Hydra-Jar®

Double Acting, Hydraulic Drilling Jar

OPERATIONS MANUAL 6-80

SMITH SERVICES
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The designs and specifications of the tools described in this Operation Manual were current on the effective date of this manual. Smith Services HE Group, whose policy is one of continuous improvement, reserves the right to discontinue models at any time, or to change designs or specifications, without notice or without incurring obligation.

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General Description

The Hydra-Jar® is a double-acting hydraulic drilling jar capable of delivering an extra-heavy impact when a bottomhole assembly becomes stuck. Designed to operate as an integral part of a drillstring, it can withstand:

- Temperatures up to 500° F.
- Pressure differentials of 10,000 psi dynamic and 20,000 psi static.
- Normal drilling conditions of *torque, pump pressure* and *long term use*.

The Hydra-Jar tool can easily be racked as part of a stand of drill collars because it is similar in length and diameter, and has compatible connections and slip setting areas.

In the drilling mode, the jarring mechanism is disengaged and is not affected by normal drilling conditions or torque.

Control of Hydra-Jar Tool

By adjusting the amount of surface push or pull (no torque or external adjustments are required) the operator can deliver very light or maximum impacts in either direction, *while* controlling the number of impacts in any given time frame.

- If the drillstring becomes stuck on bottom, the Hydra-Jar tool can deliver impact in an "up-only" direction.
- If the drillstring becomes stuck off of the bottom, the Hydra-Jar tool can deliver impact in a "down-only" direction.
- When differential sticking is encountered, and movement is needed to regain rotation and circulation, the Hydra-Jar tool will "up-jar" and "down-jar."

Advantages of Using a Hydra-Jar Tool

Universal Use in Oil and Gas Well Operations

- Drilling
- Coring
- Fishing
- Remedial Operations
- Workover
- Testing
- Offshore
- Cementing
- Sub Sea Service
- Directional and Horizontal Drilling

Easily Adjustable While in Use

- Adjustable Jar Impact
- Selective Up or Down Impact
- Variable Jar Time Cycle and Jar Intensity
- Operation Adjusted by the Working Load

Long Term Capability

- Completely Hydraulic
- Back-up Seal Systems
- High Degree of Reliability

Fishing Operations

- Variable Impacts
- Straight Push-pull
- Large Inside Diameter

High Strength Construction

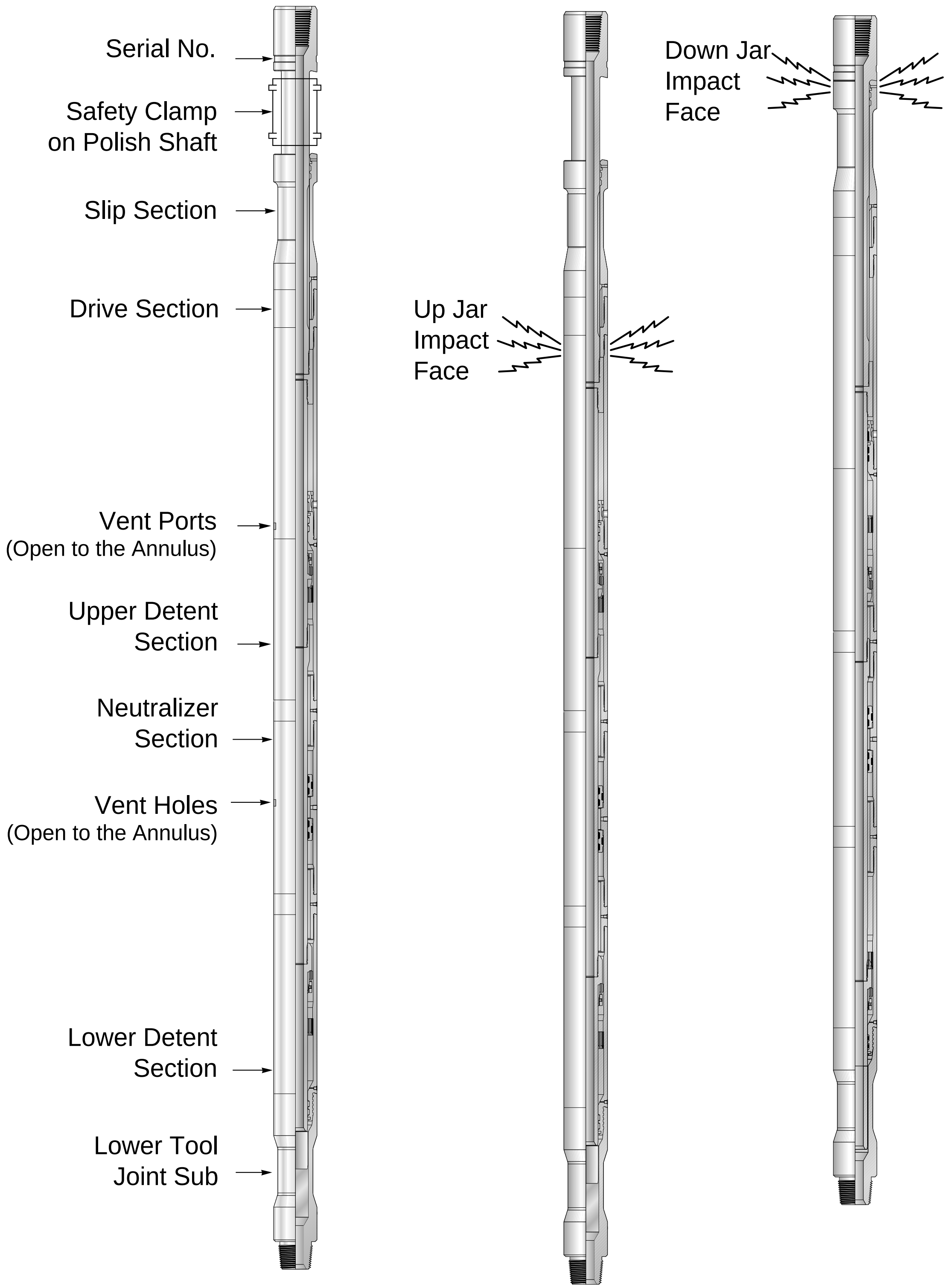
- High Strength Ductile Materials
- Key Components are Cold-worked, for Better Fatigue Life
- Can Withstand High-pressure and High-temperature Environments

Directional Drilling

- An excellent tool to use with downhole motor directional drilling application. Its straight pull and push characteristics will not disturb the directional orientation of the drillstring.

Double-Acting Hydraulic Hydra-Jar Tool

Figure 1



Assembly (when being handled)

Operation

Going in the Hole

Hydra-Jar® tools are approximately thirty feet long. Heavy-duty lift subs for tapered shoulder elevators are typically used for handling.

Jar Safety Clamp

When handling the Hydra-Jar tool above the rotary table, the **safety clamp must be on** the Hydra-Jar tool. This keeps the jar in the safe, extended position while being handled. The safety clamp is removed when the Hydra-Jar tool is lowered into the hole, see Figure 7.

Picking up the Hydra-Jar Tool

Step 1:

Place the lower drill assembly in the slips.

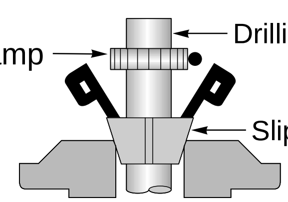


Figure 2

Step 2:

(a) Place thread protector on the tool joint thread.

(b) Clamp elevators around the lift sub.

(c) Pick up Hydra-Jar tool with elevators.

Note: *Leave safety clamp on Hydra-Jar tool*.

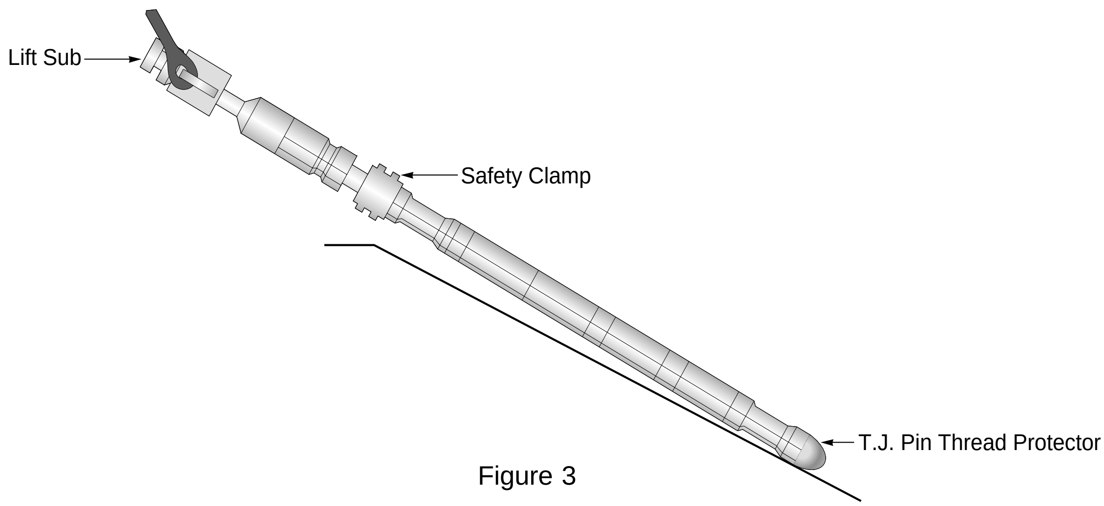


Figure 3

Step 3:

(a) Put Hydra-Jar tool in mouse hole.

(b) Tong up lift sub.

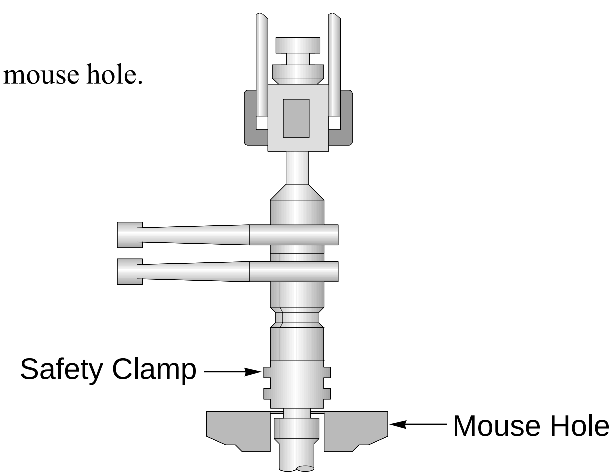


Figure 4

Step 4:

(a) Make up Hydra-Jar tool into lower drilling assembly in rotary table.

(b) Remove the drill collar clamp.

(c) Lower the string until the slips can be set in the slip section of the Hydra-Jar tool.

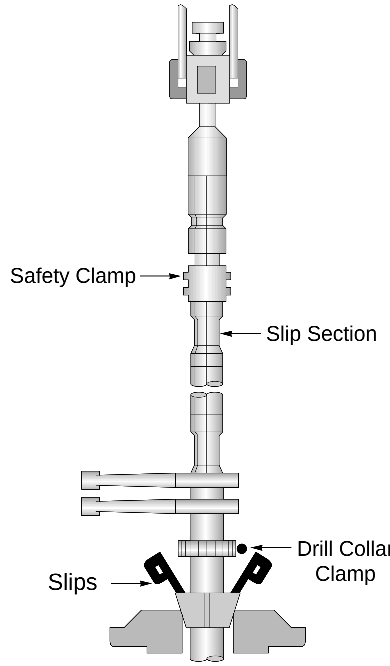


Figure 5

Step 5:

(a) Remove lift sub.

(b) Make up next full stand of drill collars or HWDP into top of Hydra-Jar tool.

(c) Tong up drill collars.

Note: *Leave Safety Clamp on Hydra-Jar tool.*

Step 6:

(a) Pick up drill collars or HWDP.

(b) Remove the slips.

(c) Slightly lower the string.

(d) **Remove the Jar Safety Clamp**.

(e) Lower the drilling assembly into the hole.

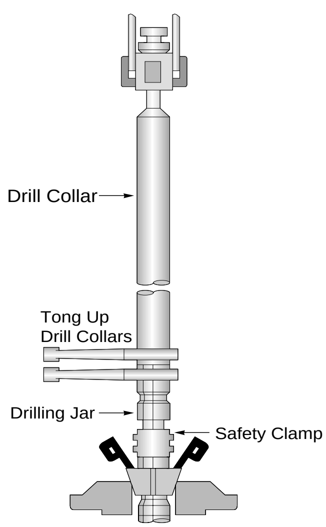


Figure 6

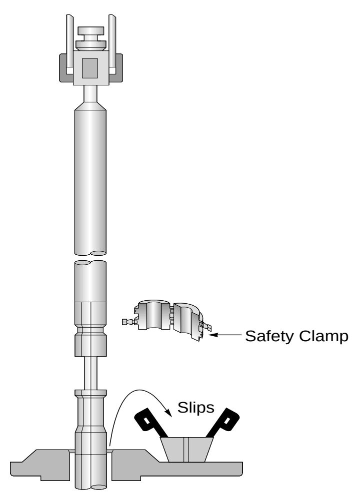


Figure 7

Jar Load

Establishing the Jar Load

With the Hydra-Jar tool in the hole, control of the tool is in the hands of the drawworks operator. Use the *Weight Indicator Reading* and the *Working String Weight above Hydra-Jar tool*, to establish jar load. Compare the load to the Specification Table 4, for the maximum detent load. In the following examples of operation it is necessary to calculate the *'working' string weight above the jar* and *drag* before calculating jar load. This weight is calculated as follows:

Working String Weight Above the Jar *equals* Drag *plus* String Weight from the Hydra-Jar tool to the Surface.

Drag *equals* Weight Indicator Reading Up *minus* Weight Indicator Reading Down.

CAUTION: *To prevent damage to the Hydra-Jar tool, do not exceed maximum detent working load (Specification Table 4) during up-jar cycle or down-jar cycle.*

Example 1: Jar Load "Up"

Up Load on Hydra-Jar tool *equals* Final Weight Indicator Reading Up before impact *minus* Working String Weight Above the Jar.

Final weight indicator reading up, before impact, is	250,000 lb
Working string weight above the jar is	150,000 lb
Which results in a jar up load of	100,000 lb

Example 2: Jar Load "Down"

Down Load on Hydra-Jar tool *equals* Final Weight Indicator Reading Down before impact *minus* Working String Weight Down.

Final weight indicator reading down, before impact, is	120,000 lb
Working string weight above the jar is	150,000 lb
Which results in a jar down load of	30,000 lb

Changing the Jar Load

Impact can be changed by adjusting the working load on the Hydra-Jar tool.

Jar Cycle

The Hydra-Jar's hydraulic delay operates within a definite time/load cycle. This allows delivery of an optimum number of impacts with sufficient time delay to pull the pipe to the required load range and set the drawworks brake. Once a rhythm of setting the Hydra-Jar tool and pulling up (or pushing down) is established, the Hydra-Jar tool can impact at a rate of approximately sixty blows per hour.

Changing the Jar Cycle

If the delay time between blows is too short, it can be extended by applying more load when setting the tool. Extending the delay time also makes it possible to apply higher working detent loads, increasing the impact force. Figure 18 shows the normal relationship between load (at the jar) and time (before impact), for a given jar size. The chart can be used to establish the delay time for a given pull (or push) load.

Up-Jarring Operation

Step 1: Establish the jar load "up" within the range shown in Table 4, *Hydra-Jar Tool Specifications.*

Step 2: Apply pull to the drillstring per the established final weight indicator reading, then wait for the Hydra-Jar tool to impact. There will be a small loss of indicator weight just before impact, which corresponds to the retraction of drillstring length. There should be a clear indication on the weight indicator after the Hydra-Jar tool has impacted. See Figure 18 for delay time verses overpull.

Step 3: To repeat the operation, slack off 10,000 to 15,000 lb below the working load down and immediately apply the previous up-jar load.

Down-Jarring Operation

CAUTION: *Do not permit spudding down or dropping larger loads than the jarring mechanism is designed to withstand.*

Step 1: Select a jar load "down," within the range shown in Table 4, *Hydra-Jar Tool Specifications,* or within the weight range just above the Hydra-Jar tool.

Step 2: Slack down per the established final weight indicator reading, then wait for the Hydra-Jar tool to impact.

Step 3: Pick up on the string until the weight indicator is above the "working" string load by 10,000 to 15,000 lb, then immediately slack off to the previously selected down jar load.

Step 4: Wait for the Hydra-Jar tool to impact down. See Figure 18 for delay time verses overpull.

Step 5: Repeat Step 3 for additional blows.

Down-jar impacts may not be transmitted through shock tools run in the lower drilling assembly.

When jarring down with small amounts of drill collars or HWDP on top of the Hydra-Jar, select a load range that will not buckle the drill pipe.

Up and Down Jarring Operations

Step 1: Select jar load for up and down, as described in *Examples 1 and 2*.

Step 2: Carry out the up-jar sequence, as described in the *Up-Jar Operation*.

Step 3: Once the Hydra-Jar tool has impacted up, slack off until the selected down weight on the Hydra-Jar tool is achieved, as described in *Down-Jar Operation*.

Step 4: The weight indicator will reflect when the Hydra-Jar tool impacts down.

Step 5: Repeat Steps 2 through 4 for continuing operation.

Setting the Hydra-Jar Tool Prematurely

If the Hydra-Jar tool is prematurely set, the string must be suspended in the elevators and allowed to impact. Following the impact, it may be run to depth. If it is set in the hole, leave the elevators on the pipe until the impact, before continuing tripping operations.

When coming out of the hole, do not slack off more than six inches before setting the slips in the rotary, or the Hydra-Jar tool may set for an up-jar impact.

Increasing Effectiveness

Using the Mud Pump

Pump pressure does not appreciably effect up-jar impacts, but decreases down-jar impacts. Therefore, the pump should be shut down or slowed before down-jarring operations begin. Pump pressure extension loads are shown in Figure 17, *Pump Pressure Extension Loads*.

Using Drill Collar Weights

Adequate weight just above the Hydra-Jar tool, provides optimum impact for down-jarring. This also *decreases* the possibility of buckling damage to the drillstring.

Using the Accelerator® Tool

When used with optimum weights listed in Table 5, the Accelerator tool increases the impact of the jar and protects the working string from destructive shock loads. An Accelerator tool is effective in achieving efficient jarring in holes where high pipe drag loads are encountered.

Coming Out of the Hole

Step 1:

(a) Attach the Safety Clamp on the polished shaft of the jar, as the Hydra-Jar tool comes through the rotary table, and before setting the rotary slips.

(b) Moderately tighten the two bolts of the safety clamp. ***Do not over-tighten safety clamp bolts.***

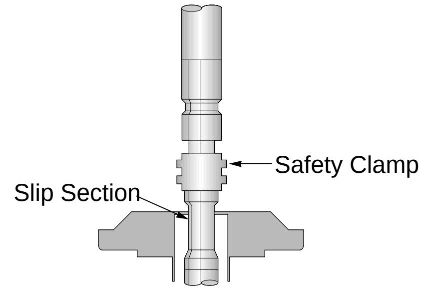


Figure 8

Step 2:

Set rotary slips on slip section of the Hydra-Jar tool. Break off and stand back drill collars or HWDP. Jar may be changed out at this point.

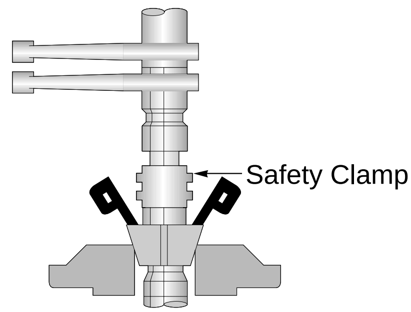


Figure 9

Step 3:

Make up and tong up lift sub into the Hydra-Jar tool, then hoist out the next stand.

Step 4:

Stand back Hydra-Jar tool with stands of drill collars or HWDP. The Hydra-Jar tool should be at the top of the stand.

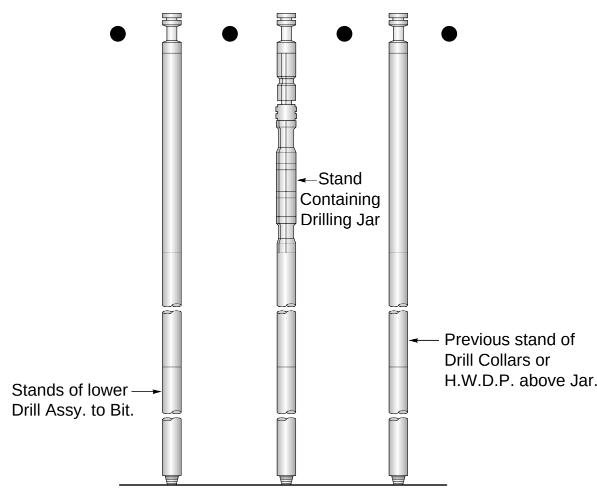


Figure 10

Change Out Recommendations

The Hydra-Jar® tool should be changed out periodically for servicing. See Table 1, *Change Out Recommendations*, to determine recommended hours of use before servicing.

To use the information in Table 1, *Change Out Recommendations*:

Step 1: Select the **Hydra-Jar tool OD**.

Step 2: Determine the drilling **use.**

Step 3: Select the **hole size** and note the corresponding **hours**.

Step 4: Determine the **bottomhole temperature** and note the corresponding **hours**.

Step 5: Compare the **hours** between the **temperature** and the drilling **use.**

Step 6: The smaller of the two will determine the service period.

Table 1
Change Out Recommendations

USE	Tool OD inches (mm): 3-1/8, 3-3/8 (79, 86)		4-1/4 (108)		4-3/4 (121)		6-1/4 (159)		6-1/2, 7, 7-1/4 (165, 178, 184)		7-3/4 (197)		8, 8-1/4, 8-1/2 (203, 210, 216)		9-1/2 (241)	
	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours	Hole Size	Hours
Rotating in straight or horizontal section, only	4-3/4 (121)	200	5-7/8 (149)	200	6-1/8 (156)	300	7-7/8 (200)	400	8-3/4 (222)	400	9-7/8 (251)	300	9-7/8 (251)	400	12-1/4 (311)	400
	5-7/8 (149)	150	6-1/8 (156)	150	6-3/4 (171)	200	8-3/4 (222)	400	9-7/8 (251)	300	12-1/4 (311)	200	12-1/4 (311)	350	17-1/2 (445)	350
			6-3/4 (171)	100	7-7/8 (200)	100	9-7/8 (251)	300	12-1/4 (311)	200	17-1/2 (444)	100	17-1/2 (445)	250	26 (660)	200
Rotating in deviated or build section	5-7/8 (149)	100	6-1/8 (156)	100	6-3/4 (171)	100	8-3/4 (222)	200	9-7/8 (251)	200	9-7/8 (251)	200	9-7/8 (251)	250	12-1/4 (311)	250
			6-3/4 (171)	75	7-7/8 (200)	75	9-7/8 (251)	200	12-1/4 (311)	100	12-1/4 (311)	100	12-1/4 (311)	150	17-1/2 (445)	150
													17-1/2 (445)	100	26 (660)	100

Recommended hours of use before servicing

Bottom Hole Temp	Tool OD inches (mm): 3-1/8, 3-3/8 (79, 86)	4-1/4 (108)	4-3/4 (121)	6-1/4 (159)	6-1/2, 7, 7-1/4 (166, 178, 184)	7-3/4 (197)	8, 8-1/4, 8-1/2 (203, 210, 216)	9-1/2 (241)
	Hours							
100-200°F 38-93°C	200	200	300	400	400	300	400	400
200-300°F 93-148°C	200	200	200	300	300	300	300	300
300-400°F 148-204°C	150	150	200	300	300	300	300	300
400-500°F 204-260°C	150	150	150	150	150	150	150	150
Fishing	100							
Milling	50							

Placement

Optimum Hydra-Jar® Tool Position

The optimum position for the Hydra-Jar tool is slightly above the transition zone, but the Hydra-Jar tool can be run below the transition zone. Examples provided in Figure 11 through 15 illustrate how to determine the position above the transition zone.

The outside diameter of the Hydra-Jar tool should be smaller than or equal to the diameter of the collar string and lower drilling assembly. This allows the Hydra-Jar tool to be free, if the lower drilling assembly becomes stuck.

Hydra-Jar Tool in Tension

The Hydra-Jar tool is generally run in tension, with adequate drill collars to provide desired weight on bit (WOB) and to maintain the transition zone below the Drilling Jar. Weight on bit changes can be accommodated, by adding to or subtracting from the drill collars below the Hydra-Jar tool, always retaining sufficient weight above the Hydra-Jar tool to provide an effective jar hammer.

Placing Hydra-Jar Tool in Compression

The Hydra-Jar tool can be, and often is, run in compression. When running in compression adequate drill collars should be placed below and above the Hydra-Jar tool to accommodate the desired WOB and maintain the transition zone above the jar. When going in the hole the Hydra-Jar tool will be extended (opened position); therefore, it is necessary to follow the procedures below in order to avoid a jar-down, as the Hydra-Jar tool is closed.

- Slowly lower the string as the bit approaches bottom. The weight indicator will read a slight reduction in string weight when the bit tags bottom.
- Continue to slowly lower string, allowing the Hydra-Jar tool to completely close and move through detent without causing an impact. A slight movement of the weight indicator needle might be detectable as the Hydra-Jar tool exits detent.
- Subsequent to this procedure, additional weight can be added as needed.

In order to avoid a jar-up when making a connection or tripping out of the hole, while the Hydra-Jar tool is run in compression, the procedures below should be followed.

- Slowly raise string off bottom, allowing the Hydra-Jar® to open and move through detent without causing an impact. Again, slight movement of the weight indicator needle will be observed as the Hydra-Jar tool exits detent. This indicates the tool is in the open position and normal practices for making a connection and coming out of hole can continue.

When re-establishing the WOB after a connection or otherwise approaching hole bottom, total WOB should be applied slowly to allow the Hydra-Jar tool to ease through detent, thus avoiding a down-jar. A gradual increase of WOB over a period of three minutes is usually sufficient to close the Hydra-Jar tool without impact.

Jar Tension Drilling Weight (JTDW)

The JTDW is generally 10 to 20 (or more) of the value selected for the desired bit weight. Enough JTDW should be selected so that subsequent variations in drilling bit weight will not permit the Hydra-Jar tool to set during the drilling operation. Enough difference between the WOB and the JTDW should be provided to prevent the Hydra-Jar tool from setting in the drilling operation. To avoid damaging or prematurely setting the Hydra-Jar tool, do not place at or near the transition zone.

Transition Zone

The transition zone can be calculated by dividing the corrected WOB by the unit weight per length of the drill collars (DC) or heavy weight drill pipe (HWDP) used.

Transition Zone in feet *equals* corrected WOB *divided by* DC wt/ft
Transition Zone in drill collars *equals* corrected WOB *divided by* wt/30ft

Known Factors:
Corrected WOB = 70,300 lb
DC wt/ft = 147 lb/ft
DC wt/30ft = 4,410 lb

Transition Zone in feet 70,300 lb ÷ 147 lb/ft = 478 ft

Transition Zone in drill collars 70,300 lb ÷ 4,410 lb = 16 DC

Weight Correction Tables

The information contained in Tables 2 and 3 can be utilized to calculate the required drillstring weight, in air, necessary to provide the desired bit weight for both straight and directional holes.

Table 2–BF–Mud Weight & Buoyancy Factor Multiplier

Mud Weight lb/Gal	8.3	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
Buoyancy Factor Multiplier	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.37	1.41	1.43

Where $BF = \frac{\text{Density of steel (PPG) - Density of mud (PPG)}}{\text{Density of steel (PPG)}}$ Density of steel = 65.44 PPG

The reciprocal (1/BF) of the Buoyancy Factor (BF) multiplier when multiplied by the air weight of drillstring members will give the buoyed weight in mud.

Table 3–AF–Hole Angle Factor Multiplier

Hole Angle	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°
1/cos Multiplier	1.0038	1.0154	1.0353	1.0642	1.1034	1.1547	1.2208	1.3054	1.4142	1.5557	1.7434	2.0000

No Angle

Use the calculations below to place the Hydra-Jar® tool in the optimum position within the drilling assembly, while maintaining the Desired Weight on Bit.

For this example, use the **Known Factors** to calculate weight, length and quantity of drill collars to make up the drilling assembly, in air.

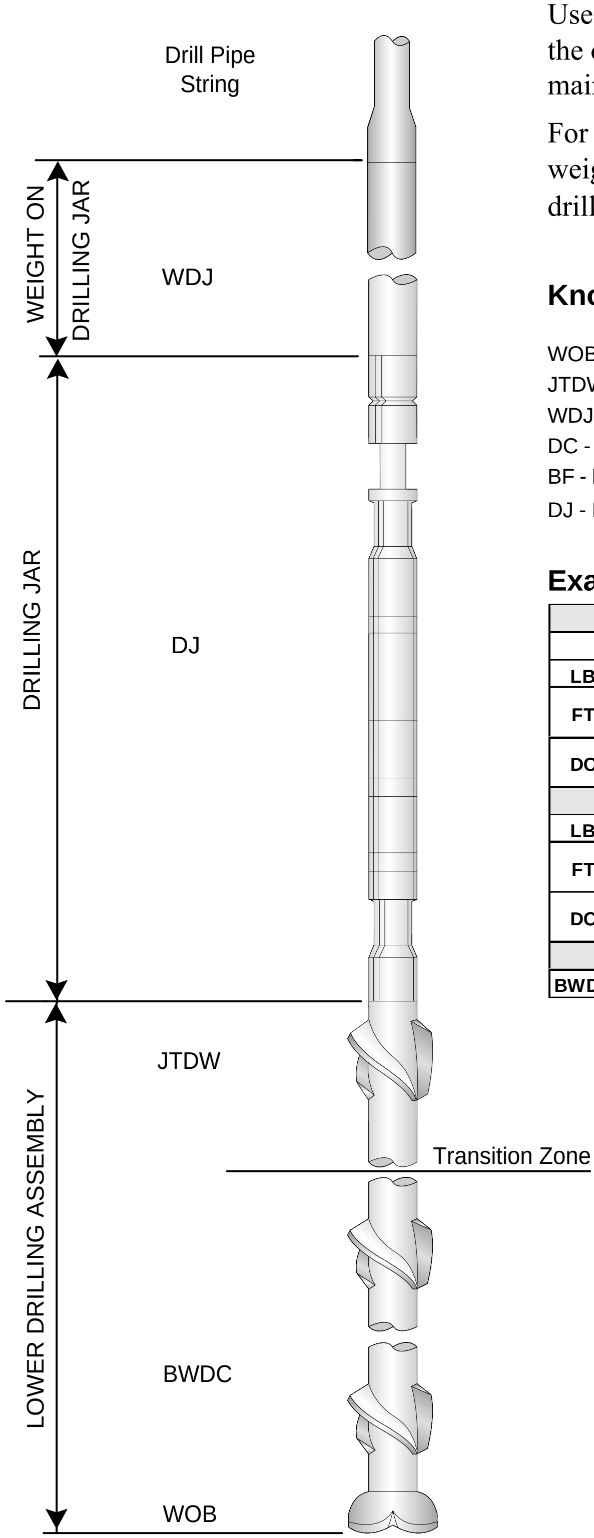


Figure 11

Known Factors

WOB- Desired Weight on Bit (buoyed)	= 40,000 lb
JTDW - Jar Tension Drilling Weight (buoyed)	= 15,000 lb
WDJ - Weight on Drilling Jar (buoyed)	= 10,000 lb
DC - Drill collar in air - 6¼ x 2¼ (90.6 lb/ft)	= 2,718 lb (each)
BF - Buoyancy factor (13 lb/gal) (Table 2)	= 1.25
DJ - Drilling Jar Weight (in air)	= 1,600 lb

Example

Drilling Assembly Above Drilling Jar					
EQUATION (IN AIR)			EXAMPLE		
LB	=	WDJ x BF	10,000 x 1.25	=	12,500 LB
FT	=	WDJ x BF / WT of DC in LB/FT	10,000 x 1.25 / 90.6	=	138 FT
DC	=	WDJ x BF / WT per 30 FT of DC	10,000 x 1.25 / 2,718	=	5 DC
Lower Drilling Assembly (LDA)					
LB	=	[JTDW + WOB] (BF)	[15,000 + 40,000] (1.25)	=	68,750 LB
FT	=	[JTDW + WOB] (BF) / WT of DC in LB/FT	[15,000 + 40,000] (1.25) / 90.6	=	759 FT
DC	=	[JTDW + WOB] (BF) / WT per 30 FT of DC	[15,000 + 40,000] (1.25) / 2,718	=	25 DC
BIT Weight Drill Collar (BWDC)					
BWDC	=	DESIRED WOB (BF)	40,000 x 1.25	=	50,000 LB

Core Drilling

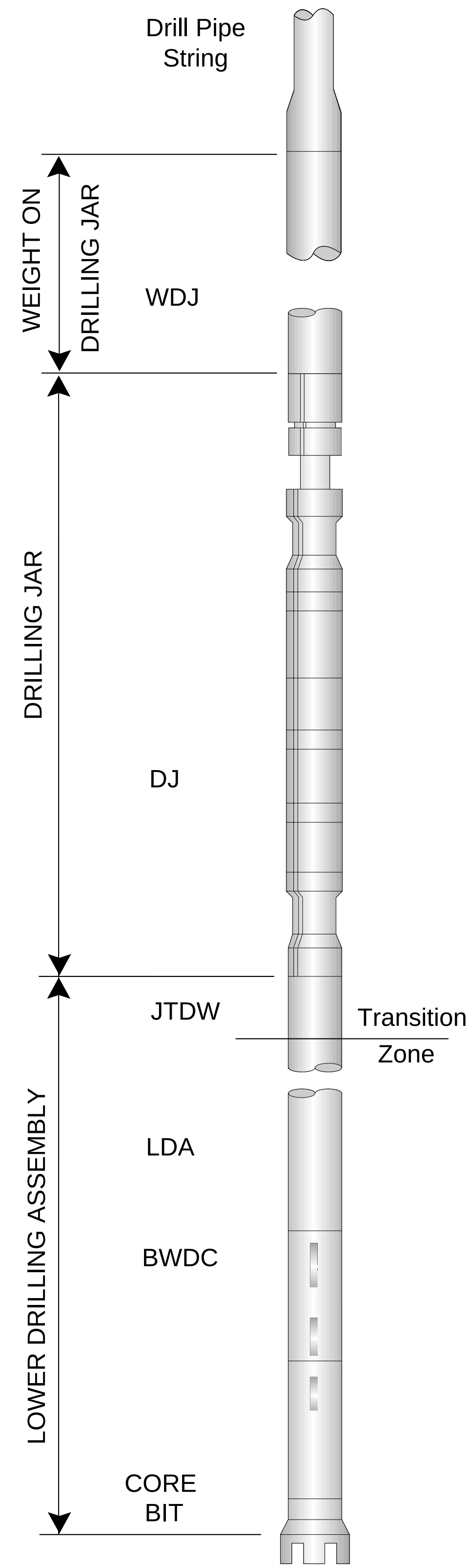


Figure 13

Use the calculations below to place the Hydra-Jar® tool in the optimum position within the drilling assembly, while maintaining the Desired Weight on Bit.

For this example, use the **Known Factors** to calculate weight, length and quantity of drill collars to make up the drilling assembly, in air.

Known Factors

WOCB - Desired Weight on Core Bit (buoyed) = 20,000 lb
JTDW - Jar Tension Drilling Weight (buoyed) = 18,000 lb
WDJ - Weight on Drilling Jar (buoyed) = 10,000 lb
DC - Drill collars - 6¼ x 2¼ (90.6 lb/ft in air) = 2,718 lb (each)
BF - Buoyancy factor (13 lb/gal) = 1.25
DJ - Drilling Jar Weight (in air) = 1,600 lb

Example

Drilling Assembly Above Drilling Jar					
EQUATION (IN AIR)			**EXAMPLE**		
LB	=	WDJ x BF	10,000 x 1.25	=	12,500 LB
FT	=	WDJ x BF / WT of DC in LB/FT	10,000 x 1.25 / 90.6	=	138 FT
DC	=	WDJ x BF / WT per 30 FT of DC	10,000 x 1.25 / 2,718	=	5 DC
Lower Drilling Assembly (LDA)					
LB	=	[JTDW + WOCB] (BF)	[18,000 + 20,000] (1.25)	=	47,500LB
FT	=	[JTDW + WOCB] (BF) / WT of DC in LB/FT	[18,000 + 20,000] (1.25) / 90.6	=	524 FT
DC	=	[JTDW + WOCB] (BF) / WT per 30 FT of DC	[18,000 + 20,000] (1.25) / 2,718	=	17 DC
WEIGHT ON CORE BIT (WOCB)					
WOCB	=	DESIRED WOB x BF	20,000 x 1.25	=	25,000 LB

Directional Drilling

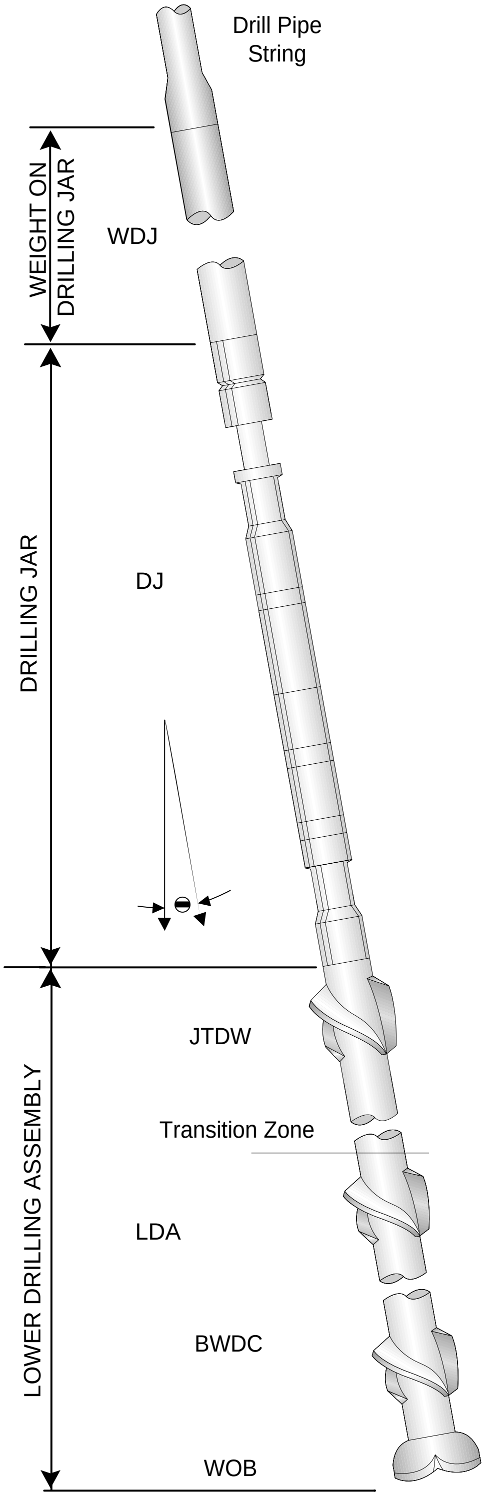


Figure 14

Use the calculations below to place the Hydra-Jar® tool in the optimum position within the drilling assembly, while maintaining the Desired Weight on Bit.

For this example, use the **Known Factors** to calculate weight, length and quantity of drill collars to make up the drilling assembly, in air.

Known Factors

WOB - Weight on Bit (buoyed)	= 45,000 lb
JTDW - Jar Tension Drilling Weight (buoyed)	= 15,000 lb
WDJ - Weight on Drilling Jar (buoyed)	= 10,000 lb
DC - Drill collars - 6¼ x 2¼ 90.6 lb/ft in air)	= 2,718 lb (each)
Hole Angle	= 35°
AF - Hole Angle Factor	= 1.22
BF - Buoyancy Factor (13 lb/gal)	= 1.25
DJ - Drilling Jar Weight (in air)	= 1,600 lb

Example

Drilling Assembly Above Drilling Jar				
EQUATION			EXAMPLE	
LB	=	WDJ x BF	10,000 x 1.25	= 12,500 LB
FT	=	WDJ x BF WT of DC in LB/FT	10,000 x 1.25 90.6	= 138 FT
DC	=	WDJ x BF WT per 30 FT of DC	10,000 x 1.25 2,718	= 5 DC
Lower Drilling Assembly (LDA)				
LB	=	[JTDW + WOB] (BF) (AF)	[15,000 + 45,000] (1.25) (1.22)	= 91,500 LB
FT	=	[JTDW + WOB] (BF) (AF) WT of DC in LB/FT	[15,000 + 45,000] (1.25) (1.22) 90.6	= 1,010 FT
DC	=	[JTDW + WOB] (BF) (AF) WT per 30 FT of DC	[15,000 + 45,000] (1.25) (1.22) 2,718	= 34 DC
BIT Weight Drill Collar (BWDC)				
BWDC	=	WOB (AF) (BF)	45,000 (1.22) (1.25)	= 68,625 LB

Directional Drilling With Motor

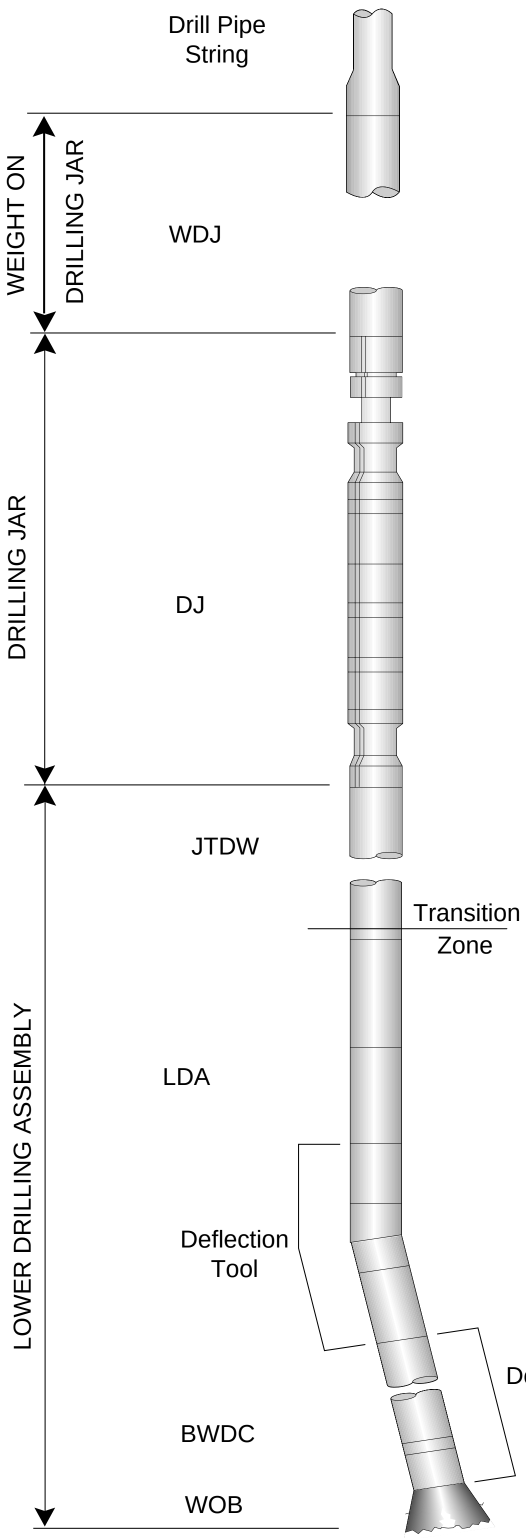


Figure 15

Use the calculations below to place the Hydra-Jar® tool in the optimum position within the drilling assembly, while maintaining the Desired Weight on Bit.

For this example, use the **Known Factors** to calculate weight, length and quantity of drill collars to make up the drilling assembly, in air.

Known Factors

WOB - Weight on Bit (buoyed)	= 30,000 lb
JTDW - Jar Tension Drilling Weight (buoyed)	= 6,000 lb
WDJ - Weight on Drilling Jar (buoyed)	= 10,000 lb
DC - Drill collars - 6¼ x 2¼ (90.6 lb/ft in air)	= 2,718 lb (each)
Hole Angle	= 35°
AF - Hole Angle Factor	= 1.22
BF - Buoyancy Factor (13 lb/gal)	= 1.25
DJ - Drilling Jar (in air)	= 1,600 lb

Example

Drilling Assembly Above Drilling Jar					
		EQUATION	EXAMPLE		
LB	=	WDJ x BF	10,000 x 1.25	=	12,500 LB
FT	=	WDJ x BF / WT of DC in LB/FT	10,000 x 1.25 / 90.6	=	138 FT
DC	=	WDJ x BF / WT per 30 FT of DC	10,000 x 1.25 / 2,718	=	5 DC
Lower Drilling Assembly (LDA)					
LB	=	[JTDW + WOB] (BF) (AF)	[6,000 + 30,000] (1.25) (1.22)	=	54,900 LB
FT	=	[JTDW + WOB] (BF) (AF) / WT of DC in LB/FT	[6,000 + 30,000] (1.25) (1.22) / 90.6	=	606 FT
DC	=	[JTDW + WOB] (BF) (AF) / WT per 30 FT of DC	[6,000 + 30,000] (1.25) (1.22) / 2,718	=	20 DC
BIT Weight Drill Collar (BWDC)					
BWDC	=	WOB (AF) (BF)	30,000 (1.22) (1.25)	=	45,750 LB

Tables & Charts

Table 4
Hydra-Jar® Tool Specifications

Tool O.D. inches (mm)	3-1/8 (79)	3-1/8 (86)	4-1/4 (108)	4-3/4 (121)	4-3/4 (121)	6-1/4 (159)	6-1/2 (165)	7 (178)	7-1/4 (184)	7-3/4 (197)	8 (203)	8-1/4 (210)	8-1/2 (216)	9-1/2 (241)
Tool I.D. inches (mm)	1-1/4 (32)	1-1/2 (38)	2 (51)	2-1/4 (57)	2-1/4 (57)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)
Tool Joint Connections	2-3/8 API REG	2-3/8 API IF	2-7/8 API IF	3-1/2 API IF	3-1/2 API IF	4-1/2 XH	4-1/2 API IF	5 H90	5-1/2 H90	6-5/8 API REG	6-5/8 API REG	6-5/8 API REG	6-5/8 API REG	7-5/8 API REG
Overall Length "Extended" ft-in (mm)	22' 10" (6,969)	24' 5" (7,442)	29' 10" (9,093)	29' 10" (9,093)	29' 10" (9,093)	31' 2" (9,499)	31' 2" (9,499)	31' 6" (9,601)	31' 6" (9,601)	32' (9,754)	32' (9,754)	32' (9,754)	32' (9,754)	32' 6" (9,906)
Max. Detent Working Load lbf (N)	46,000 (204,608)	44,000 (195,712)	70,000 (311,360)	80,000 (355,840)	95,000 (422,560)	150,000 (667,200)	175,000 (778,400)	230,000 (1,023,040)	240,000 (1,067,520)	260,000 (1,156,480)	300,000 (1,334,400)	350,000 (1,556,800)	350,000 (1,556,800)	500,000 (2,224,000)
Tensile Yield Strength lbf (N)	215,000 (956,320)	232,580 (1,034,516)	310,000 (1,378,880)	460,000 (2,046,080)	460,000 (2,046,080)	730,000 (3,247,040)	900,000 (4,003,200)	1,100,000 (4,892,800)	1,200,000 (5,337,600)	1,300,000 (5,782,400)	1,600,000 (7,116,800)	1,700,000 (7,561,600)	1,700,000 (7,561,600)	2,000,000 (8,896,000)
Torsion Yield Strength lbf•ft (N•m)	5,600 (7,592)	6,100 (8,270)	16,000 (21,692)	21,000 (28,470)	21,000 (28,470)	50,000 (67,787)	61,000 (82,700)	65,000 (88,123)	77,000 (104,392)	118,000 (159,978)	118,000 (159,978)	118,000 (159,978)	118,000 (159,978)	200,000 (271,150)
Up Stroke inches (millimeters)	7 (178)	7 (178)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)	8 (203)
Down Stroke inches (millimeters)	7 (178)	7 (178)	7 (178)	7 (178)	7 (178)	7 (178)	7 (178)	8 (203)	8 (203)	7 (178)	7 (178)	8 (203)	8 (203.20)	8 (203.20)
Total Stroke inches (millimeters)	21 (533)	21 (533)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)	25 (635)
Tool Weight lb (kg)	350 (159)	500 (227)	800 (362)	1,050 (476)	1,050 (476)	1,600 (725)	1,850 (839)	2,600 (1,179)	3,000 (1,360)	3,200 (1,451)	3,550 (1,610)	4,000 (1,814)	4,500 (2,041)	5,600 (2,540)

Torsional yield strength is based on the tool joint connection. Tensile yield, torsional yield and maximum overpull values above are calculated per API RP7G utilizing the published yield strength of the material. Further information on these and other specifications is available upon request.

Table 5
Hydra-Jar® Tool and Accelerator® Tool Weight Tables

Tool OD Inches (mm) Tool Joint Connection	3-1/8 OD (79) 2-3/8 API REG	3-3/8 OD (86) 2-3/8 API IF	4-1/4 OD (108) 2-7/8 API IF MOD	4-3/4 OD (121) 3-1/2 API FH-IF	6-1/4 OD (159) 4-1/2 API IF MOD	6-1/2 OD (165) 4-1/2 API IF MOD	7 OD (178) 5 H90	7-1/4 OD (184) 5 H90	7-3/4 OD (197) 6-5/8 API REG	8 OD (203) 6-5/8 API REG	8-1/4 OD (210) 6-5/8 API REG	8-1/2 OD (216) 6-5/8 API REG	9-1/2 OD (241) 7-5/8 API REG
Jar and Accel. Load lbf (N)	Weight of Collars and Quantity of Collars - lb. (kg)												
20,000 (88,960)	4,000 6 (1,814 4)	4,000 5 (1,814 5)	4,000 4 (1,814 4)										
25,000 (111,200)	5,000 9 (2,267 8)	5,000 6 (2,267 6)	5,000 5 (2,267 5)										
30,000 (133,440)	6,000 9 (2,721 9)	6,000 8 (2,721 8)	6,000 6 (2,721 6)										
40,000 (177,920)	8,000 12 (3,628 12)	8,000 10 (3,628 10)	8,000 8 (3,628 8)	8,000 5 (3,628 5)									
50,000 (222,400)			10,000 10 (4,535 10)	10,000 7 (4,535 7)	10,000 4 (4,535 4)	10,000 4 (4,535 4)	10,000 3 (4,535 3)	10,000 3 (4,535 3)					
75,000 (333,600)			15,000 14 (6,803 14)	15,000 10 (6,803 10)	15,000 6 (6,803 6)	15,000 5 (6,803 5)	15,000 5 (6,803 5)	15,000 4 (6,803 4)					
100,000 (444,800)				20,000 13 (9,071 13)	20,000 8 (9,071 8)	20,000 7 (9,071 7)	20,000 6 (9,071 6)	20,000 6 (9,071 6)					
125,000 (556,000)					25,000 10 (11,339 10)	25,000 9 (11,339 9)	25,000 8 (11,339 8)	25,000 7 (11,339 7)	25,000 6 (11,339 6)	25,000 6 (11,339 6)	25,000 5 (11,339 5)	25,000 5 (11,339 5)	
150,000 (667,200)					30,000 12 (13,607 12)	30,000 11 (13,607 11)	30,000 9 (13,607 9)	30,000 8 (13,607 8)	30,000 7 (13,607 7)	30,000 7 (13,607 7)	30,000 6 (13,607 6)	30,000 6 (13,607 6)	30,000 5 (13,607 5)
175,000 (778,400)					35,000 14 (15,875 14)	35,000 13 (15,875 13)	35,000 10 (15,875 10)	35,000 10 (15,875 10)	35,000 9 (15,875 9)	35,000 8 (15,875 8)	35,000 7 (15,875 7)	35,000 7 (15,875 7)	35,000 5 (15,875 5)
200,000 (889,600)							40,000 12 (18,143 12)	40,000 11 (18,143 11)	40,000 10 (18,143 10)	40,000 9 (18,143 9)	40,000 8 (18,143 8)	40,000 8 (18,143 8)	40,000 6 (18,143 6)
250,000 (1,112,000)									50,000 12 (22,679 12)	50,000 11 (22,679 11)	50,000 11 (22,679 11)	50,000 10 (22,679 10)	50,000 8 (22,679 8)
300,000 (1,334,400)									60,000 15 (27,215 15)	60,000 14 (27,215 14)	60,000 13 (27,215 13)	60,000 12 (27,215 12)	60,000 9 (27,215 9)
350,000 (1,556,800)													70,000 11 (31,751 11)
Drill Collar Size Inches (mm) WT/30'	3-1/8 OD (79) 1-1/4 ID (32) 657 lb (298 kg)	3-3/8 OD (86) 1-1/2 ID (38) 732 lb (332 kg)	4-1/4 OD (108) 2-1/4 ID (57) 1,041 lb (472 kg)	4-3/4 OD (120) 2 ID (51) 1,488 lb (674 kg)	6-1/4 OD (159) 2-13/16 ID (71) 2,519 lb (1142 kg)	6-1/2 OD (165) 2-13/16 ID (71) 2,774 lb (1258 kg)	7 OD (178) 2-13/16 ID (71) 3,313 lb (1502 kg)	7-1/4 OD (184) 2-13/16 ID (71) 3,598 lb (1632 kg)	7-3/4 OD (197) 3 ID (76) 4,080 lb (1850 kg)	8 OD (203) 3 ID (76) 4,398 lb (1994 kg)	8-1/4 OD (210) 3 ID (76) 4,723 lb (2142 kg)	8-1/2 OD (216) 3 ID (76) 5,173 lb (2346 kg)	9-1/2 OD (241) 3 ID (76) 6,618 lb (3001 kg)
Impact Blow x1000 lbf (N)	Min: 90 (400) Max: 200 (890)	90 (400) 200 (890)	150 (667) 250 (1112)	180 (800) 300 (1334)	400 (1779) 650 [illegible]	400 (1779) 700 (3113)	450 (2001) 750 (3336)	450 (2001) 750 (3336)	500 (2224) 800 (3558)	500 (2224) 800 (3558)	600 (2668) 900 (4003)	600 (2668) 900 (4003)	1,000 (4448) 2,000 (8896)

This area represents insufficient drill collar weights that cause excessively high impact loads on jar and fishing tools.

This area represents excessive drill collar weights that diminish the efficiency of the jar acceleration effort.

The **Jar Impact Blow** is a product of the Energy Equation:

$$E = 1/2 \frac{W}{g} V^2$$

Where E is the energy available to perform the impact work and accelerates the Jar Weight (W) to the Velocity (V) which is exponential in value.

Table 6
Amplification Factor

Jar Size (inches) OD x ID	Drill Pipe DIA	Drill Pipe LB/FT	Heavy WT Drill Pipe DIA	Heavy WT Drill Pipe LB/FT	Drill Collars DIA	Drill Collars LB/FT	Amplification Factor (M)	L Jar Load (LBF)	F Jar Blow (LBF)
3-1/8 x 1-1/4	2-3/8	6.65	—	—	3-1/8	22.0	2.64	40,000	105,600
3-3/8 x 1-1/2	2-3/8	6.65	—	—	3-3/8	24.4	2.93	40,000	117,200
4-1/4 x 2	2-7/8	6.87	—	—	4-1/4	37.5	4.36	50,000	218,000
		10.40					2.89	50,000	144,000
		13.30	3-1/2	26	—	—	1.56	75,000	117,000
4-3/4 x 2-1/4	3-1/2	15.50	3-1/2	26	—	—	1.34	75,000	101,000
		13.30	—	—	4-3/4	49.5	2.99	75,000	225,000
		15.50	—	—	4-3/4	49.5	2.56	75,000	193,000
		16.60	4-1/2	42	—	—	2.02	100,000	202,000
		20.00	4-1/2	42	—	—	1.68	100,000	168,000
6-1/4 x 2-3/4		16.60	5	50	—	—	2.41	100,000	241,000
	4-1/2	20.00	5	50	—	—	2.00	100,000	200,000
		16.60	—	—	6-1/4	83.9	4.04	100,000	404,000
6-1/2 x 2-3/4		20.00	—	—	6-1/4	83.9	3.35	100,000	335,000
		16.60	—	—	6-1/2	92.5	4.52	100,000	452,000
		20.00	—	—	6-1/2	92.5	3.71	100,000	371,000
	5	19.50	5	50	—	—	2.05	100,000	205,000
		19.50	—	—	6-1/2	92.5	3.80	100,000	380,000
		16.60	5-1/2	57	—	—	2.74	100,000	274,000
	4-1/2	20.00	5-1/2	57	—	—	2.28	100,000	238,000
7 x 2-3/4		16.60	—	—	7	110.5	5.31	100,000	531,000
		20.00	—	—	7-1/4	119.5	4.77	100,000	477,000
7-1/4 x 2-3/4		19.50	5-1/2	57	—	—	2.33	100,000	233,000
	5	19.50	—	—	7	110.5	4.53	100,000	453,000
		19.50	—	—	7-1/4	119.5	4.89	100,000	489,000
	4-1/2	16.60	—	—	7-3/4	136.1	6.56	150,000	987,000
7-3/4 x 3		20.00	—	—	7-3/4	136.1	5.45	150,000	818,000
		19.50	6-5/8	70	—	—	2.87	150,000	430,500
8 x 3	5	19.50	—	—	7-3/4	136.1	5.60	150,000	840,000
		19.50	—	—	8	150.5	6.36	150,000	956,000
		19.50	6-5/8	70	—	—	2.87	150,000	430,500
8-1/4 x 3	5	19.50	—	—	8-1/4	157.5	6.45	150,000	967,500
		19.50	—	—	8-1/2	172.5	7.07	150,000	1,060,500
8-1/2 x 3		21.90	6-5/8	70	—	—	2.55	150,000	382,500
	5-1/2	21.90	—	—	8-1/4	157.5	5.75	150,000	835,500
		21.90	—	—	8-1/2	172.5	6.29	150,000	943,500
		21.90	6-5/8	70	—	—	2.55	150,000	382,500
	5-1/2	21.90	—	—	9	191.9	7.00	150,000	1,050,000
9-1/2 x 3		21.90	—	—	9-1/2	216.6	7.90	150,000	1,185,000
	6-5/8	25.20	6-5/8	70	—	—	2.23	150,000	334,500
		25.20	—	—	9-1/2	216.6	6.86	150,000	1,029,000

Amplification Factor (M) = WT/FT HWDP *or* DC ÷ WT/FT *of* drill pipe x [0.799].
[0.799] = Empirical Factor obtained by comparing theoretical impact calculations to measured impact data.

Example: *Impact Jar Blow (F) = Amplification Factor (M) x Jar Load (L)*

Table 6 shows the ratio of jar weight members to string members in LB/FT to arrive at the Amplification Factor. Locate 6-1/4 x 2-3/4 jar size on Table 6. Find 4-1/2 DIA 16.60 LB/FT drill pipe and 6-1/4 DIA 90.6 LB/FT drill collars for an amplification factor (M) of 4.04.
With a jar load (L) of 100,000 LBF, then jar blow (F) equals 4.04 x 100,000 or 404,000 LBF of Impact Jar Blow.

Hydra-Jar® Tool Fishing Diagram

The fishing diagram and fishing dimensions are used to determine the type and size of equipment needed to recover a Hydar-Jar part lost in the hole.

Figure 16

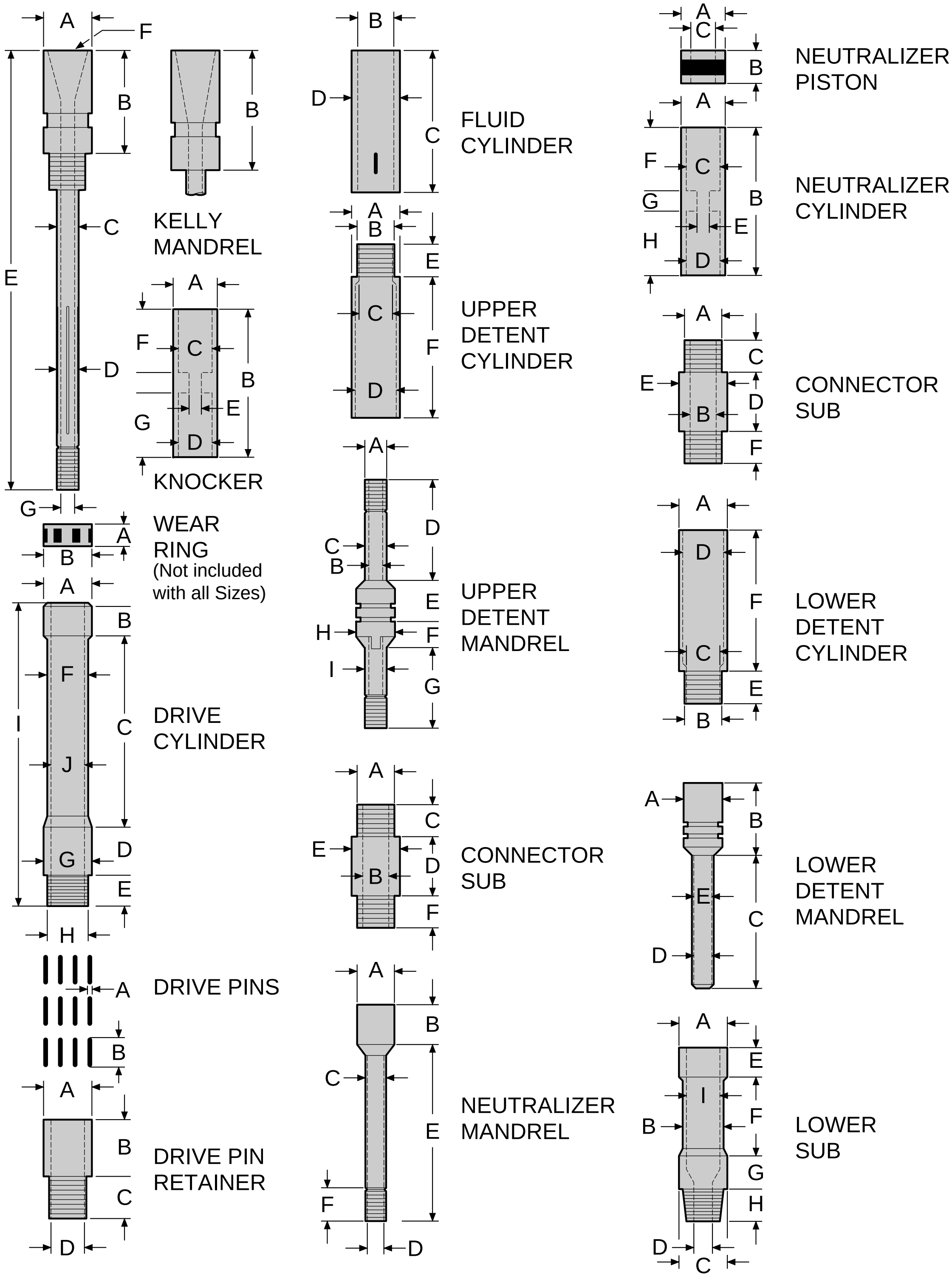


Table 7
Hydra-Jar® Fishing Dimensions—inches (mm)

Dimensions reflect parts that have not been reworked or re-machined.

Tool OD inches (mm)	3-1/8 (79)	3-3/8 (86)	4-1/4 (108)	4-3/4 (121)	4-3/4 (121)	6-1/4 (159)	6-1/2 (165)	7 (178)	7-1/4 (184)	7-3/4 (197)	8 (203)	8-1/4 (210)	8-1/2 (216)	9-1/2 (241)
Tool ID inches (mm)	1-1/4 (32)	1-1/2 (38)	2 (51)	2-1/4 (57)	2-1/4 (57)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)
Working Load lbf (N)	46,000 (204,608)	44,000 (195,712)	70,000 (311,360)	80,000 (355,840)	95,000 (422,560)	150,000 (667,200)	175,000 (778,400)	230,000 (1,023,040)	240,000 (1,067,520)	260,000 (1,156,480)	300,000 (1,334,400)	350,000 (1,556,800)	350,000 (1,556,800)	500,000 (2,224,000)
KELLY MANDREL														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	Not Applicable	Not Applicable	Not Applicable	21-7/16 (544.5)	21-7/16 (544.5)	18-3/8 (466.7)	25-7/16 (646.1)	24-11/32 (618.3)	24-25/64 (619.52)	18 (457.2)	18 (457.2)	17-13/16 (452.4)	17-27/32 (453.2)	24-3/32 (612.0)
B1	16 (406.4)	16 (406.4)	22-5/16 (566.7)	27-5/16 (693.7)	27-5/16 (693.7)	30-1/4 (768.4)	30-1/4 (768.4)	29-1/4 (743.0)	29-1/4 (743.0)	24 (609.6)	24 (609.6)	24 (609.6)	24 (609.6)	Not Applicable
C	2-9/64 (54.4)	2-33/64 (63.9)	3-1/32 (77.0)	3-3/8 (85.7)	3-3/8 (85.7)	4-3/8 (111.1)	4-3/8 (111.1)	4-7/8 (123.8)	4-7/8 (123.8)	5-3/16 (131.8)	5-3/16 (131.8)	6 (152.4)	6 (152.4)	6-3/4 (171.5)
D	2 (50.8)	2-1/4 (57.2)	3 (76.2)	3-5/16 (84.1)	3-5/16 (84.1)	4-5/16 (109.5)	4-5/16 (109.5)	4-5/8 (117.5)	4-5/8 (117.5)	5-1/8 (130.2)	5-1/8 (130.2)	5-1/2 (139.7)	5-1/2 (139.7)	6 (152.4)
E	Not Applicable	Not Applicable	Not Applicable	108-1/2 (2756.0)	108-1/2 (2756.0)	112 (2844.8)	119 (3022.6)	119-5/16 (3030.5)	119-5/16 (3030.5)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	125-3/8 (3184.5)
E1	74-7/8 (1901.8)	81-7/8 (2079.6)	103-3/8 (2625.7)	108-1/2 (2756.0)	108-1/2 (2756.0)	119 (3022.6)	119 (3022.6)	119-5/16 (3030.5)	119-5/16 (3030.5)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	Not Applicable
F	2-5/8 REG	2-3/8 I.F.	2-7/8 I.F.	3-1/2 I.F.	3-1/2 I.F.	4-1/2 I.F.	4-1/2 I.F.	4-1/2 I.F.	5 H-90	6-7/8 REG	6-7/8 REG	6-5/8 REG	6-5/8 REG	7-5/8 REG
G	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
WEAR RING														
A	Not Applicable	Not Applicable	Not Applicable	6 (152.4)	6 (152.4)	5 (127.0)	5 (127.0)	5-1/16 (128.6)	5-1/16 (128.6)	6-3/8 (161.9)	6-3/8 (161.9)	6-1/2 (165.1)	6-1/2 (165.1)	7-1/2 (190.5)
B	Not Applicable	Not Applicable	Not Applicable	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-5/8 (244.5)
DRIVE CYLINDER														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8,)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9,)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	5 (127.0)	8-3/8 (212.7)	7-7/8 (200.0)	7-7/8 (200.0)	7-7/8 (200.0)	7-7/8 (200.0)	7-7/8 (200.0)	9-5/16 (236.5)	9-5/16 (236.5)	7-7/8 (200.0)	7-7/8 (200.0)	9-7/8 (250.8)	9-25/32 (248.4)	12-1/2 (317.5)
C	14 (355.6)	13-17/32 (343.7)	22-3/4 (577.9)	22-3/4 (577.9)	22-3/4 (577.9)	24-1/2 (622.3)	24-1/2 (622.3)	22-63/64 (583.8)	22-63/64 (583.8)	20 (508.0)	20 (508.0)	18 (457.2)	18-3/32 (459.58)	25-1/2 (647.0)
D	4-5/8 (117.5)	3-3/8 (85.7)	9-3/8 (238.1)	9-3/8 (238.1)	9-3/8 (238.1)	16-1/2 (419.1)	16-1/2 (419.1)	8-3/64 (204.4)	8-3/64 (204.4)	9-1/2 (241.3)	9-1/2 (241.3)	13-41/64 (346.5)	13-11/16 (347.7)	7-19/64 (185.3)
E	3-3/4 (95.3)	3-3/4 (95.3)	4-7/8 (123.8)	5-15/32 (138.9)	5-15/32 (138.9)	5-7/8 (149.2)	5-7/8 (149.2)	5-53/64 (148.0)	5-25/32 (146.8)	7-13/32 (188.1)	7-13/32 (188.1)	7-23/64 (186.9)	7-5/16 (185.7)	7-19/32 (192.9)
F	2-7/8 (73.0)	3-1/8 (79.4)	3-5/8 (92.1)	4-1/8 (104.8)	4-1/8 (104.8)	5-1/2 (139.7)	5-1/2 (139.7)	6 (152.4)	6 (152.4)	6-1/2 (165.1)	6-1/2 (165.1)	7-1/2 (190.5)	7-1/2 (190.5)	8-3/4 (222.3)
G	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8,)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
H	2-5/8 (66.7)	2-7/8 (73.0)	3-3/4 (95.3)	4-1/8 (104.8)	4-1/8 (104.8)	5-5/8 (142.9)	5-5/8 (142.9)	6-1/8 (155.6)	6-1/8 (155.6)	6-7/8 (174.6)	6-7/8 (174.6)	7-1/8 (181.0)	7-1/8 (181.0)	7-3/4 (196.9)
I	27-3/8 (695.3)	31-3/8 (796.9)	44-7/8 (1139.8)	44-7/8 (1139.8)	44-7/8 (1139.8)	48-7/16 (1230.3)	48-7/16 (1230.3)	48-7/8 (1241.4)	48-7/8 (1241.4)	48-7/8 (1241.4)	48-7/8 (1241.4)	48-7/8 (1241.4)	48-7/8 (1241.4)	52-7/8 (1343.1)
J	2-9/64 (54.4)	2-17/32 (64.3)	3-1/32 (77.0)	3-25/64 (86.1)	3-25/64 (86.1)	4-13/32 (111.9)	4-13/32 (111.9)	4-29/32 (124.6)	4-29/32 (124.6)	5-13/64 (132.2)	5-13/64 (132.2)	6-1/32 (153.2)	6-1/32 (153.2)	6-25/32 (172.2)
DRIVE PINS														
A	3/8 (9.5)	5/16 (7.9)	3/8 (9.5)	3/8 (9.5)	3/8 (9.5)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	3/4 (19.1)	1 (25.4)
B	5 (127.0)	5 (127.0)	5 (127.0)	5 (127.0)	5 (127.0)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)	6 (152.4)
DRIVE PIN RETAINER SUB														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8,)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	10-15/64 (259.9)	10-17/64 (260.8)	6-1/8 (155.6)	7-1/32 (178.6)	7-1/32 (178.6)	8-7/8 (225.4)	8-7/8 (225.4)	8-59/64 (226.6)	8-61/64 (227.4)	10 (254.0)	10 (254.0)	10-3/4 (273.1)	10 (254.0)	10-7/32 (256.6)
C	3-3/4 (95.3)	3-3/4 (95.3)	5-1/4 (133.4)	4-31/32 (126.2)	4-31/32 (126.2)	6 (152.4)	6 (152.4)	6-61/64 (176.6)	6-29/32 (175.4)	6 (152.4)	6 (152.4)	5-61/64 (151.2)	5-29/32 (150.0)	8-7/32 (208.8)
D	2-1/64 (51.2)	2-7/8 (73.0)	3-1/32 (77.0)	3-11/32 (84.9)	3-11/32 (84.9)	4-21/64 (109.9)	4-21/64 (109.9)	4-21/32 (118.3)	4-21/32 (118.3)	5-1/4 (133.4)	5-1/4 (133.4)	5-5/8 (142.9)	5-5/8 (142.9)	6-1/16 (154.0)

Table 7 (continued)
Hydra-Jar® Fishing Dimensions—inches (mm)

Dimensions reflect parts that have not been reworked or re-machined.

Tool OD inches (mm)	3-1/8 (79)	3-3/8 (86)	4-1/4 (108)	4-3/4 (121)	4-3/4 (121)	6-1/4 (159)	6-1/2 (165)	7 (178)	7-1/4 (184)	7-3/4 (197)	8 (203)	8-1/4 (210)	8-1/2 (216)	9-1/2 (241)
Tool ID inches (mm)	1-1/4 (32)	1-1/2 (38)	2 (51)	2-1/4 (57)	2-1/4 (57)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)
Working Load lbf (N)	46,000 (204,608)	44,000 (195,712)	70,000 (311,360)	80,000 (355,840)	95,000 (422,560)	150,000 (667,200)	175,000 (778,400)	230,000 (1,023,040)	240,000 (1,067,520)	260,000 (1,156,480)	300,000 (1,334,400)	350,000 (1,556,800)	350,000 (1,556,800)	500,000 (2,224,000)
FLUID CYLINDER														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	2-17/32 (64.3)	2-3/8 (69.9)	3-5/8 (92.1)	4 (101.6)	4 (101.6)	5-29/64 (138.51)	5-29/64 (138.51)	5-7/8 (149.2)	5-7/8 (149.2)	6-5/8 (168.3)	6-5/8 (168.3)	6-7/8 (174.6)	6-7/8 (174.6)	7-5/16 (185.7)
C	43-3/4 (1111.3)	55-5/8 (1412.9)	52-7/16 (1331.9)	51-1/8 (1298.6)	51-1/8 (1298.6)	54-5/8 (1387.8)	54-5/8 (1387.8)	55-15/16 (1420.8)	55-15/16 (1420.8)	60-3/4 (1543.1)	60-3/4 (1543.1)	60-3/4 (1543.1)	60-3/4 (1543.1)	60 (1524.0)
DETENT CYLINDER & UPPER DETENT CYLINDER														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9,)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	2-5/8 (66.7)	2-7/8 (73.0)	3-3/4 (95.3)	4-1/8 (104.8)	4-1/8 (104.8)	5-5/8 (142.9)	5-5/8 (142.9)	6-1/8 (155.6)	6-1/8 (155.6)	6-7/8 (174.6)	6-7/8 (174.6)	7-1/8 (181.0)	7-1/8 (181.0)	7-3/4 (196.9)
C	1-53/64 (46.4)	2-5/64 (52.8)	2-17/32 (64.3)	2-51/64 (71.0)	2-53/64 (71.8)	3-33/64 (89.3)	3-33/64 (89.3)	3-49/64 (95.7)	3-49/64 (95.7)	4-35/64 (115.5)	4-35/64 (115.5)	4-35/64 (115.5)	4-35/64 (115.5)	5-1/32 (127.8)
D	2-15/32 (62.7)	2-7/8 (73.0)	3-1/2 (88.9)	3-7/8 (98.4)	3-15/16 (100.0)	5 (127.0)	5 (127.0)	5-1/2 (139.7)	5-1/2 (139.7)	6-3/8 (161.9)	6-3/8 (161.9)	6-3/8 (161.9)	6-3/8 (161.9)	7-1/4 (184.2)
E	3-3/4 (95.3)	4-3/8 (111.1)	4-31/32 (126.2)	4-31/32 (126.2)	4-31/32 (126.2)	5-3/4 (146.1)	5-3/4 (146.1)	6-1/8 (155.6)	6-5/64 (154.4)	7 (177.8)	7 (177.8)	6-61/64 (176.6)	6-29/32 (175.4)	8-7/32 (208.8)
F	34-1/2 (876.3)	38-1/2 (977.9)	52-17/32 (1334.3)	52-17/32 (1334.3)	52-17/32 (1334.3)	54-9/16 (1385.9)	54-9/16 (1385.9)	54-5/8 (1387.5)	54-43/64 (1388.7)	54-7/8 (1393.8)	54-7/8 (1393.8)	54-59/64 (1395.0)	54-31/32 (1396.2)	57-29/32 (1470.8)
UPPER DETENT MANDREL														
A	1-49/64 (44.9)	2-1/64 (51.2)	2-1/2 (63.5)	2-3/4 (69.9)	2-3/4 (69.9)	3-7/16 (87.31)	3-7/16 (87.31)	3-1/2 (88.9)	3-1/2 (88.9)	4-1/2 (114.3)	4-1/2 (114.3)	4-1/4 (108.0)	4-1/4 (108.0)	4-3/4 (120.7)
B	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
C	1-13/16 (46.0)	2-1/16 (52.4)	2-33/64 (63.9)	2-49/64 (70.3)	2-13/16 (71.4)	3-1/2 (88.9)	3-1/2 (88.9)	3-3/4 (95.3)	3-3/4 (95.3)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	5 (127.0)
D	40 (1016.0)	47-23/32 (1212.1)	48-7/16 (1230.3)	47-3/8 (1203.3)	47-3/8 (1203.3)	49 (1244.6)	49 (1244.6)	49-1/64 (1245.0)	49-1/64 (1245.0)	53-3/8 (1355.7)	53-3/8 (1355.7)	59-3/8 (1508.1)	59-3/8 (1508.1)	52-3/4 (1339.9)
E	3-5/8 (92.1)	2-5/8 (66.7)	5 (127.0)	5 (127.0)	5 (127.0)	5-1/2 (139.7)	5-1/2 (139.7)	5-1/2 (139.7)	5-1/2 (139.7)	6 (152.4)	6 (152.4)	3-1/2 (88.9)	3-1/2 (88.9)	5-5/8 (142.9)
F	2-3/16 (55.6)	2-3/16 (55.6)	2-7/8 (73.0)	2-7/8 (73.0)	2-7/8 (73.0)	3 (76.2)	3 (76.2)	2 (50.8)	2 (50.8)	3-1/2 (88.9)	3-1/2 (88.9)	1-1/2 (38.1)	1-1/2 (38.1)	2-7/8 (73.0)
G	13-3/8 (339.7)	14-23/32 (373.9)	18 (457.2)	18 (457.2)	18 (457.2)	20 (508.0)	20 (508.0)	20 (508.0)	20 (508.0)	21-9/16 (547.7)	21-9/16 (547.7)	21-9/16 (547.7)	21-9/16 (547.7)	22-1/16 (560.4)
H	2-13/32 (61.1)	2-21/32 (67.5)	3-3/8 (85.7)	3-3/4 (95.3)	3-3/4 (95.3)	4-3/4 (120.7)	4-3/4 (120.7)	5-3/8 (136.5)	5-3/8 (136.5)	6-1/8 (155.6)	6-1/8 (155.6)	6-1/8 (155.6)	6-1/8 (155.6)	7 (177.8)
I	1-13/16 (46.0)	2-1/16 (52.4)	2-33/64 (63.9)	2-49/64 (70.3)	2-3/4 (69.9)	3-1/2 (88.9)	3-1/2 (88.9)	3-3/4 (95.3)	3-3/4 (95.3)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	5 (127.0)
CONNECTOR SUB														
A	2-5/8 (66.7)	2-7/8 (73.0)	3-3/4 (95.3)	4-1/8 (104.8)	4-1/8 (104.8)	5-7/8 (149.2)	5-7/8 (149.2)	6-1/8 (155.6)	6-1/8 (155.6)	6-7/8 (174.6)	6-7/8 (174.6)	6-7/8 (174.6)	6-7/8 (174.6)	7-3/4 (196.9)
B	2-3/32 (53.2)	2-11/32 (59.5)	2-63/64 (75.8)	3-3/8 (85.7)	3-3/8 (85.7)	4-1/2 (114.3)	4-1/2 (114.3)	4-1/2 (114.3)	4-1/2 (114.3)	5-1/2 (139.7)	5-1/2 (139.7)	4-7/8 (123.8)	4-7/8 (123.8)	5-3/8 (136.5)
C	3-3/4 (95.3)	3-3/4 (95.3)	4-31/32 (126.2)	4-31/32 (126.2)	4-31/32 (126.2)	5-7/8 (149.2)	5-7/8 (149.2)	5-53/64 (148.0)	5-25/32 (146.8)	6-1/2 (165.1)	6-1/2 (165.1)	6-13/32 (162.7)	6-23/64 (161.5)	6-63/64 (177.4)
D	8 (203.2)	8 (203.2)	7-1/16 (179.4)	7-1/16 (179.4)	7-1/16 (179.4)	9-1/8 (231.8)	9-1/8 (231.8)	9-7/32 (234.2)	9-19/64 (236.1)	10 (254.0)	10 (254.0)	10-11/64 (258.4)	10-17/64 (260.8)	9-13/32 (238.9)
E	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (196.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
F	3-3/4 (95.3)	3-3/4 (95.3)	4-31/32 (126.2)	4-31/32 (126.2)	4-31/32 (126.2)	5-7/8 (149.2)	5-7/8 (149.2)	5-53/64 (148.0)	5-25/32 (146.8)	6-1/2 (165.1)	6-1/2 (165.1)	6-13/32 (162.7)	6-23/64 (161.5)	6-63/64 (177.4)

Table 7 (continued)
Hydra-Jar® Fishing Dimensions—inches (mm)

Dimensions reflect parts that have not been reworked or re-machined.

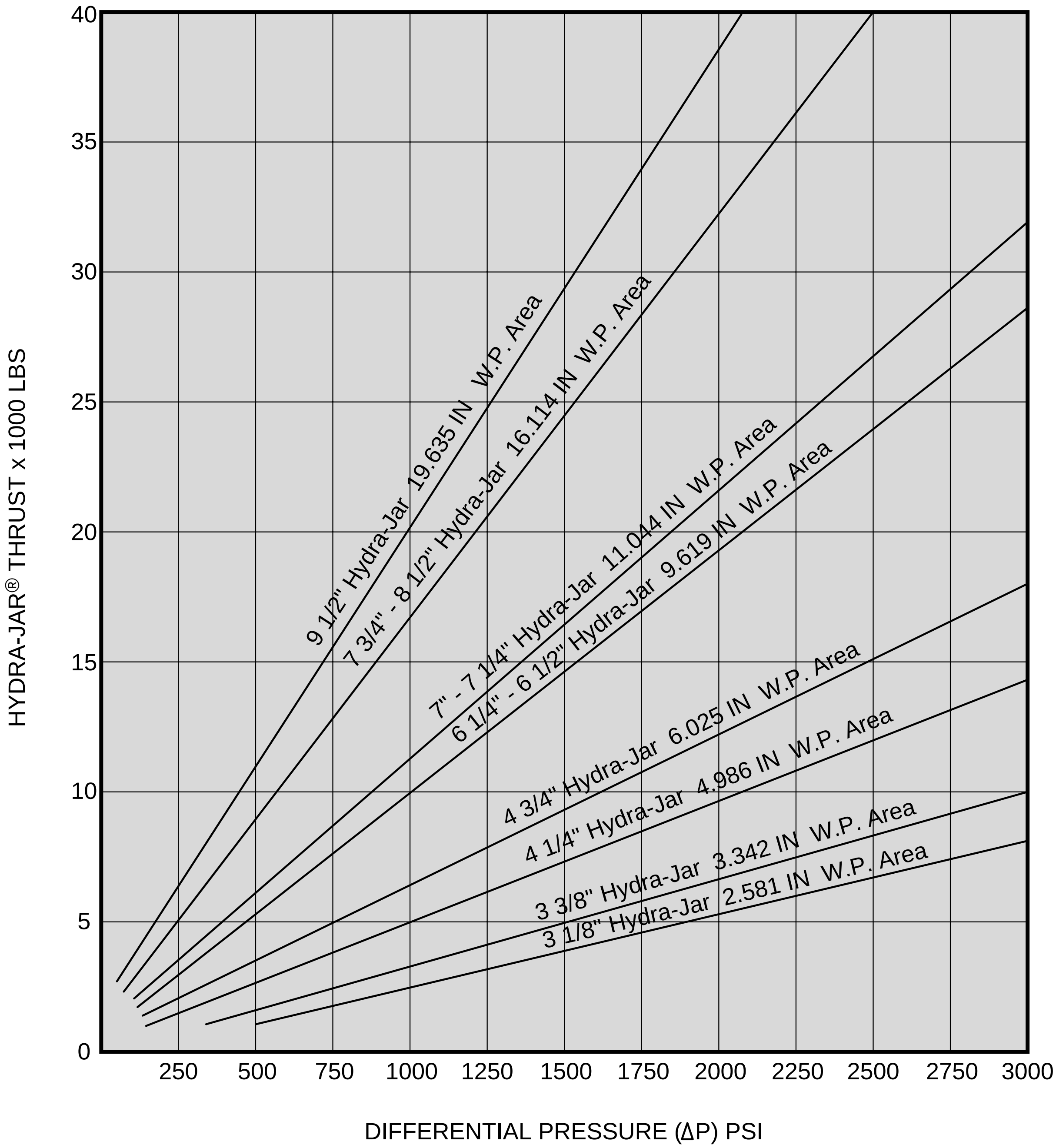
Tool OD inches (mm)	3-1/8 (79)	3-3/8 (86)	4-1/4 (108)	4-3/4 (121)	4-3/4 (121)	6-1/4 (159)	6-1/2 (165)	7 (178)	7-1/4 (184)	7-3/4 (197)	8 (203)	8-1/4 (210)	8-1/2 (216)	9-1/2 (241)
Tool ID inches (mm)	1-1/4 (32)	1-1/2 (38)	2 (51)	2-1/4 (57)	2-1/4 (57)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)
Working Load lbf (N)	46,000 (204,608)	44,000 (195,712)	70,000 (311,360)	80,000 (355,840)	95,000 (422,560)	150,000 (667,200)	175,000 (778,400)	230,000 (1,023,040)	240,000 (1,067,520)	260,000 (1,156,480)	300,000 (1,334,400)	350,000 (1,556,800)	350,000 (1,556,800)	500,000 (2,224,000)
NEUTRALIZER MANDREL														
A	2 (50.8)	2-1/4 (57.2)	2-7/8 (73.0)	3-5/16 (84.1)	3-5/16 (84.1)	4-3/8 (111.1)	4-3/8 (111.1)	4-3/8 (111.1)	4-3/8 (111.1)	5-1/4 (133.4)	5-1/4 (133.4)	4-3/4 (120.7)	4-3/4 (120.7)	5-1/4 (133.4)
B	7-1/2 (190.5)	7-21/32 (194.8)	7-7/16 (188.9)	7-1/8 (181.0)	7-1/8 (181.0)	7-1/16 (179.4)	7-1/16 (179.4)	8-9/32 (210.3)	8-9/32 (210.3)	8-5/8 (219.1)	8-5/8 (219.1)	6-1/2 (165.1)	6-1/2 (165.1)	9-1/8 (231.8)
C	1-13/16 (46.1)	2-1/16 (52.4)	2-33/64 (63.9)	2-49/64 (70.3)	2-49/64 (70.3)	3-1/2 (88.9)	3-1/2 (88.9)	3-3/4 (95.3)	3-3/4 (95.3)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	5 (127.0)
D	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
E	62-9/16 (1589.1)	62-9/16 (1589.1)	85 (2159.0)	87-3/4 (2228.9)	87-3/4 (2228.9)	93-15/16 (2386.0)	93-15/16 (2386.0)	92-23/32 (2355.1)	92-23/32 (2355.1)	99-5/8 (2530.5)	99-5/8 (2530.5)	98-1/4 (2495.6)	98-1/4 (2495.6)	94-3/8 (2397.1)
F	2-13/32 (61.1)	2-13/32 (61.1)	3-11/16 (93.7)	3-11/16 (93.7)	3-11/16 (93.7)	4-1/4 (198.0)	4-1/4 (198.0)	4-27/64 (112.3)	4-27/64 (112.3)	5-3/32 (129.4)	5-3/32 (129.4)	5 (127.0)	5 (127.0)	5 (127.0)
NEUTRALIZER PISTON														
A	2-31/64 (63.1)	2-47/64 (69.5)	3-39/64 (91.7)	3-63/64 (101.2)	3-63/64 (101.2)	5-23/64 (136.1)	5-23/64 (136.1)	5-47/64 (145.7)	5-47/64 (145.7)	6-31/64 (164.7)	6-31/64 (164.7)	6-31/64 (164.7)	6-31/64 (164.7)	7-23/64 (186.9)
B	3 (76.2)	3 (76.2)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)	4 (101.6)
C	1-53/64 (46.4)	2-5/64 (52.8)	2-17/32 (64.3)	2-51/64 (71.0)	2-51/64 (71.0)	3-33/64 (89.3)	3-33/64 (89.3)	3-49/64 (95.7)	3-49/64 (95.7)	4-35/64 (115.5)	4-35/64 (115.5)	4-35/64 (115.5)	4-35/64 (115.5)	5-1/64 (127.4)
NEUTRALIZER CYLINDER														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8,)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (195.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	32-5/8 (828.7)	28-5/8 (727.1)	45-1/4 (1149.4)	45-5/16 (1150.9)	45-5/16 (1150.9)	46-3/8 (1177.9)	46-3/8 (1177.9)	46-3/8 (1177.9)	46-3/8 (1177.9)	50-1/4 (1276.4)	50-1/4 (1276.4)	50-1/4 (1276.4)	50-1/4 (1276.4)	47 (1193.8)
C	2-1/2 (63.5)	2-3/4 (69.9)	3-5/8 (92.1)	4 (101.6)	4 (101.6)	5-3/8 (136.5)	5-3/8 (136.5)	5-3/4 (146.1)	5-3/4 (146.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	7-3/8 (187.3)
D	2-1/2 (63.5)	2-3/4 (69.9)	3-5/8 (92.1)	4 (101.6)	4 (101.6)	5-3/8 (136.5)	5-3/8 (136.5)	5-3/4 (146.1)	5-3/4 (146.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	7-3/8 (187.3)
E	1-15/16 (49.2)	2-3/16 (55.6)	3 (76.2)	3 (76.2)	3 (76.2)	4 (101.6)	4 (101.6)	5 (127.0)	5 (127.0)	4-3/4 (120.7)	4-3/4 (120.7)	5-1/2 (139.7)	5-1/2 (139.7)	6-1/2 (165.1)
F	14-13/16 (376.2)	12-13/16 (325.4)	21-3/4 (552.5)	21-3/4 (552.5)	21-3/4 (552.5)	22-5/16 (566.7)	22-5/16 (566.7)	21-3/16 (538.2)	20-1/8 (511.2)	24-1/8 (612.8)	24-1/8 (612.8)	23-1/8 (587.4)	23-1/8 (587.4)	22-1/2 (571.5)
G	3 (76.2)	3 (76.2)	1-3/4 (44.5)	1-13/16 (46.0)	1-13/16 (46.0)	1-3/4 (44.5)	1-3/4 (44.5)	4 (101.6)	4 (101.6)	2 (50.8)	2 (50.8)	4 (101.6)	4 (101.6)	2 (50.8)
H	14-13/16 (376.2)	12-13/16 (325.4)	21-3/4 (552.5)	21-3/4 (552.5)	21-3/4 (552.5)	22-5/16 (566.7)	22-5/16 (566.7)	21-3/16 (538.2)	20-1/8 (511.2)	24-1/8 (612.8)	24-1/8 (612.8)	23-1/8 (587.4)	23-1/8 (587.4)	22-1/2 (571.5)
LOWER DETENT CYLINDER														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (165.1)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (195.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	2-5/8 (66.7)	2-7/8 (73.0)	3-3/4 (95.3)	4-1/8 (104.8)	4-1/8 (104.8)	5-5/8 (142.9)	5-5/8 (142.9)	5-3/4 (146.1)	5-3/4 (146.1)	6-7/8 (174.6)	6-7/8 (174.6)	6-7/8 (174.6)	6-7/8 (174.6)	7-3/4 (196.9)
C	1-53/64 (46.4)	2-5/64 (52.8)	2-17/32 (64.3)	2-51/64 (71.0)	2-51/64 (71.0)	3-33/64 (89.3)	3-33/64 (89.3)	3-49/64 (95.7)	3-49/64 (95.7)	4-35/64 (115.6)	4-35/64 (115.6)	4-35/64 (115.5)	4-35/64 (115.5)	5-1/32 (127.8)
D	2-15/32 (62.7)	2-49/64 (70.3)	3-1/2 (88.9)	3-7/8 (98.4)	3-7/8 (98.4)	5 (127.0)	5 (127.0)	5-1/2 (139.7)	5-1/2 (139.7)	6-3/8 (161.9)	6-3/8 (161.9)	6-3/8 (161.9)	6-3/8 (161.9)	7-1/4 (184.2)
E	3-3/4 (95.3)	4-3/8 (111.1)	4-31/32 (126.2)	4-31/32 (126.2)	4-31/32 (126.2)	5-3/4 (146.1)	5-3/4 (146.1)	6-1/8 (155.6)	6-5/64 (154.4)	7 (177.8)	7 (177.8)	6-61/64 (176.6)	6-29/64 (163.9)	8-7/32 (208.8)
F	34-1/2 (876.3)	31-5/8 (803.3)	52-17/32 (1334.3)	52-17/32 (1334.3)	52-17/32 (1334.3)	54-9/16 (1385.9)	54-9/16 (1385.9)	54-5/8 (1387.8)	54-43/64 (1388.7)	54-7/8 (1393.8)	54-7/8 (1393.8)	54-59/64 (1395.0)	54-31/32 (1396.2)	57-29/32 (1470.8)

Table 7 (continued)
Hydra-Jar® Fishing Dimensions—inches (mm)

Dimensions reflect parts that have not been reworked or re-machined.

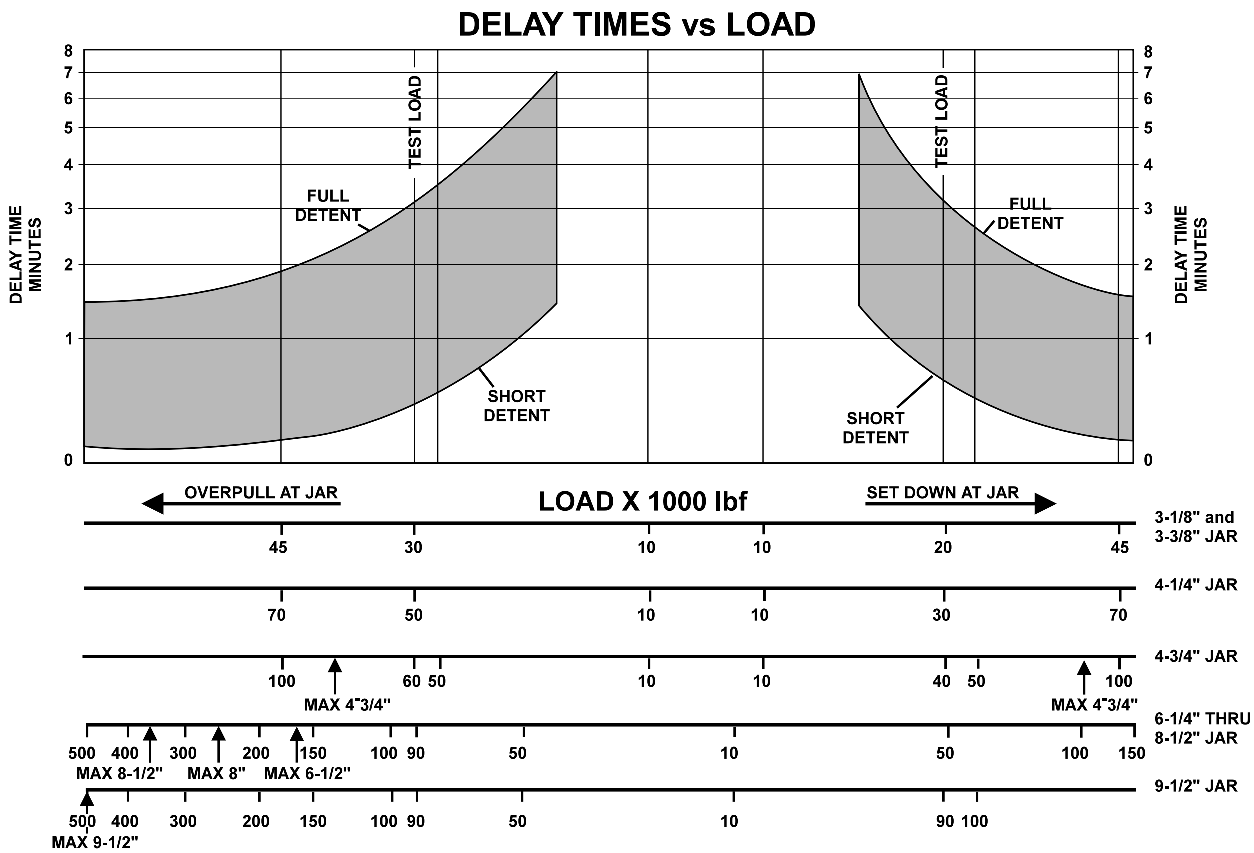
Tool OD inches (mm)	3-1/8 (79)	3-3/8 (86)	4-1/4 (108)	4-3/4 (121)	4-3/4 (121)	6-1/4 (159)	6-1/2 (165)	7 (178)	7-1/4 (184)	7-3/4 (197)	8 (203)	8-1/4 (210)	8-1/2 (216)	9-1/2 (241)
Tool ID inches (mm)	1-1/4 (32)	1-1/2 (38)	2 (51)	2-1/4 (57)	2-1/4 (57)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	2-3/4 (70)	3 (76)	3 (76)	3 (76)	3 (76)	3 (76)
Working Load lbf (N)	46,000 (204,608)	44,000 (195,712)	70,000 (311,360)	80,000 (355,840)	95,000 (422,560)	150,000 (667,200)	175,000 (778,400)	230,000 (1,023,040)	240,000 (1,067,520)	260,000 (1,156,480)	300,000 (1,334,400)	350,000 (1,556,800)	350,000 (1,556,800)	500,000 (2,224,000)
LOWER DETENT MANDREL														
A	2-13/32 (61.1)	2-21/32 (67.5)	3-3/8 (85.7)	3-3/8 (85.7)	3-3/8 (85.7)	4-3/4 (120.7)	4-3/4 (120.7)	5-1/4 (133.4)	5-1/4 (133.4)	6-1/8 (155.6)	6-1/8 (155.6)	6-1/8 (155.6)	6-1/8 (155.6)	6-7/8 (175.6)
B	7-11/16 (195.3)	4-1/16 (103.2)	12 (304.8)	10-1/2 (266.7)	10-1/2 (266.7)	12-3/8 (314.3)	12-3/8 (314.3)	8-15/32 (215.1)	13-31/32 (354.8)	13 (330.2)	13 (330.2)	8-1/2 (215.9)	8-1/2 (215.9)	13-1/4 (336.6)
C	27-3/4 (704.9)	35-9/32 (896.1)	41-1/2 (1054.1)	42 (1066.8)	42 (1066.8)	42 (1066.8)	42 (1066.8)	45-29/32 (1166.1)	40-13/32 (1026.3)	41-3/4 (1060.5)	41-3/4 (1060.5)	40-1/4 (1022.4)	40-1/4 (1022.4)	43-5/8 (1108.1)
D	1-13/16 (46.0)	2-1/16 (52.4)	2-33/64 (63.9)	2-49/64 (70.3)	2-49/64 (70.3)	3-1/2 (88.9)	3-1/2 (88.9)	3-3/4 (95.3)	3-3/4 (95.3)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	4-17/32 (115.1)	5 (127.0)
E	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
LOWER SUB														
A	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	61/4 (158.8)	61/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (195.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
B	2-7/8 (73.0)	3-1/8 (79.4)	3-3/4 (95.3)	4 (101.6)	4 (101.6)	5 (127.0)	5 (127.0)	5-1/2 (139.7)	5-1/2 (139.7)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	8-1/2 (215.9)
C	3-1/8 (79.4)	3-3/8 (85.7)	4-1/4 (108.0)	4-3/4 (120.7)	4-3/4 (120.7)	6-1/4 (158.8,)	6-1/2 (165.1)	7 (177.8)	7-1/4 (184.2)	7-3/4 (195.9)	8 (203.2)	8-1/4 (209.6)	8-1/2 (215.9)	9-1/2 (241.3)
D	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
E	5 (127.0)	7-1/4 (184.2)	7-5/8 (193.7)	12-3/4 (323.9)	12-3/4 (323.9)	12-5/32 (308.9)	11-3/4 (298.5)	11-3/4 (298.5)	11-23/64 (288.5)	12 (304.8)	11-9/16 (293.7)	11-9/16 (293.7)	14-5/16 (363.5)	11-3/4 (298.5)
F	18-1/2 (38.11)	18 (457.2)	23-7/8 (606.4)	19 (482.6)	19 (482.6)	17-7/16 (442.9)	17-13/16 (452.4)	17-13/16 (452.4)	18-13/64 (462.5)	18 (457.2)	15-7/8 (4033..2)	18-7/16 (468.3)	19-13/64 (487.8)	18 (457.2)
G	39-1/2 (1003)	41-1/2 (1054)	47-3/4 (1213)	47-3/4 (1213)	47-3/4 (1213)	58 (1473)	58 (1473)	58 (1473)	58 (1473)	50 (1270)	50 (1270)	50 (1270)	50 (1270)	51 (1295)
H	1-15/16 (49.2)	2-3/16 (55.6)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3-3/4 (95.3)	3-3/4 (95.3)	4 (101.6)	4 (101.6)	4-3/4 (120.7)	4-3/4 (120.7)	4-3/4 (120.7)	4-3/4 (120.7)	5-1/8 (130.2)
KNOCKER														
A	2-1/2 (63.5)	2-47/64 (69.5)	3-9/16 (90.5)	3-7/8 (98.4)	3-7/8 (98.4)	5-1/4 (133.4)	5-1/4 (133.4)	5-3/4 (146.1)	5-3/4 (146.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-3/4 (171.5)	6-3/4 (171.5)	7-1/8 (181.0)
B	7-1/8 (181.0)	7-1/8 (181.0)	10-3/8 (263.5)	10-3/8 (263.5)	10-3/8 (263.5)	11-7/8 (301.6)	11-7/8 (301.6)	12-5/8 (320.7)	12-5/8 (320.7)	13-15/16 (354.0)	13-15/16 (354.0)	13-15/16 (354.0)	13-15/16 (354.0)	12 (304.8)
C	1-29/32 (48.4)	2-5/32 (54.8)	2-29/32 (73.8)	3-5/32 (80.2)	3-5/32 (80.2)	4-3/64 (102.8)	4-3/64 (102.8)	4-23/64 (110.7)	4-23/64 (110.7)	4-59/64 (125.0)	4-59/64 (125.0)	5-11/64 (131.4)	5-11/64 (131.4)	5-57/64 (149.6)
D	1-11/16 (42.7)	1-15/16 (49.2)	2-13/32 (61.1)	2-21/32 (67.5)	2-21/32 (67.5)	3-21/64 (84.5)	3-21/64 (84.5)	3-13/32 (86.5)	3-13/32 (86.5)	4-5/16 (109.6)	4-5/16 (109.6)	4-11/64 (106.0)	4-11/64 (106.0)	4-41/64 (117.9)
E	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	2-1/4 (57.2)	2-1/4 (57.2)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	2-3/4 (69.9)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)	3 (76.2)
F	3-3/8 (85.7)	1-15/16 (49.2)	5 (127.0)	5 (127.0)	5 (127.0)	5-7/8 (149.2)	5-7/8 (149.2)	6-3/8 (161.9)	6-3/8 (161.9)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/2 (165.1)	6-1/8 (155.6)
G	3-1/4 (82.6)	3-1/4 (82.6)	4-3/8 (111.1)	4-3/8 (111.1)	4-3/8 (111.1)	5 (127.0)	5 (127.0)	5-1/4 (133.4)	5-1/4 (133.4)	6-7/16 (163.5)	6-7/16 (163.5)	6-7/16 (163.5)	6-7/16 (163.5)	4-7/8 (123.8)

Figure 17



HYDRA-JAR® THRUST x 1000 LBS
0
5
10
15
20
25
30
35
40
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
DIFFERENTIAL PRESSURE (ΔP) PSI
9 1/2" Hydra-Jar 19.635 IN W.P. Area
7 3/4" - 8 1/2" Hydra-Jar 16.114 IN W.P. Area
7" - 7 1/4" Hydra-Jar 11.044 IN W.P. Area
6 1/4" - 6 1/2" Hydra-Jar 9.619 IN W.P. Area
4 3/4" Hydra-Jar 6.025 IN W.P. Area
4 1/4" Hydra-Jar 4.986 IN W.P. Area
3 3/8" Hydra-Jar 3.342 IN W.P. Area
3 1/8" Hydra-Jar 2.581 IN W.P. Area

Figure 18



Full Detent

Hydra-Jar® tool in the fully opened (or closed) position, prior to striking.

Short Detent

Hydra-Jar tool in a partially opened (or closed) position, prior to striking.

Delay Time

The time elapsed between cocking and firing the Hydra-Jar tool. Hole drag not accounted for in Figure 18.

Test Load

Functional test performed at service centers.

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