
Thread Connections *(downhole)*	3-1/8” Standard Top Sub (2-3/4” - 6 Acme) Box		

**Minimum of five (5) pins required to survive an RP-67 drop test. **Alternate match-drilled sub-assembly required.*

Hydraulic (Ball) Actuated Firing Heads
1.690” Standard- and High-Pressure Applications

GEODynamics’ Hydraulic (Ball) Actuated Firing Heads (FHHA) are primarily designed for perforating in wells with existing perforations and are compatible with coiled tubing and workover operations. The firing head provides maximum safety to personnel and equipment at surface during make-up and retrieval. While running in the well, the firing head is pressure-balanced, allowing circulation or displacement of completion fluids prior to perforating.

The device is actuated by circulating the appropriate diameter stainless steel ball onto a polished seat and simultaneously increasing the tubing/coiled tubing pressure to achieve the required differential pressure across the ball seat/actuating piston. When the pins shear, the piston is driven into a GEODynamics Safety Mechanical Firing Head and the ballistics are detonated. After shearing/perforating, the device opens a port in the outer housing and the well can once again be circulated.

FEATURES/BENEFITS

- Requires a minimum hydrostatic pressure at the firing head to operate
- Requires differential pressure after ball is seated in actuating piston
- Ideal for vertical, deviated, and horizontal wells
- Not affected by electrical sources or radio frequencies

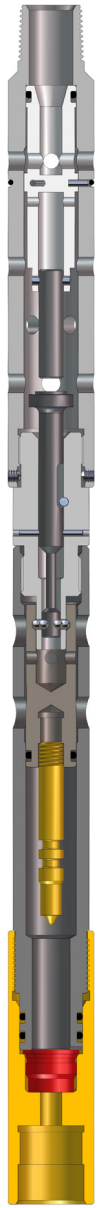
Assembly P/N	TC-FHHA-16-LP00	TC-FHHA-16-HP00
Application	Standard Pressure	High Pressure
Tool OD	1.69 in / 42.93 mm	
Tubing Thread Connection	1.315 NU 10 RD Pin Up	
Min. Operating Pressure of Aux Firing Device	500 psi / 3.45 MPa	2,000 psi / 13.79 MPa
Max. Operating Pressure of Aux Firing Device	7,500 psi / 51.71 MPa	20,000 psi / 137.90 MPa
Seal Ratings	10,000 psi STD without Back-up Rings; 20,000 psi HI-TEMP with PEEK Back-up Rings	
Tensile Strength	40,000 lbs / 177.92 kN	
Shear Pin Value	‡ 1,050 psi per pin @ 70°F (0.130” dia. GEODynamics shear pin only)	

‡ Differential Pressure – Three (3) shear pins require approximately 3,150 psi differential to shear at 70°F.

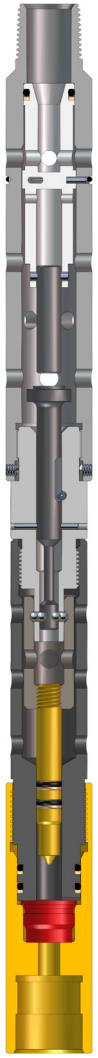
Actuating Balls (Ordered Separately)	
Stainless Ball Bearing, 1/2”	HD-BBSS-500
Stainless Ball Bearing, 9/16”	HD-BBSS-563

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature		
Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.



TC-FHHA-16-LP00
Standard Pressure Applications



TC-FHHA-16-HP00
High Pressure Applications

Revised: February 10, 2025 5:21 PM

Hydraulic (Ball) Actuated Firing Heads
2.500” Standard- and High-Pressure Applications

GEODynamics’ Hydraulic (Ball) Actuated Firing Heads (FHHA) are primarily designed for perforating in wells with existing perforations and are compatible with coiled tubing and workover operations. The firing head provides maximum safety to personnel and equipment at surface during make-up and retrieval. While running in the well, the firing head is pressure-balanced, allowing circulation or displacement of completion fluids prior to perforating.

The device is actuated by circulating the appropriate diameter stainless steel ball onto a polished seat and simultaneously increasing the tubing/coiled tubing pressure to achieve the required differential pressure across the ball seat/actuating piston. When the pins shear, the piston is driven into a GEODynamics Safety Mechanical Firing Head and the ballistics are detonated. After shearing/perforating, the device opens a port in the outer housing and the well can once again be circulated.

FEATURES/BENEFITS

- Minimum pinning recommendation of 1,800 psi
- Requires a minimum hydrostatic pressure at the firing head to operate
- Requires differential pressure after ball is seated in actuating piston
- Ideal for vertical, deviated, and horizontal wells
- Not affected by electrical sources or radio frequencies

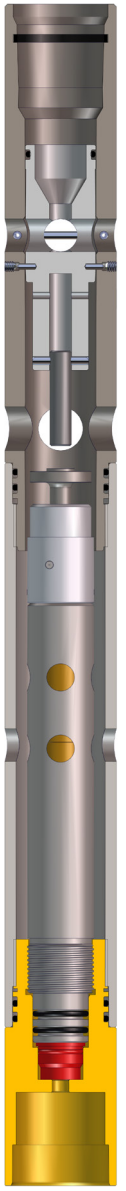
Assembly P/N	TC-FHHA-25-LP00	TC-FHHA-25-HP00
Application	Standard Pressure	High Pressure
Tool OD	2.50 in / 63.50 mm	
Tubing Thread Connection	1.900 EU 10 RD Box Up, Compatible with 2.06 IJ	
Min. Operating Pressure of Aux Firing Device	500 psi / 3.45 MPa	2,000 psi / 13.79 MPa
Max. Operating Pressure of Aux Firing Device	7,500 psi / 51.71 MPa	20,000 psi / 137.90 MPa
Seal Ratings	10,000 psi STD without Back-up Rings; 20,000 psi HI-TEMP with PEEK Back-up Rings	
Tensile Strength	100,000 lbs / 444.82 kN	
Shear Pin Value	‡ 425 psi per pin @ 70°F (0.130” dia. GEODynamics shear pin only)	

‡ Differential Pressure – Eight (8) shear pins require approximately 3,400 psi differential to shear at 70°F.

Actuating Balls (Ordered Separately)	
Stainless Ball Bearing, 9/16”	HD-BBSS-563
Stainless Ball Bearing, 3/4”	HD-BBSS-750
Stainless Ball Bearing, 1”	HD-BBSS-1000

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature		
Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.



TC-FHHA-25-LP00
Standard Pressure Applications

TC-FHHA-25-HP00
High Pressure Applications

Revised: February 10, 2025 5:21 PM

Hydraulic (Ball) Actuated Firing Heads
3.125" Standard- and High-Pressure Applications

GEODynamics' Hydraulic (Ball) Actuated Firing Heads (FHHA) are primarily designed for perforating in wells with existing perforations and are compatible with coiled tubing and workover operations. The firing head provides maximum safety to personnel and equipment at surface during make-up and retrieval. While running in the well, the firing head is pressure-balanced, allowing circulation or displacement of completion fluids prior to perforating.

The device is actuated by circulating the appropriate diameter stainless steel ball onto a polished seat and simultaneously increasing the tubing/coiled tubing pressure to achieve the required differential pressure across the ball seat/actuating piston. When the pins shear, the piston is driven into a GEODynamics Safety Mechanical Firing Head and the ballistics are detonated. After shearing/perforating, the device opens a port in the outer housing and the well can once again be circulated.

FEATURES/BENEFITS

- Minimum pinning recommendation of 1,800 psi
- Requires a minimum hydrostatic pressure at the firing head to operate
- Requires differential pressure after ball is seated in actuating piston
- Ideal for vertical, deviated, and horizontal wells
- Not affected by electrical sources or radio frequencies

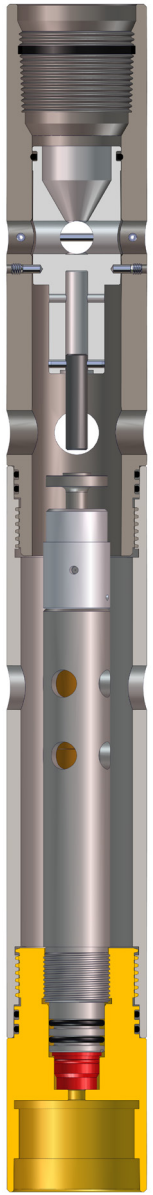
Assembly P/N	TC-FHHA-31-LP00	TC-FHHA-31-HP00
Application	Standard Pressure	High Pressure
Tool OD	3.125 in / 79.38 mm	
Tubing Thread Connection	2-3/8 EU 8 RD Box Up	
Min. Operating Pressure of Aux Firing Device	500 psi / 3.45 MPa	2,000 psi / 13.79 MPa
Max. Operating Pressure of Aux Firing Device	7,500 psi / 51.71 MPa	20,000 psi / 137.90 MPa
Seal Ratings	10,000 psi STD without Back-up Rings; 20,000 psi HI-TEMP with PEEK Back-up Rings	
Tensile Strength	150,000 lbs / 667.23 kN	
Shear Pin Value	‡ 550 psi per pin @ 70°F (0.189" dia. GEODynamics shear pin only)	

‡ Differential Pressure – Six (6) shear pins require approximately 3,300 psi differential to shear at 70°F.

Actuating Balls (Ordered Separately)	
Stainless Ball Bearing, 9/16"	HD-BBSS-563
Stainless Ball Bearing, 3/4"	HD-BBSS-750
Stainless Ball Bearing, 1"	HD-BBSS-1000
Stainless Ball Bearing, 1-1/4"	HD-BBSS-1250
Stainless Ball Bearing, 1-1/2"	HD-BBSS-1500

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature		
Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.



TC-FHHA-31-LP00
Standard Pressure Applications

TC-FHHA-31-HP00
High Pressure Applications

Revised: February 10, 2025 5:21 PM

Hydraulic (Ball) Actuated Firing Heads
4.000” Standard- and High-Pressure Applications

GEODynamics’ Hydraulic (Ball) Actuated Firing Heads (FHHA) are primarily designed for perforating in wells with existing perforations and are compatible with coiled tubing and workover operations. The firing head provides maximum safety to personnel and equipment at surface during make-up and retrieval. While running in the well, the firing head is pressure-balanced, allowing circulation or displacement of completion fluids prior to perforating.

The device is actuated by circulating the appropriate diameter stainless steel ball onto a polished seat and simultaneously increasing the tubing/coiled tubing pressure to achieve the required differential pressure across the ball seat/actuating piston. When the pins shear, the piston is driven into a GEODynamics Safety Mechanical Firing Head and the ballistics are detonated. After shearing/perforating, the device opens a port in the outer housing and the well can once again be circulated.

FEATURES/BENEFITS

- Minimum pinning recommendation of 1,800 psi
- Requires a minimum hydrostatic pressure at the firing head to operate
- Requires differential pressure after ball is seated in actuating piston
- Ideal for vertical, deviated, and horizontal wells
- Not affected by electrical sources or radio frequencies

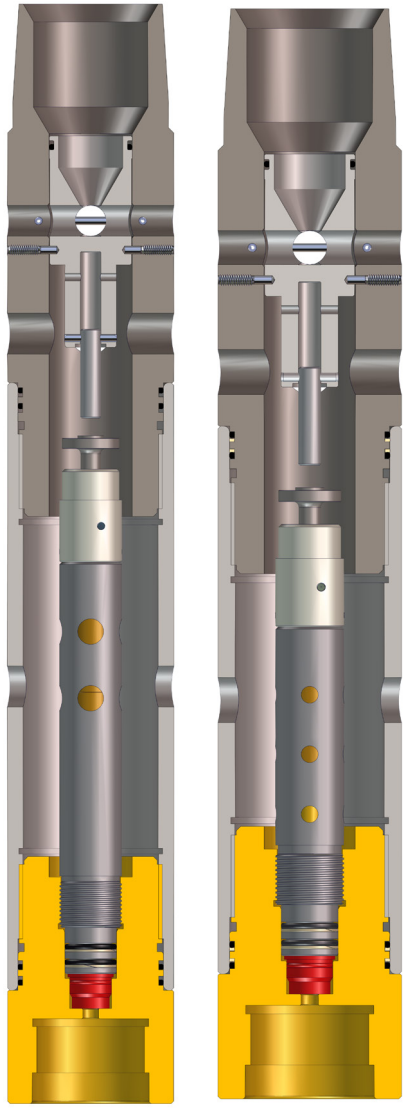
Assembly P/N	TC-FHHA-40-LP00	TC-FHHA-40-HP00
Application	Standard Pressure	High Pressure
Tool OD	4.0 in / 101.60 mm	
Tubing Thread Connection	3-1/2 EU 8 RD Pin Up	
Min. Operating Pressure of Aux Firing Device	500 psi / 3.45 MPa	2,000 psi / 13.79 MPa
Max. Operating Pressure of Aux Firing Device	7,500 psi / 51.71 MPa	20,000 psi / 137.90 MPa
Seal Ratings	10,000 psi STD without Back-up Rings; 20,000 psi HI-TEMP with PEEK Back-up Rings	
Tensile Strength	300,000 lbs / 1,334.47 kN	
Shear Pin Value	‡ 550 psi per pin @ 70°F (0.189” dia. GEODynamics shear pin only)	

‡ Differential Pressure – Six (6) shear pins require approximately 3,300 psi differential to shear at 70°F.

Actuating Balls (Ordered Separately)	
Stainless Ball Bearing, 9/16”	HD-BBSS-563
Stainless Ball Bearing, 3/4”	HD-BBSS-750
Stainless Ball Bearing, 1”	HD-BBSS-1000
Stainless Ball Bearing, 1-1/4”	HD-BBSS-1250
Stainless Ball Bearing, 1-1/2”	HD-BBSS-1500

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature		
Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.



TC-FHHA-40-LP00
Standard Pressure Applications

TC-FHHA-40-HP00
High Pressure Applications

Revised: February 10, 2025 5:21 PM

Dual Firing Heads
3.125” Top Fired Dual, Pressure-Actuated

GEODynamics

GEODynamics’ 3-1/8” Top Fired Dual Firing Heads provide two means of detonating a perforating gun with both actuators placed on the top end of the perforating assembly. The primary actuator is a pressure-actuated firing device, with or without a pyrotechnic delay, while the backup firing system can be a safety mechanical or pressure-actuated firing device with or without a pyrotechnic delay.

The backup firing system can be one of several standard firing assemblies available in the GEODynamics TCP Product Line. This modular design allows for multiple configuration options, suitable for a variety of bottom hole conditions. The Top Fired Dual Firing Head is also available for use with the GEODynamics Auto-Release Firing Assembly, by request.

FEATURES/BENEFITS

- Minimum pinning recommendation of 4,320 psi
- Cannot be detonated at surface without applying pressure
- Can be run on top of GEODynamics TCP guns
- Primary actuator is pressure-actuated, compatible with multiple back-up firing assemblies.
- Available with or without a pyrotechnic delay
- Suitable for numerous bottomhole conditions
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	3.13 in	79.50 mm
Calculated Tensile	170,000 lbs / 756.20 kN	

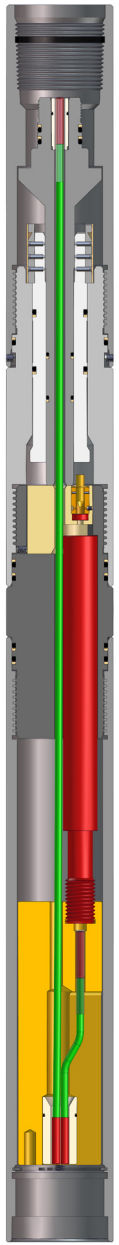
Pressure Specifications		
Min. Operating Pressure	4,320 psi	29.79 MPa
Max. Operating Pressure	20,000 psi	137.90 MPa
Collapse Pressure	20,000 psi	137.90 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		
Shear Pin Value @ 70°F (0.130 dia. GEODynamics shear pin only)	540 psi/pin	3.72 MPa

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

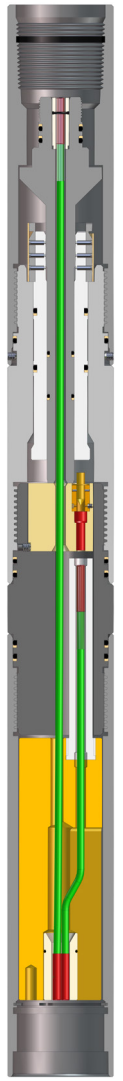
†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Pressure-Actuated

Thread Connections
2-3/8” EU 8 RD API Box Up



TC-FHTF-31-A100



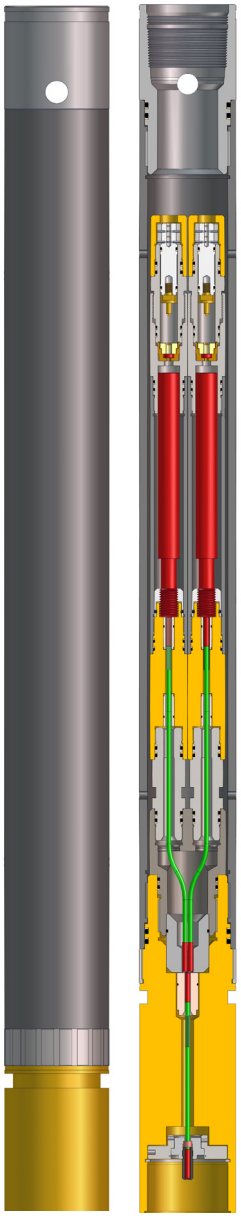
TC-FHND-0313-0000

Revised: February 10, 2025 5:21 PM

Dual Firing Heads
4.500” Pyrotechnic Delay, Pressure-Actuated

The 4-1/2” Dual Pyrotechnic Delay Firing Head provides a detonation system for TCP applications requiring hydraulic pressure to fire the guns. This firing head assembly is designed for well conditions that are not suitable for detonating bars and for applications where a backup firing head is required.

The firing heads use precision shear pins to provide a desired actuating pressure (± 5%) for a perforating assembly. An appropriate actuating pressure will be a function of hydrostatic pressure, auxiliary pressure actuated tools, casing pressure limits, and a safety factor. All pressure constraints and variables must be considered when determining an appropriate actuating pressure. When actuated, the firing heads initiate a 1” CAD pyrotechnic delay fuse. The fuse provides a 6-minute delay before detonating the gun system.



TC-FHPD-D-16-45

FEATURES/BENEFITS

- Minimum recommended operating pressure of *4,875 psi
- Cannot be detonated at surface without applying pressure
- Must apply the required pressure at the tool to actuate firing heads
- Ideal for vertical, deviated, and horizontal wells
- Can be run on top or bottom of GEODynamics TCP guns
- Can be used to detonate multiple gun systems
- Can be used on work string, coiled tubing, and sucker rod conveyance methods
- Can be used to actuate perforating assemblies, setting tools, and cutters
- Not affected by electrical sources or radio frequencies; radio silence not required

Mechanical Specifications		
Tool Size/ Maximum OD	4.50 in	114.30 mm
Makeup Length	58.09 in	147.55 cm
Overall Length	58.09 in	147.55 cm
Calculated Tensile	385,000 lbs	1,712.57 kN

Pressure Specifications		
Minimum Operating Pressure*	4,875 psi	33.61 MPa
Maximum Operating Pressure	20,000 psi	137.90 MPa
Collapse Pressure	20,000 psi	137.90 MPa
Seal Ratings 10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		
Shear Pin Value (0.100 dia. GEODynamics shear pin only)	975 psi	6.72 MPa

** Minimum of five (5) pins required to survive an RP-67 drop test.*

Temperature Specifications		
Seal Temperature Ratings†		
90 Duro Buna Nitrile	275°F	135°C
90 Duro HNBR	350°F	177°C
90 Duro Viton	375°F	191°C
Operating Temperature Determined by explosive package used		

†Choose o-ring material based on fluid compatibility and wellbore temperature requirements.

Firing Head Specifications	
Firing Head Type	Dual (primary and back-up)
Delay Time	Six (6) -minute pyrotechnic delay

Thread Connections	
Crossover (Uphole)	2-7/8” or 3-1/2” EUE 8 RD
4-1/2” Tandem (Downhole)	3-15/16” - 6P ACME-2G

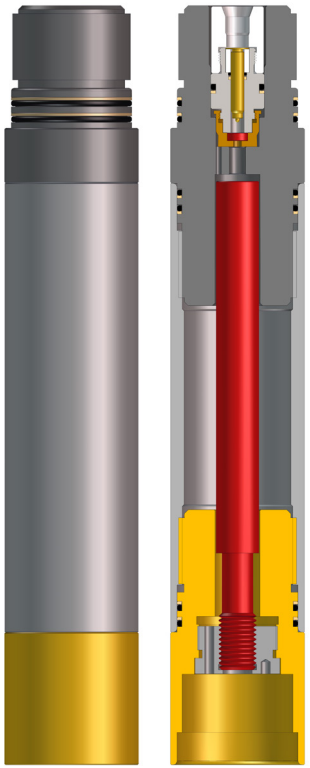
Revised: February 10, 2025 5:21 PM

Sequential Delay Shot Detection Devices
2.50” to 4.50” Gun Systems

GEODynamics

GEODynamics’ has designed and developed an improved Sequential Delay Shot Detection device for use in the completion of oil and gas wells. The device strictly follows the technology and teachings of expired United States Patent Numbers 5,078,210 and 5,062,485. This device is used to:

- Provide an extended delay time to any mechanical or pressure-actuated firing head.
- Provide positive shot detection and shot verification within a perforating assembly.
- Provide a positive fluid isolation means in a long perforating assembly.
- Mitigate the effect of ballistic shock on downhole tools. Can be used in place of mechanical shock absorbers when modelling software predicts overstress of downhole tools by the ballistic shock.
- Increase the shot density in a particular zone of interest by shooting the same zone with two or more gun assemblies with a single trip into the wellbore.



TC-SDTD-31-A100

FEATURES/BENEFITS

- Compatible with all gun sizes.
- Uses the industry standard six (6) -minute pyrotechnic delay fuse technology.
- Proprietary design is rated at 20,000 psi as tested (30,000 psi calculated) and provides improved pressure integrity and wellbore safety over competing designs with lower pressure ratings. Pressure integrity is important to safeguard against an unintended detonation that can occur due to a system leak in a less robust design.
- Uses detonation of the adjacent gun or firing head to sequentially transmit the ballistic energy between each gun or series of guns.

IMPORTANT NOTICE

- To ensure that internal components and ignitors are not overstressed, GEODynamics’ Sequential Delay Shot Detection device uses detonation cord as the energetic material that continues the detonation sequence. No bi-directional booster or other activator is prescribed.
- For details on prior art, refer to United States Patents: 5,078,210 and 5,062,485 *expired*.

SPECIFICATIONS

Assembly P/N	TC-SDTD-25-A100	TC-SDTD-27-A100	TC-SDTD-28-A100	TC-SDTD-31-A100	TC-SDTD-33-A100	TC-SDTD-40-A100	TC-SDTD-45-A100
OD	2.50 in / 63.50 mm	2.75 in / 69.85 mm	2.88 in / 73.15 mm	3.125 in / 79.38 mm	3.38 in / 85.85 mm	4.00 in / 101.60 mm	4.50 in / 114.30 mm
Make-Up Length	18.80 in / 0.48 m	17.55 in / 0.45 m	17.55 in / 0.45 m	17.98 in / 0.46 m	17.98 in / 0.46 m	17.55 in / 0.45 m	17.36 in / 0.44 m
Collapse Rating	20,000 psi / 137.90 MPa	23,000 psi / 158.58 MPa	23,000 psi / 158.58 MPa	20,500 psi / 141.34 MPa	20,500 psi / 141.34 MPa	19,500 psi / 134.45 MPa	17,000 psi / 117.21 MPa
Calculated Tensile	140,000 lbs / 622.75 kN	150,000 lbs / 667.23 kN	150,000 lbs / 667.23 kN	180,000 lbs / 800.68 kN	180,000 lbs / 800.68 kN	320,000 lbs / 1,423.43 kN	375,000 lbs / 1,668.08 kN
Seal Ratings	10,000 psi @ 290°F without back-up rings; 20,000 psi @ 375°F with PEEK back-up rings						
Delay Time	Six (6) -minute pyrotechnic delay						
Temperature Rating	Determined by explosive package used						
Connection (UH, Pin)	2-1/2” Gun	2-3/4” Gun	2-7/8” Gun	3-1/2” Gun	3-3/8” Gun	4” Gun	4-1/2” Gun
Connection (DH, Box)	2-1/8”, 8A x 2.0” (2-1/2” Top Sub)			3-1/8” QC (Standard Top Sub)			

Release Assemblies
Auto-Release Firing Assemblies, 2.375” to 3.500” Tubing

GEODynamics’ Auto-Release Firing Assemblies are designed for perforating the wellbore and simultaneously dropping the guns. The Auto-Release design ensures reliable drop-off of the guns in low hydrostatic well conditions and/or with relatively short gun assemblies. In addition, the unique design allows use of the same Auto-Release Firing Assembly in extreme overbalance conditions.

GEODynamics’ Auto-Release Firing Assemblies are compatible with a wide variety of standard Pressure Actuated (FHPA), Pyrotechnic Delay (FHPD), or Safety Mechanical (FHSM) Firing Heads.

TC-AR288-0000

FEATURES/BENEFITS

- Immediately releases the guns upon detonation
- Eliminates the need for wireline to release guns
- Does not restrict tubing ID after release
- Can be used for underbalanced or overbalanced perforating
- Automatically opens tubing end for other tools and operations (logging, production testing, treating, etc.)
- Leaves perforations uncovered
- Provides a re-entry guide after release

SPECIFICATIONS

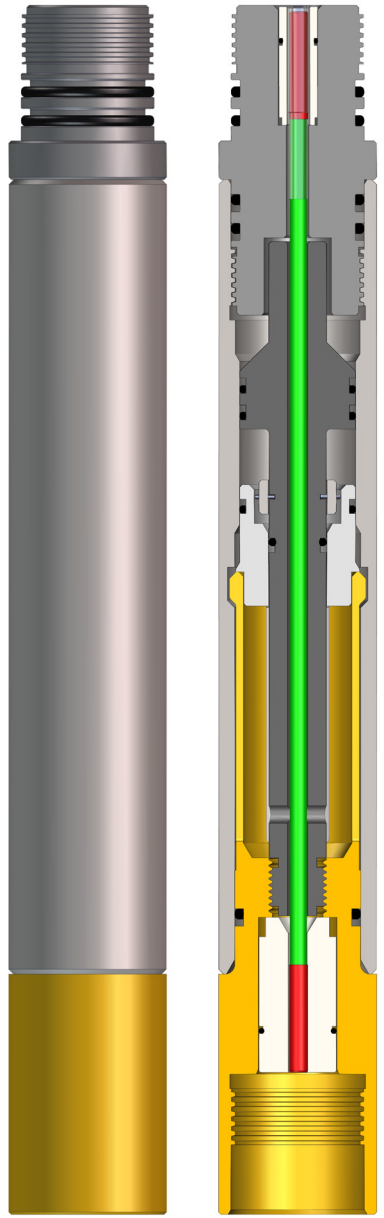
Assembly P/N	TC-AR238-0000	TC-AR288-0000	TC-AR350-0000
Tubing Thread Connection	2-3/8” EU 8 RD Box	2-7/8” EU 8 RD Box	3-1/2” EU 8 RD Box
Maximum Diameter	2.92 in / 74.17 mm	3.38 in / 85.85 mm	4.25 in / 107.95 mm
Fishing Diameter	2.88 in / 73.15 mm	3.125 in / 79.38 mm	4.25 in / 107.95 mm
ID After Release	2.208 in / 56.08 mm	2.445 in / 62.10 mm	3.125 in / 79.38 mm
Temperature Rating	Determined by explosive package used		
Collapse Pressure	13,500 psi / 93.08 MPa	16,500 psi / 113.76 MPa	17,000 psi / 117.21 MPa
Burst Pressure	20,000 psi / 137.90 MPa	20,000 psi / 137.90 MPa	20,000 psi / 137.90 MPa
Seal Ratings	10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings		
Maximum Differential	10,000 psi / 68.94 MPa	10,000 psi / 68.94 MPa	8,000 psi / 55.15 MPa
Calculated Tensile	46,000 lbs. / 204.62 kN	60,000 lbs. / 266.89 kN	115,000 lbs. / 511.55 kN

Revised: February 10, 2025 5:21 PM

Patents: www.oilstatesintl.com/patents

Release Assemblies
Auto-Release Firing Assembly for Eline, 2.03” OD

GEODynamics’ Eline Auto-Release Firing Assembly is designed for perforating the wellbore and simultaneously dropping the guns. The Auto-Release design ensures reliable drop-off of the guns in low hydrostatic well conditions and/or with relatively short gun assemblies. In addition, the unique design allows use of the same Auto-Release Firing Assembly in extreme overbalance conditions.



TC-AR203-E000

FEATURES/BENEFITS

- Immediately releases the guns upon detonation
- Can be used for underbalanced or overbalanced perforating
- Leaves perforations uncovered

SPECIFICATIONS

Assembly P/N	TC-AR203-E000
Thread Connections	1-11/16” - 8P Stub ACME (2” gun pin up and box down)
Maximum Diameter	2.03 in / 51.56 mm
Fishing Diameter	2.03 in / 51.56 mm
Temperature Rating	Determined by explosive package used
Collapse Pressure	10,000 psi / 69 MPa
Seal Ratings	10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings
Calculated Tensile	30,000 lbs. minimum

Revised: February 10, 2025 5:21 PM

Release Assemblies
Hydraulic-Actuated Auto-Release Firing Assembly, 3.500” Tubing, LP and HP

GEODynamics

GEODynamics’ Hydraulic-Actuated Auto-Release Firing Assembly combines our 2-1/2” Hydraulic (Ball) Actuated Firing Head (FHHA) with our 3-1/2” Auto-Release Firing Assembly into one tool designed for P&A applications. The firing head provides maximum safety to personnel and equipment at surface during make-up and retrieval. While running in the well, the firing head is pressure-balanced, allowing circulation or displacement of completion fluids prior to perforating. The Auto-Release design ensures reliable drop-off of the guns in low hydrostatic well conditions and/or with relatively short gun assemblies.

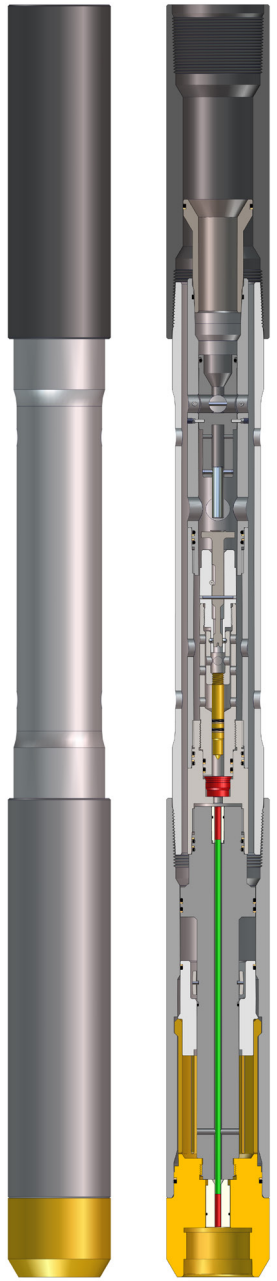
FEATURES/BENEFITS

- Firing head requires hydrostatic pressure at the firing head to operate; minimum pinning recommendation is 1,800 psi.
- Firing head requires differential pressure after ball is seated in actuating piston.
- Immediately releases the guns upon detonation; eliminates the need for wireline to release guns.
- Can be used for underbalanced or overbalanced perforating.
- Automatically opens tubing end for other tools and operations (logging, production testing, treating, etc.).
- Leaves perforations uncovered.
- Provides a re-entry guide after release.

SPECIFICATIONS

Assembly P/N	TC-ARHA350-LP00	TC-ARHA350-HP00
Tubing Thread Connection	3-1/2” EU 8 RD Box	
Maximum Diameter OD	4.25 in / 108 mm	
Make-Up Length	53.31 in / 135.41 cm	
Fishing Diameter	4.25 in / 108 mm	
ID After Release	2.875 in / 73 mm	
Collapse Pressure	17,000 psi / 117 MPa	
Maximum Differential	8,000 psi / 55 MPa	
Calculated Tensile	115,000 lbs. min. / 511.54 kN	
Min. Operating Pressure of Aux Firing Device	500 psi / 3.45 MPa	2,000 psi / 13.79 MPa
Max. Operating Pressure of Aux Firing Device	7,500 psi / 51.71 MPa	20,000 psi / 137.90 MPa
Temperature Rating	Determined by explosive package used	
Seal Ratings	10,000 psi STD without Back-up Rings; 20,000 psi HI-TEMP with PEEK Back-up Rings	
Shear Pin Value	‡ 425 psi per pin @ 70°F (0.130” dia. GEODynamics shear pin only)	

‡ Differential Pressure – Eight (8) shear pins require approximately 3,400 psi differential to shear at 70°F.



TC-ARHA350-HP00

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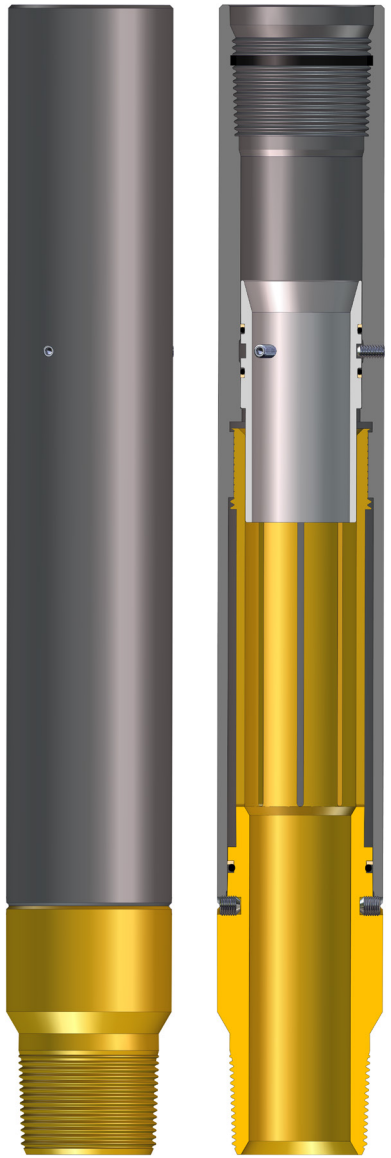
Patents: www.oilstatesintl.com/patents

Release Assemblies
Mechanical Tubing Releases, 2.375” to 4.500” Tubing

GEODynamics’ Mechanical Tubing Release provides an economical and reliable method for dropping the Tubing Conveyed Perforating Assembly. The device is usually run a minimum of thirty feet above the firing mechanism. The Mechanical Tubing Release is operated by engaging the release latch with the appropriate wireline shifting tool and jarring upward to shift the latch and drop the guns.

A wide range of latches is available to provide compatibility with the tubing string and all auxiliary equipment. The upper housing of the Mechanical Tubing Release is designed to provide a re-entry guide after the tool is separated.



TC-MR239-0000

FEATURES/BENEFITS

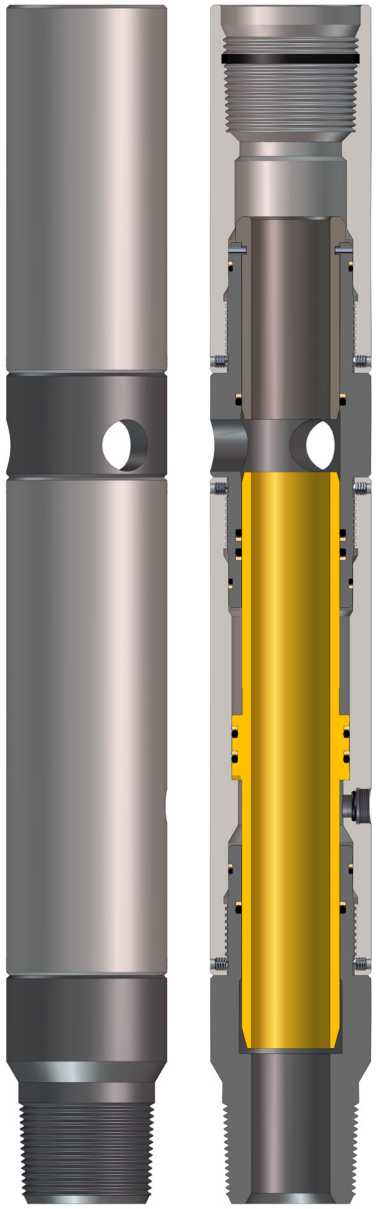
- Provides economical method for releasing guns
- Uses standard shifting tools
- Does not restrict tubing ID after release
- Opens tubing end for other tools and operations (logging, production testing, treating, etc.)
- Leaves perforations uncovered

SPECIFICATIONS

Assembly P/N	TC-MR239-0000	TC-MR288-0000	TC-MR350-0000	TC-MR450-0000
Tubing Thread Connection	2-3/8” EU 8 RD API Box Up X Pin Down	2-7/8” EU 8 RD API Box Up X Pin Down	3-1/2” EU 8 RD API Box Up X Pin Down	4-1/2” EU 8 RD API Box Up X Pin Down
Maximum Diameter	3.06 in / 77.72 mm	3.50 in / 88.90 mm	4.38 in / 111.25 mm	5.56 in / 141.22 mm
ID	Determined by Latch - Per Job Requirements			
Calculated Tensile	80,000 lbs. / 355.86 kN	95,000 lbs. /422.58 kN	120,000 lbs. / 533.78 kN	170,000 lbs. / 756.20 kN
Differential Pressure Rating	9,500 psi / 65.50 MPa	10,000 psi / 68.94 MPa	10,000 psi / 68.94 MPa	12,000 psi / 82.74 MPa
Overall Length	21.38 in / 0.54 m	21.54 in / 0.55 m	21.63 in / 0.55 m	23.63 in / 0.60 m
Seal Ratings	10,000 psi @ 290°F without back-up rings 20,000 psi @ 375°F with PEEK back-up rings			

Circulating/Fill-Up Valves
2.375", 2.875", and 3.500" Tubing

GEODynamics' Circulating/Fill-Up Valve is utilized to automatically establish a predetermined fluid cushion in the tubing or drill pipe while running into the well. The device may also be used as a Circulating Vent in conjunction with a Pressure-Actuated Vent to set a Hydraulic Set Packer, thereby eliminating the need to run a Standing Valve or Plug.



TC-CV23-0000

FEATURES/BENEFITS

- Economical, simple, safe, and reliable.
- Can be closed with hydrostatic or hydrostatic plus applied pressure
- Eliminates the need to top fill the work string while running in hole
- Precision shear pins guarantee actuation at required pressure
- Can be run in conjunction with DST tools
- Partial cushion TCP perforating
- Permanent completions
- Can be run with other venting tools to establish required underbalance
- Redressable on location

SPECIFICATIONS

Assembly P/N	TC-CV23-0000	TC-CV28-0000	TC-CV35-0000
Tubing Thread Connections	2-3/8" EU API Box Up x Pin Down	2-7/8" EU API Box Up x Pin Down	3-1/2" EU API Box Up x Pin Down
Overall Length	23.0 in / 0.58 m	24.6 in / 0.62 m	25.6 in / 0.65 m
Outside Diameter	3.06 in / 77.72 mm	3.88 in / 98.55 mm	4.62 in / 117.35 mm
Inside Diameter	1.50 in / 38.10 mm	2.25 in / 57.15 mm	2.87 in / 72.90 mm
Max. Operating Pressure	10,000 psi / 68.95 MPa		
Max. Differential	8,000 psi / 55.16 MPa		
Burst Pressure	18,000 psi / 124.10 MPa	13,000 psi / 89.63 MPa	11,500 psi / 79.29 MPa
Collapse Pressure	16,000 psi / 110.32 MPa	12,000 psi / 82.74 MPa	11,000 psi / 79.84 MPa
Seal Ratings	10,000 psi STD 20,000 psi with Viton and PEEK Back-up rings		
Tensile Strength	150,000 lbs / 667.23 kN	200,000 lbs / 889.64 kN	200,000 lbs / 889.64 kN

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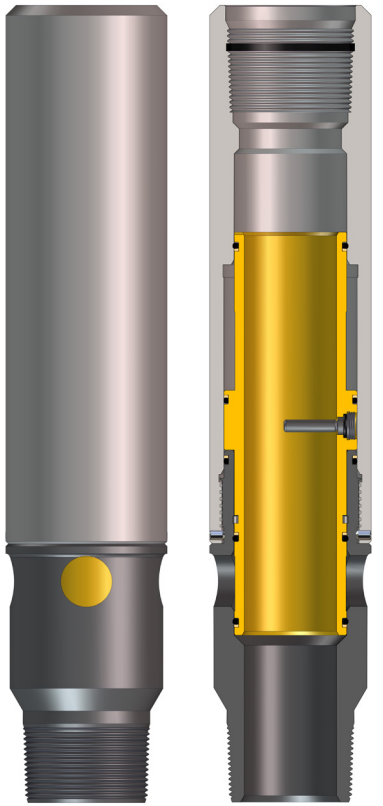
Patents: www.oilstatesintl.com/patents

Production Vents
Bar-Operated, 2.375”, 2.875”, and 3.500” Tubing

GEODynamics

GEODynamics’ Bar-Operated (OBV) Production Vents provide a means of running tubing-conveyed perforating guns into the well with no fluid entry into the tubing and establish a production flow path when operated/opened. The production vent design features eliminate the need to swab or displace with nitrogen in order to achieve the desired under balance and should be considered an essential component when completing with open perforations below the packer. This line of production vents can also be used in combination with the GEODynamics’ Circulating/Fill-up Valve to automatically establish the required fluid level in the tubing.



TC-BPV-28-OBV

FEATURES/BENEFITS

- Economical, simple, safe, and reliable. Offers an inexpensive way to create necessary underbalance.
- Allows the hole to be totally contained at the wellhead before the surge.
- Allows the sleeve to lock in place once the port is opened.
- Can be run with any packer.
- Does not rely on tubing manipulation; hydrostatic pressure in the tubing is the only force required.
- Can be run in conjunction with Circulating/Fill-up Valve.
- Redressable on location.

SPECIFICATIONS

Assembly P/N	TC-BPV-23-OBV	TC-BPV-28-OBV	TC-BPV-35-OBV
Tubing Thread Connections	2-3/8” EU API Box Up x Pin Down	2-7/8” EU API Box Up x Pin Down	3-1/2” EU API Box Up x Pin Down
Length	18.4 in / 0.47 m	19.5 in / 0.50 m	26.5 in / 0.67 m
Outside Diameter	3.06 in / 77.72 mm	3.93 in / 99.82 mm	4.75 in / 120.65 mm
Inside Diameter	1.50 in / 38.10 mm	2.25 in / 57.15 mm	2.88 in / 73.15 mm
Max. Operating Pressure	14,750 psi / 101.70 MPa	14,000 psi / 96.53 MPa	10,500 psi / 72.39 MPa
Differential Rating	5,000 psi / 34.47 MPa		
Seal Ratings	10,000 psi STD without Back-up rings 15,000 psi with Viton and PEEK Back-up rings		
Tensile Strength	150,000 lbs / 667.23 kN	210,000 lbs / 934.13 kN	250,000 lbs / 1,112.06 kN
Min. Operating Pressure	500 psi in Tubing		

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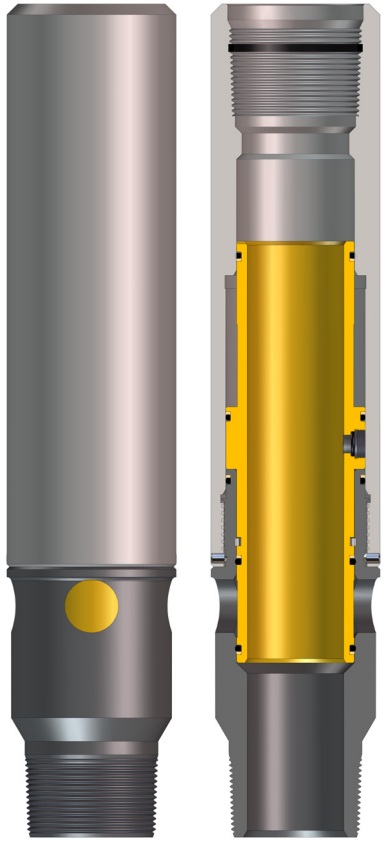
Production Vents
Pressure-Actuated, 2.375", 2.875", and 3.500" Tubing

GEODynamics' Pressure-Actuated (ORD) Production Vents provide a means of running tubing-conveyed perforating guns into the well with no fluid entry into the tubing and establish a production flow path when operated/opened. The production vent design features eliminate the need to swab or displace with nitrogen in order to achieve the desired under balance and should be considered an essential component when completing with open perforations below the packer. This line of production vents can also be used in combination with the GEODynamics' Circulating/Fill-up Valve to automatically establish the required fluid level in the tubing.



TC-BPV-28-ORD

FEATURES/BENEFITS

- Economical, simple, safe, and reliable. Offers an inexpensive way to create necessary underbalance.
- Can be run in vertical, deviated, or horizontal wells.
- Can be run with full range of perforating gun system firing heads.
- Allows the hole to be totally contained at the wellhead before the surge.
- Allows the sleeve to lock in place once the port is opened.
- Does not rely on tubing manipulation; hydrostatic pressure in the tubing is the only force required.
- Can be run in conjunction with Circulating/Fill-up Valve.
- Redressable on location.

SPECIFICATIONS

Assembly P/N	TC-BPV-23-ORD	TC-BPV-28-ORD	TC-BPV-35-ORD
Tubing Thread Connections	2-3/8" EU API Box Up x Pin Down	2-7/8" EU API Box Up x Pin Down	3-1/2" EU API Box Up x Pin Down
Length	18.4 in / 0.47 m	19.5 in / 0.50 m	26.5 in / 0.67 m
Outside Diameter	3.06 in / 77.72 mm	3.93 in / 99.82 mm	4.75 in / 120.65 mm
Inside Diameter	1.50 in / 38.10 mm	2.25 in / 57.15 mm	2.88 in / 73.15 mm
Max. Operating Pressure	14,750 psi / 101.70 MPa	14,000 psi / 96.53 MPa	10,500 psi / 72.39 MPa
Differential Rating	5,000 psi / 34.47 MPa		
Seal Ratings	10,000 psi STD without Back-up rings 15,000 psi with Viton and PEEK Back-up rings		
Tensile Strength	150,000 lbs / 667.23 kN	210,000 lbs / 934.13 kN	250,000 lbs / 1,112.06 kN
Min. Operating Pressure	1,000 psi PAD-I Rupture Disc		

Gun Hangers
3.500” to 9.625” Casing

GEODynamics

GEODynamics’ Gun Hangers provide an independent means of running and suspending a perforating assembly adjacent to the producing formation. The perforating assembly is run to depth and logged into position. The gun hanger assembly is set by manipulating the drill pipe, wireline, slickline, or coiled tubing. After placing on depth, the running tool is actuated and releases the bottom hole assembly.

After all surface preparations and testing are completed, the well is pressurized, and the guns are detonated. Upon detonation, the perforating guns and gun hanger are automatically dropped into the rathole. The device relies solely on hydraulics to release. No special licensing and shipping of shaped charges or ballistics are required to ship this device to international destinations on short notice.

TC-GH550-0000

FEATURES/BENEFITS

- No tubing required between guns and packer
- No intervention work required to drop the assembly
- No restrictions in the casing below the tubing
- Maximum underbalanced pressure can be used
- Multiple deployment methods via drill pipe, wireline, slickline, or coiled tubing
- Multi set/unset capability
- Ideal for monobore completions
- Bottom-mounted hanger assembly is not affected by perforating debris (top-mounted hangers can get stuck when underbalance carries debris uphole during perforation)
- Can be used with both hydraulic and electronic firing systems
- Not affected by electrical sources or radio frequencies—radio silence not required

SPECIFICATIONS

Assembly P/N	TC-GH350-0000	TC-GH450-0000	TC-GH550-0000	TC-GH700-0000	TC-GH962-0000
Casing Size	3.500”	4.500”	5.500”	7.000”	9.625”
Maximum Tool OD	2.78 in / 70.61 mm	3.77 in / 95.76 mm	4.50 in / 114.30 mm	5.50 in / 139.70 mm	8.13 in / 206.50 mm
Overall Tool Length	45.17 in / 114.73 cm	61.97 in / 157.40 cm	61.97 in / 157.40 cm	61.97 in / 157.40 cm	78.92 in / 200.46 cm
Calculated Tensile	60,000 lbs / 267 kN	125,000 lbs / 556 kN	125,000 lbs / 556 kN	125,000 lbs / 556 kN	200,000 lbs / 889 kN
Minimum Gun Weight	500 lbs / 226.80 kg	500 lbs / 226.80 kg	1,000 lbs / 453.59 kg	1,000 lbs / 453.59 kg	1,000 lbs / 453.59 kg
Maximum Gun Weight	25,000 lbs / 11,340 kg	35,000 lbs / 15,876 kg	40,000 lbs / 18,144 kg	50,000 lbs / 22,680 kg	75,000 lbs / 34,019 kg
Collapse Rating	20,000 psi / 137.90 MPa				
Thread Connection (UH, Box)	2” 8 STUB ACME	2-3/4” 6 ACME	2-3/4” 6 ACME	2-3/4” 6 ACME	2-3/4” 6 ACME
Thread Connection (DH, Pin)	1” 8 STUB ACME	2-3/8” NU 10 RD	2-3/8” NU 10 RD	2-3/8” NU 10 RD	4-1/2” 8 RD LTC

Revised: February 10, 2025 5:21 PM

Radioactive Marker Subs
2.375” to 4.500” Tubing

GEODynamics’ Radioactive Marker (RA) sub accepts a radioactive disk for use in depth correlation of the tubing conveyed perforating bottomhole assembly. The radioactive material is a 1.0 microcurie (µCi) Cobalt-60 disk source.

FEATURES/BENEFITS

- Economical, simple, safe, and reliable.
- Can be run in conjunction with all GEODynamics TCP firing heads.
- RA source is easily detected by a gamma ray or gamma ray neutron tool.
- A steel plug screw safely contains the RA source inside a cavity on the housing, ensuring full recovery of the radioactive disk.
- Full opening.
- Custom threads available on request: IF, PH-6, BTS-8, CS Hydril

SPECIFICATIONS

Assembly P/N	TC-RA-0238-0000	TC-RA-0288-0000	TC-RA-0350-0000	TC-RA-0450-0000
Thread Connections*	2-3/8” EUE 8RD API STD Box Up X Pin Down	2-7/8” EUE 8RD API STD Box Up X Pin Down	3-1/2” EUE 8RD API STD Box Up X Pin Down	4-1/2” EUE 8RD API STD Box Up X Pin Down
Outside Diameter	3.25 in. / 8.26 cm	3.75 in. / 9.53 cm	4.50 in. / 11.43 cm	5.56 in. / 14.12 cm
Inside Diameter	1.88 in. / 4.78 cm	2.38 in. / 6.05 cm	3.00 in. / 7.62 cm	3.96 in. / 10.06 cm
Overall Length	12.00 in. / 30.48 cm	12.00 in. / 30.48 cm	12.00 in. / 30.48 cm	16.00 in. / 40.64 cm
Makeup Length	8.70 in. / 22.10 cm	8.70 in. / 22.10 cm	8.40 in. / 21.34 cm	11.30 in. / 28.70 cm
Top End to Source**	5.75 in. / 14.61 cm	5.75 in. / 14.61 cm	5.75 in. / 14.61 cm	7.75 in. / 19.69 cm
Max. Operating Pressure	15,000 psi / 103.42 MPa	15,000 psi / 103.42 MPa	15,000 psi / 103.42 MPa	14,000 psi / 96.53 MPa
Calculated Tensile	210,000 lbs / 934.10 kN	275,000 lbs / 1,223.26 kN	375,000 lbs / 1,668.08 kN	500,000 lbs / 2,224.11 kN

**Custom threads available on request: IF, PH-6, BTS-8, CS Hydril. **Radioactive material not included.*

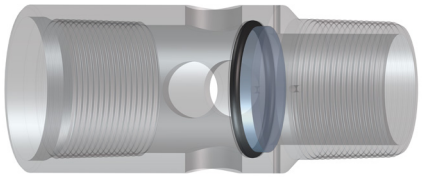
Debris Subs
2.375” to 5.500” Tubing

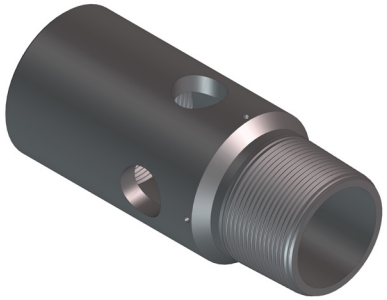
GEODynamics

GEODynamics’ Debris Sub is run between the firing head and packer. This sub acts as a debris barrier to prevent debris from settling on top of the firing head, and in the case of pressure-operated firing heads, it prevents the fluid hammer effect. The ports are used for production, injection, or to simply act as a tubing drain when pulling out of hole. The recommended minimum distance from the port debris barrier to a bar drop firing head is 30 feet. There is no minimum distance requirement above a pressure-operated firing head.

FEATURES/BENEFITS

- Economical, simple, safe, and reliable.
- Allows debris to be circulated off the glass disc through the flow ports above the glass disc.
- Acts as a perforated sub for circulation or production.
- Can be run with either a mechanical or pressure-actuated firing head.
- Available in standard or non-standard materials.





TC-FD-0288-0000

2-7/8” Fill Disc Assembly

SPECIFICATIONS

Assembly P/N	TC-FD-0238-0000	TC-FD-0288-0000	TC-FD-0350-0000	TC-FD-0450-0000
Thread Connections	2-3/8” EUE 8RD API STD Box Up x Pin Down	2-7/8” EUE 8RD API STD Box Up x Pin Down	3-1/2” EUE 8RD API STD Box Up x Pin Down	4-1/2” EUE 8RD API STD Box Up x Pin Down
Barrier Type	Glass Disc			
Overall Length	8.25 in. / 209.55 mm	8.50 in. / 215.90 mm	11.00 in. / 279.40 mm	11.00 in. / 279.40 mm
Makeup Length	6.00 in. / 152.40 mm	6.12 in. / 155.45 mm	7.62 in. / 193.55 mm	7.75 in. / 196.85 mm
Outside Diameter	3.125 in. / 79.38 mm	3.688 in. / 93.68 mm	4.50 in. / 114.30 mm	5.50 in. / 139.70 mm
Inside Diameter	2.00 in. / 50.80 mm	2.44 in. / 61.98 mm	3.00 in. / 76.20 mm	3.94 in. / 100.08 mm
Flow Area	4.91 in^2 / 31.68 cm^2	4.91 in^2 / 31.68 cm^2	7.71 in^2 / 49.74 cm^2	12.43 in^2 / 80.19 cm^2
Calculated Tensile	158,000 lbs / 702.82 kN	197,000 lbs / 876.30 kN	330,000 lbs / 1,467.91 kN	420,000 lbs / 1,868.25 kN
O-Ring	OR-N569-330	OR-N569-334	OR-N569-339	OR-N569-346
Glass Disc	TC-FD-0238-0001	TC-FD-0288-0001	TC-FD-0350-0001	TC-FD-0450-0001

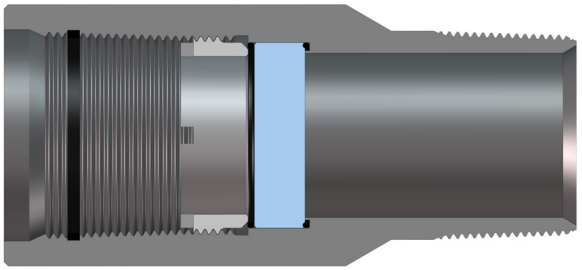
TC-FD-0350-0000

3-1/2” Fill Disc Assembly

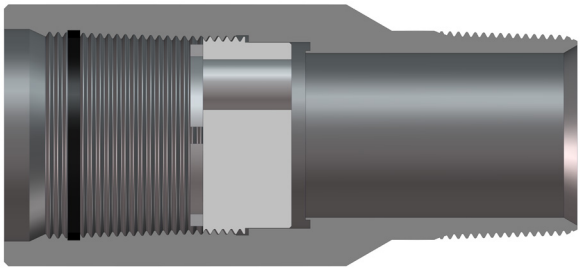
Underbalance Surge Tool
2.875” Tubing

GEODynamics

GEODynamics’ Underbalance Surge Tool was designed to provide a post perforation procedure for surging a well. The recommended approach is the “Short Trip Surge” method. After perforating the well, trip out of the hole with the workstring to reach the level of fluid necessary to achieve the desired underbalance. Install the underbalance surge tool assembly with the bar catcher assembly one joint below it. The tempered lime glass disc in the surge tool creates a barrier that provides an air chamber above it to surface. The bar catcher prevents the drop bar from reaching the firing head and causing damage or becoming entangled with an existing drop bar. When surging, it is recommended to position the guns above the perforations to prevent sand influx around the guns that could result in “stuck guns.”



2-7/8” Underbalance Surge Tool Assembly
TC-UB287-0000

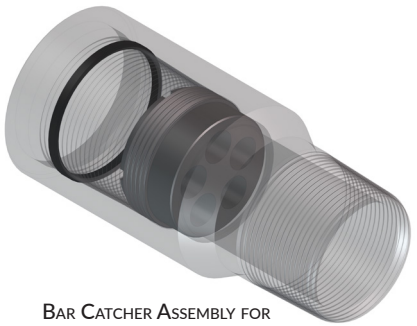


Bar Catcher Assembly for 2-7/8” Underbalance Surge Tool
TC-UB287-BC00

SPECIFICATIONS

Assembly P/N	TC-UB287-0000	TC-UB287-BC00
Thread Connections	2-7/8” EU 8RD Modified Box Up 2-7/8” EU 8RD Standard API Pin Down	
Overall Length	8.50 in. / 215.90 mm	
Makeup Length	5.75 in. / 146.05 mm	
Outside Diameter	3.67 in. / 92.22 mm	
Inside Diameter	2.35 in. / 59.69 mm	
Calculated Tensile	280,000 lbs. / 1245.50 kN	
Max Operating Pressure	20,000 psi / 137.90 MPa	
Max Differential Pressure	4,500 psi / 31.03 MPa (with 3/4” Glass Disc)	
Seal Ring	TC-SR288	
O-Ring	OR-V95G-145 (*QTY 2*)	N/A
Barrier Type	Glass Disc	Ported Ring
Glass Disc	TC-UB287-0075	N/A
Bar Catcher Ring	N/A	TC-UB287-0004

2-7/8” Underbalance Surge Tool Assembly
TC-UB287-0000



Bar Catcher Assembly for 2-7/8” Underbalance Surge Tool
TC-UB287-BC00

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Patents: www.oilstatesintl.com/patents

LIFT SUB ASSEMBLY COMPONENTS

Assembly P/N	Description	Lift Cap P/N	Joint P/N	Coupling P/N
TC-LT15-000	Lift Sub Assembly, 1-9/16" Tandem, 1-3/4", 2-1/8", and 2-1/2" Top Sub	TC-LT00-238	TC-PUP23-002N 2-3/8", 4.7#/ft, N-80	TC-LT15-003
TC-LT175-000	Lift Sub Assembly, 1-3/4" Tandem			TC-LT175-003
TC-LT21-000	Lift Sub Assembly, 2-1/8" Tandem			TC-LT21-003
TC-LT25-000	Lift Sub Assembly, 2-1/2" Tandem			TC-LT25-003
TC-LT27-QC0	Lift Sub Assembly, 2-3/4" & 2-7/8" Top Sub			TC-LT27-QC3
TC-LT27-000	Lift Sub Assembly, 2-3/4" Tandem			TC-LT27-003
TC-LT28-000	Lift Sub Assembly, 2-7/8" Tandem			TC-LT28-003
TC-LT31-000	Lift Sub Assembly, 3-1/8" Tandem & Top Sub		TC-PUP23-602P 2-3/8", 6.5#/ft, P-110	TC-LT31-003
TC-LT33-000	Lift Sub Assembly, 3-3/8" Tandem			TC-LT33-003
TC-LT40-000	Lift Sub Assembly, 4" Tandem			TC-LT40-003
TC-LT45-000	Lift Sub Assembly, 4-1/2" & 4-5/8" Tandem	TC-LT00-288	TC-PUP28-902P 2-7/8," 8.7#/ft, P-110	TC-LT45-003
TC-LT51-000	Lift Sub Assembly, 5-1/8" Tandem			TC-LT51-003
TC-LT675-000	Lift Sub Assembly, 6-3/4"" Tandem			TC-LT675-003
TC-LT70-000	Lift Sub Assembly, 7" Tandem			TC-LT70-003

COUPLING SPECIFICATIONS

Coupling P/N	Description	Uphole Thread	Downhole Thread
TC-LT15-003	Coupling, Tandem Lift Sub, 1-9/16"	2-3/8" EU (8 Rnd)	1-9/32" 12P STUB ACME-2G
TC-LT175-003	Coupling, Tandem Lift Sub, 1-3/4"		1-7/16" 12P STUB ACME-2G
TC-LT21-003	Coupling, Tandem Lift Sub, 2-1/8"		1-11/16" - 8P STUB ACME-2G
TC-LT25-003	Coupling, Tandem Lift Sub, 2-1/2"		2-1/8" - 8P ACME-2G
TC-LT27-QC3	Coupling, 2-3/4" & 2 7/8" Top Lift Sub		2-1/8" - 6P ACME-2G
TC-LT27-003	Coupling, Tandem Lift Sub, 2-3/4"		2-3/8" - 6P ACME-2G
TC-LT28-003	Coupling, Tandem Lift Sub, 2-7/8"		2-1/2" - 6P ACME-2G
TC-LT31-003	Coupling, Tandem Lift Sub, 3-1/8"		2-3/4" - 6P ACME-2G
TC-LT33-003	Coupling, Tandem Lift Sub, 3-3/8"		2-13/16" - 6P ACME-2G
TC-LT40-003	Coupling, Tandem Lift Sub, 4"		3-9/16" - 6P ACME-2G
TC-LT45-003	Coupling, Tandem Lift Sub, 4-1/2"	2-7/8" EU (8 Rnd)	3-15/16" - 6P ACME-2G
TC-LT51-003	Coupling, Tandem Lift Sub, 5-1/8"		4-1/2" - 6P ACME-2G
TC-LT675-003	Coupling, Tandem Lift Sub, 6-3/4"		5-3/4"-6P ACME-2G
TC-LT70-003	Coupling, Tandem Lift Sub, 7"		6-1/4" - 5P ACME 2G

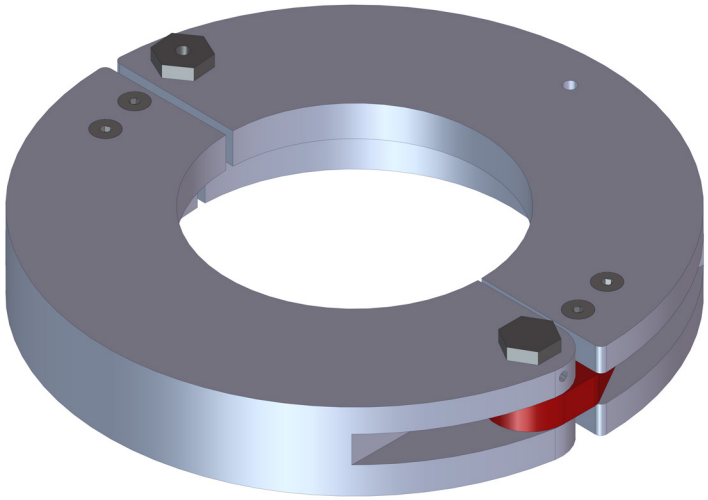
Lift Sub Assembly, 4-1/2 & 4-5/8" Tandem
TC-LT45-000 (shown)

Revised: February 10, 2025 5:21 PM

LIFTING CLAMP ASSEMBLIES

Assembly P/N	Description	† Safe Working Load (lbs)	† Shear Rating (lbs)
TC-LC-0288-0000	Lifting Clamp Assembly, 2-7/8”	105,000	345,000
TC-LC-0313-0000	Lifting Clamp Assembly, 3-1/8”	115,000	375,000
TC-LC-0338-0000	Lifting Clamp Assembly, 3-3/8”	125,000	400,000
TC-LC-0400-0000	Lifting Clamp Assembly, 4”	150,000	480,000
TC-LC-0450-0000	Lifting Clamp Assembly, 4-1/2”	170,000	540,000
TC-LC-0462-0000	Lifting Clamp Assembly, 4-5/8”	174,000	550,000
TC-LC-0475-0000	Lifting Clamp Assembly, 4-3/4”	175,000	575,000
TC-LC-0513-0000	Lifting Clamp Assembly, 5-1/8”	190,000	620,000
TC-LC-0675-0000	Lifting Clamp Assembly, 6-3/4”	255,000	815,000
TC-LC-0700-0000	Lifting Clamp Assembly, 7”	265,000	845,000
TC-LC-0700-T000	Lifting Clamp Assembly, 7”	249,000	795,000

† All ratings are based on 4145 steel with a minimum 32 Rockwell C (Rc). Contact GEODynamics Engineering for other materials.



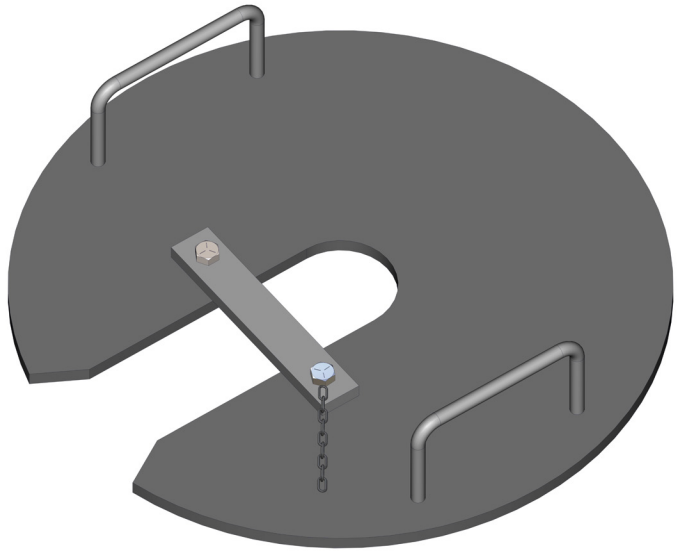
6.75” Lifting Clamp Assy
TC-LC-0675-0000 (*shown*)

Support Plates
Offshore Support Plates

Support plates hold the perforating guns in place on the rig floor. Offshore Support Plates feature a large outer diameter (22" OD) for compatibility with offshore applications.

SPECIFICATIONS

Gun O.D.	Part Number	Description	Yield Rating		Weight	
			(lbf)	*(daN)*	*(lb)*	*(kg)*
1-9/16"	TC-SP16-000	1-9/16" Support Plate	25,000	11,121	28	12.7
2"	TC-SP20-000	2" Support Plate	30,000	13,345	31	14.1
2-1/2"	TC-SP25-000	2-1/2" Support Plate	32,000	14,234	31	14.1
2-3/4" & 2-7/8"	TC-SP27-000	2-3/4" and 2-7/8" Support Plate	31,000	13,789	31	14.1
3-1/8"	TC-SP31-000	3-1/8" Support Plate	38,000	16,903	53	24.0
3-3/8"	TC-SP33-000	3-3/8" Support Plate	41,000	18,238	53	24.0
4"	TC-SP40-000	4" Support Plate	70,000	31,138	53	24.0
4-1/2"	TC-SP45-000	4-1/2" Support Plate	75,000	33,362	51	23.1
5-1/8"	TC-SP51-000	5-1/8" Support Plate	80,000	35,586	50	22.7
7"	TC-SP70-000	7" Support Plate	100,000	44,482	86	39.0



NOTES

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