Schlumberger

Hydra-Jar AP

Double-Acting, Hydraulic Drilling Jar

Operating Instructions

ES20.39872J

Table of Contents

The last page of this engineering specification is 39.

Section 1

General Description

The Hydra-Jar AP* Drilling Jar is a double-acting hydraulic drilling jar capable of delivering (an extra heavy) with (the maximum Impact/ Impulse values) 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 AP 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 AP 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 AP tool can deliver impact in an “up-only” direction.
- If the drillstring becomes stuck off of the bottom, the Hydra-Jar AP tool can deliver impact in an “up” or “down” direction; however, a “down-only” direction is recommended to free the drillstring.
- When differential sticking is encountered, and movement is needed to regain rotation and circulation, the Hydra-Jar AP tool will “up-jar” and “down-jar.”

Advantages of Using a Hydra-Jar AP 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 Fishing Operations

- Completely Hydraulic
- Back-up Seal Systems
- High Degree of Reliability
- Variable Impacts
- Straight Push-pull
- Large Inside Diameter

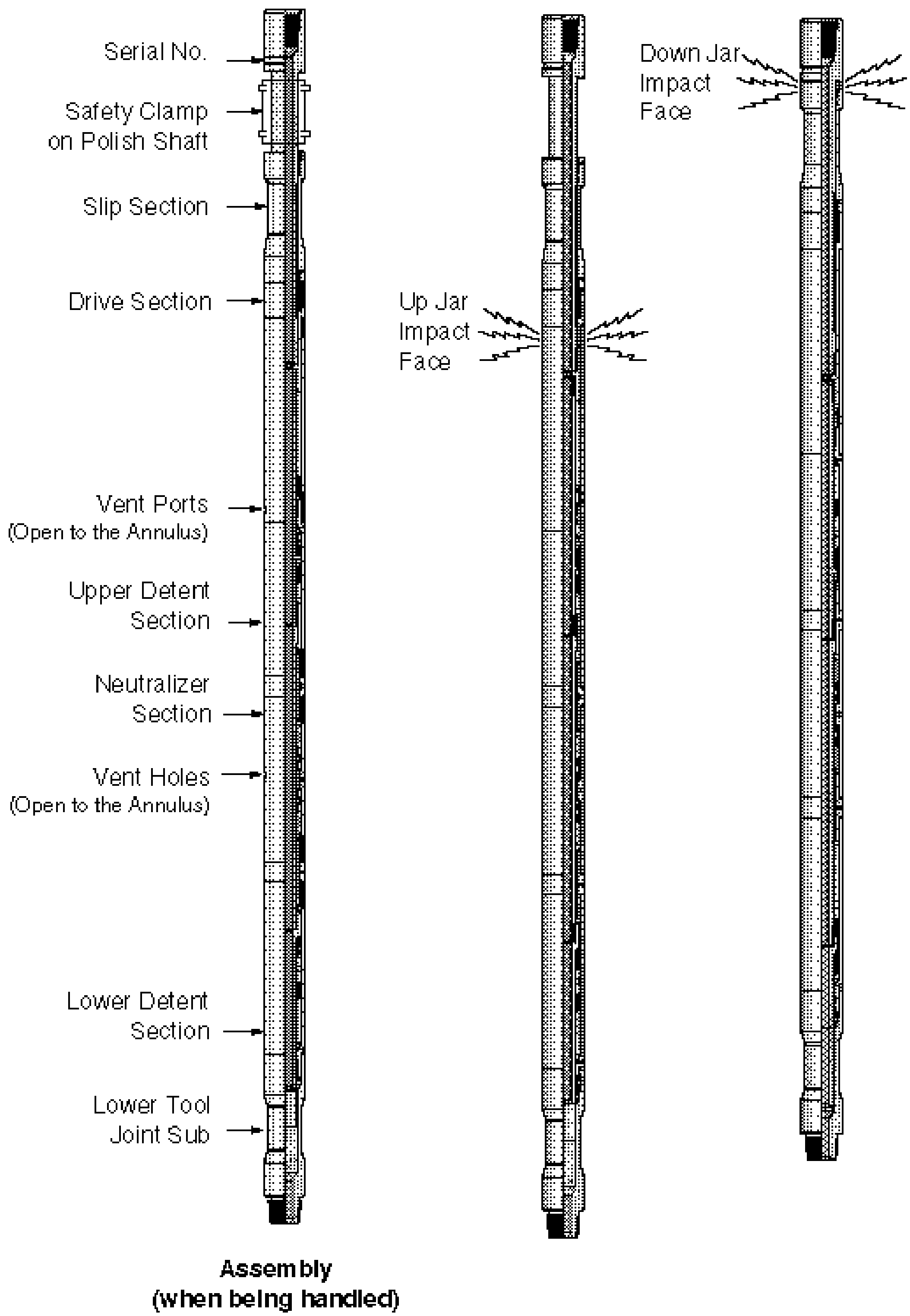
High Strength Construction

- High-strength ductile materials
- Key components are cold-worked, for better fatigue life
- Can withstand high-pressure and high-temperature environments
- Abrasion resistant phenolic ID coating
- Super HVOF mandrel coating for extreme corrosion and wear resistance
- Improved Mud scrapers and seals
- New increased bearing surfaces for greater mandrel protection
- Improved drive system for increase resistance to torque and impact damage
- New FEA fatigue analysis improvements
- Automated data acquisition testing procedures

Directional Drilling

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

Figure 1 Double-Acting Hydraulic Hydra-Jar AP drilling Jar



Section 2

Operation

Going in the Hole

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

Picking up the Hydra-Jar AP Tool

Step 1:

(a) Place the lower drill assembly in the slips.

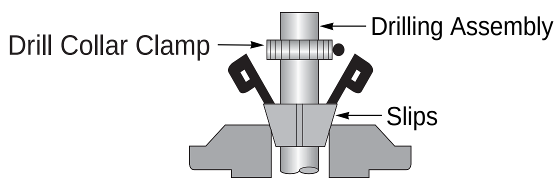


Figure 2

Step 2:

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

(b) Clamp elevators around the lift sub.

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

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

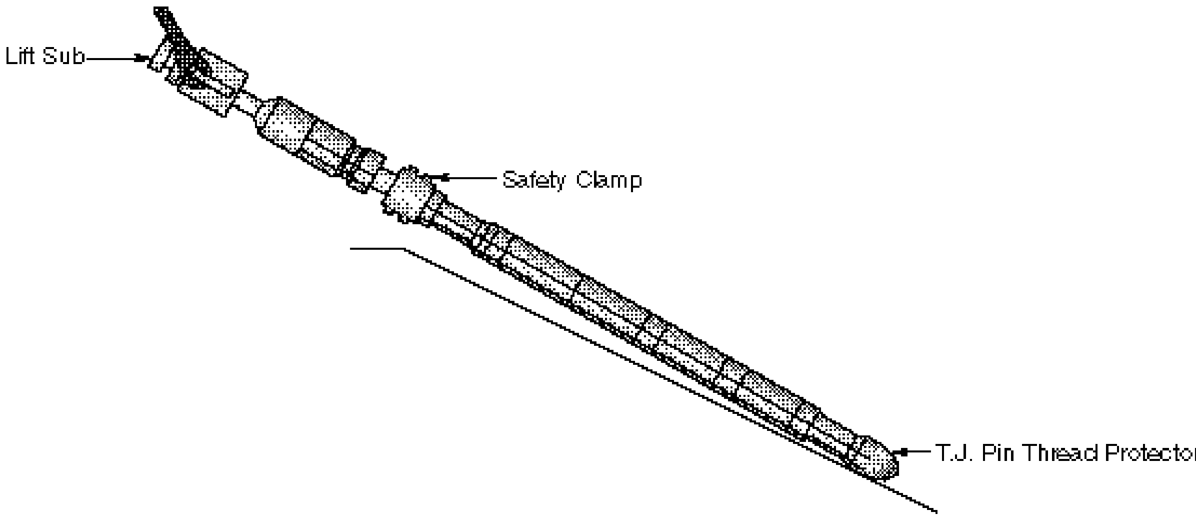


Figure 3

Step 3:

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

(b) Tong up lift sub.

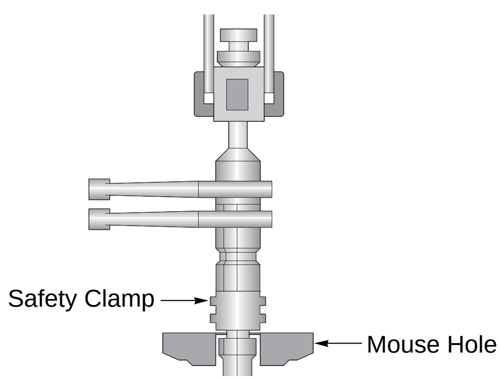


Figure 4

Step 4:

(a) Make up Hydra-Jar AP tool into drilling assembly in rotary table per the recommended Jar- Pact* impact tool BHA placement software.

(b) Remove the drill collar clamp.

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

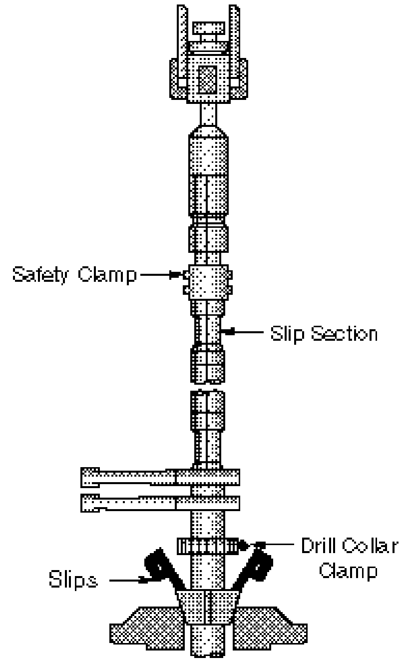


Figure 5

Step 5:

(a) Remove lift sub.

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

(c) Tong up drill collars.

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

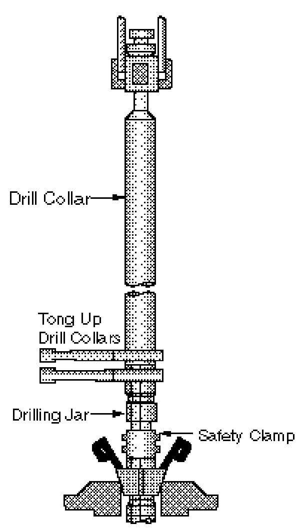


Figure 6

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.

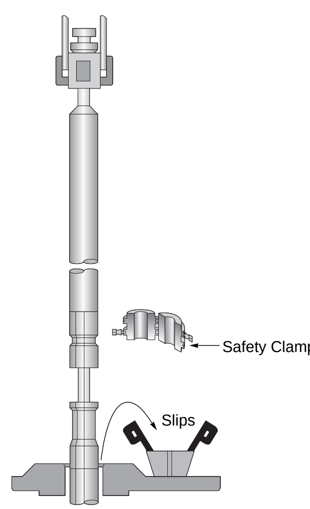


Figure 7

Jar Load

Establishing the Jar Load

With the Hydra-Jar AP 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 AP tool, to establish jar load. Compare the load to Table 7 Hydra-Jar AP Tool Specification, 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 AP tool to the Surface. Drag equal. Weight Indicator Reading Up minus *Weight* Indicator Reading Down.

CAUTION: ***To prevent damage to the Hydra-Jar AP tool, do not exceed maximum detent working load (Table 7) during up-jar cycle or down-jar cycle.***

Example 1: Jar Load "Up"

Up Load on Hydra-Jar AP 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 AP 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 AP tool.

Jar Cycle

The Hydra-Jar AP tool 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 draw works brake. Once a rhythm of setting the Hydra-Jar AP tool and pulling up (or pushing down) is established, the Hydra-Jar AP 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 21** 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 7 Hydra-Jar AP Tool Specification.

Step 2: Apply pull to the drillstring per the established weight indicator reading and then wait for the Hydra-Jar AP 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 AP tool has impacted. See Figure 21 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 7 Hydra-Jar AP Tool Specification, or within the weight range just above the Hydra-Jar AP tool.

Step 2: Slack down per the established weight indicator reading, then wait for the Hydra-Jar AP 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 AP tool to impact down. See Figure 21 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 AP, 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 AP tool has impacted up, slack off until the selected down weight on the Hydra-Jar AP tool is achieved, as described in *Down-Jar Operation*.

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

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

Setting the Hydra-Jar AP Tool Prematurely

If the Hydra-Jar AP 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 AP tool may set for an up-jar impact.

Increasing Effectiveness

Using the Mud Pump

Pump pressure does not appreciably affect 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 20, *Pump Pressure Extension Loads*.

Using Drill Collar Weights

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

Contact local representative for optimum collar and weight placement through the Jar-Pact* impact tool BHA placement software.

Using the Accelerator AP Tool

When used with optimum weights listed in Table 8 Hydra-Jar AP Tool and Accelerator Tool Weight Tables, 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.

Jar-Pact analysis is available through local representatives.

Coming Out of the Hole

Step 1:

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

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

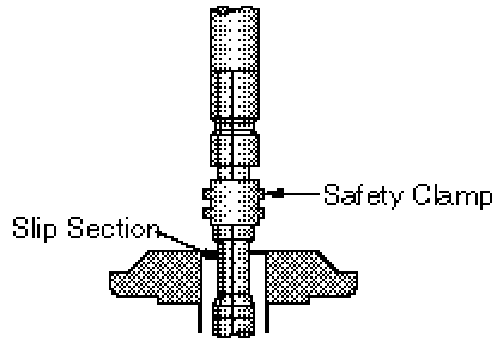


Figure 8

Step 2:

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

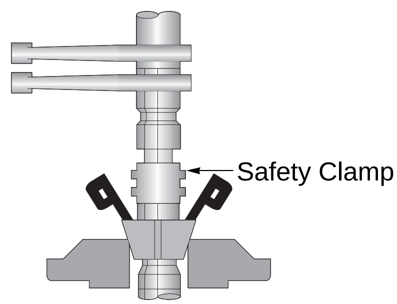


Figure 9

Step 3:

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

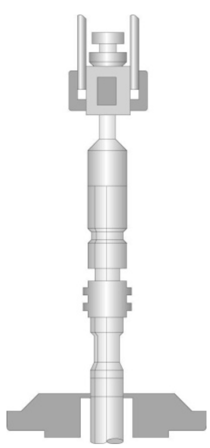


Figure 10

Step 4:

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

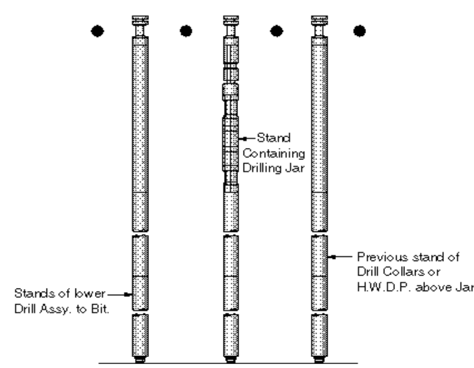


Figure 11

Jar Latch

The Safety-Lok Jar Latch offers the security of a mechanical Jar but the versatility of a hydraulic tool. The Hydra-Jar AP drilling jar has just gotten simpler to use. By adding the optional mechanical latching section, you can ensure that the drilling Jar will not fire unexpectedly during a trip or a connection. The Safety-Lok tool holds the drilling Jar's mandrel in its neutral position until sufficient load is applied to release or unlock it. Once released, the Hydra-Jar AP tool goes into its normal jarring cycle with the driller in complete control of the operation. When impact is no longer required, simply re-lock the mandrel, and continue drilling or tripping operations. Transmission of torque to the bottom of the hole is not affected by the operation of the Safety-Lok. The Safety-Lok tool is set to unlock at a predetermined tensile or compressive load. See Table 1**.**

Features & Benefits

- The Safety-Lok tool allows normal drilling operations without accidentally firing the Jar, while preventing damage to surface equipment, and eliminating the potential of dropping the drillstring.
- Unique Safety-Lok tool design ensures reliable, positive catch every time.
- Robust design means the Safety-Lok tool can be actuated many times without compromise.
- Overall length means the Hydra-Jar AP tool can be easily handled on the rig floor with standard rig equipment

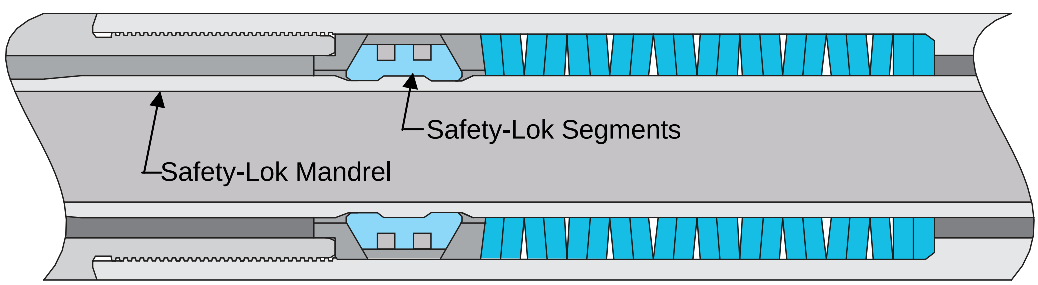


Figure 12
Safety-Lok Tool

Note: *Placement of the Hydra-Jar AP tool should be 30% of the Safety-Lok tool setting either in tension or compression.*

The Safety-Lok is a mechanical latch securing the Hydra-Jar AP tool in the neutral position during normal drilling operations. The predetermined release is set higher than normal drilling forces, keeping the Hydra-Jar AP tool in the neutral position and preventing premature firing. When running the Hydra-Jar AP tool in compression, the compressive load across the Hydra-Jar AP tool should be no greater than 30% of the down release setting. **The Safety-Lock is not recommended for running the Jar in tension**, as the weight and drag below the tool may unlatch the tool unknowingly. Should the drillstring become stuck, jarring operation is simple:

Up Jar

Apply a pull load at the drilling jar higher than the Safety-Lok setting. This will unlatch the tool allowing the Hydra-Jar AP tool to go into the hydraulic detent. After the delay time of the detent, the drilling jar will release and fire as normal. Normal up jar cycling can be achieved by simply lowering the drillstring to re-cock the Jar. If another up impact is required, simply pick up the desired overpull on the hydraulic detent at this time. To return to normal drilling operations, slack off enough weight, about 10,000 pounds, to re-latch the tool.

Down Jar

Apply a compression load greater than the Safety-Lok setting. This will unlatch the tool allowing the Hydra-Jar AP tool to go into the hydraulic detent. After the delay time of the detent, the drilling jar will release and fire as normal. Normal down jar cycling can be achieved by simply raising the drillstring to re-cock the drilling jar. If another down impact is required, simply lower the desired weight on the hydraulic detent. To return to normal drilling operations, pick up enough weight, about 10,000 pounds, to re-latch the tool.

Safety Clamp

A Safety Clamp is not required when the tool is in the latch position, but a Safety Clamp will be shipped with each tool. If after jarring up and tripping out of the hole, the tool cannot be reset (due to insufficient weight above the tool); the Safety Clamp should be installed in order to rack the tool safely. When drilling is continued and weight is applied to the drilling jar, it will re-latch without firing or damage to the lower BHA.

Stand-Off Sub

The Schlumberger Stand-Off Sub has a larger OD than the nominal tool OD. The Stand-Off Subs are strategically placed on our drilling tools to reduce wall contact in directional wells; thus, reducing OD wear.

The standard Hydra-Jar AP drilling jar can be modified for directional application by replacing three subs with a Stand-Off Sub. This will result in:

- Reduced hole wall contact
- Reduced drilling jar OD wear

Benefits include:

- Reduced risk of differential sticking
- Increased jar life
- Improved hole cleaning
- Reduced torque and drag

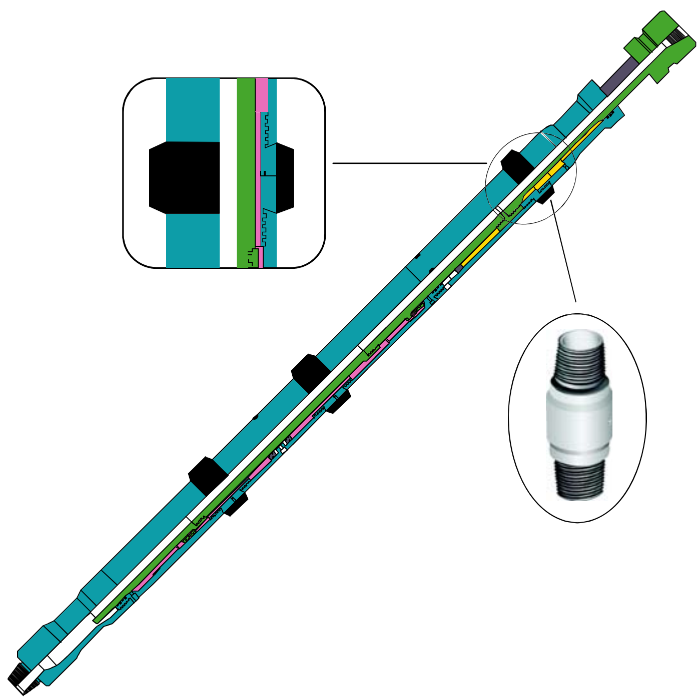


Figure 13
Stand-Off Sub

Recommended Operational Practice with the Hydra-Jar AP Drilling Jar

The following are some recommended guidelines on normal operational practices using the Hydra-Jar AP tool. Failure to follow these guidelines may result in damages that shall be deemed as abnormal wear and tear on the tool. For optimum performance, placement, and BHA recommendations contact your local representative to analyze your drilling conditions using the Hydra-Jar AP Jar-Pact program.

- The Hydra-Jar AP tool should be positioned in the drill string according to the recommendations as outlined in this manual.
- The Hydra-Jar AP tool should be changed out according to the change out recommendations as outlined in this manual.
- The Hydra-Jar AP tool should not be placed within 90 feet of any cross sectional change in the BHA.
- The Hydra-Jar AP tool should be properly sized to the size of the tubulars (HWDP / DC) that it is placed within and to the size of the well bore that it is used in to ensure optimum performance and to avoid premature damage to the tool.
- Dropping the drill sting and performing string shot or explosive back off with the Hydra-Jar AP tool in the string is not recommended and can result in tool damages.
- Corrosive acids should not be pumped down hole when the Hydra-Jar AP tool is in the drill string.
- All Hydra-Jar AP tool have a recommended maximum load rating which is supplied in this manual. Exceeding these loads is not recommended.
- If an Accelerator tool is to be used, always use a compatible type accelerator to optimize efficiency and to prevent damage to the Hydra-Jar AP tool.
- The Hydra-Jar AP tool should be located a minimum of 90 feet away from the top stabilizer. Never run a stabilizer or reamer above the Hydra-Jar AP tool since this can reduce the effectiveness of the Jar when jarring.
- The number of drill collars used to design a BHA should not exceed the amount of bit weight required plus a safety factor. Rotating excessive drill collars in tension would result in significant lateral vibrations. These vibrations reduce the overall life of the Hydra-Jar AP tool.
- Always place a minimum of 10% to 20% of the expected drilling jar overpull as hammer weight above the drilling jar.
- Maintain 20% of bit weight between the drilling jar and the neutral point to ensure that it is outside the neutral point transition zone.

- Always be aware that the placement of the drilling jar needs to be reconsidered when there is a change in drilling parameters.
- Always place Accelerator within the hammer weight run above the Hydra-Jar AP drilling jar.
- Run some hammer weight above the Accelerator AP tool, if possible, to load the tool for down impacts.
- Strong consideration should be given to running dual jars in horizontal holes.
- If the dual drilling jar system is not available then the maximum loading at the bottom drilling Jar would be limited to the overpull limit or buckling load of the drill pipe. This would be substantially lower than the impact forces provided by firing the top drilling Jar to load the bottom-drilling Jar.
- If the Hydra-Jar AP tools are to be run in tandem, placement will be based on the results using a Jar-Pact analysis.
- A minimum run pipe spacing of 1000 feet should be kept between the two drilling Jars to avoid damaging the lower drilling Jar due to the top drilling Jar impacts.
- When running the Jar Placement Analysis, the overpull in the upper drilling Jar can also be decreased in order to reduce the magnitude of the blows transmitted to the lower drilling Jar to prevent damage. Either way can be chosen to protect the lower drilling Jar.
- The Jar-Pact Placement Analysis will indicate when the drilling Jars are placed too close to each other.
- It is not recommended operating the Hydra-Jar AP /Accelerator tools with torque in the string. This could reduce the tensile and torsional designed maximum loads limits and result in tool damage. Trapped torque is not recommended while operating these tools.
- If torque is present, then the published design loads limits do not apply and Design Engineering should be consulted.

Section 3

Placement

Optimum Hydra-Jar AP Tool Position

For optimum performance, placement, and BHA recommendations contact your local representative to analyze your drilling conditions using the Hydra-Jar AP Jar-Pact program.

The optimum position for the Hydra-Jar AP tool is slightly above the transition zone, but the Hydra-Jar AP tool can be run below the transition zone.

Operating the Drilling Jar in Tension or Compression

Drilling with the Hydra-Jar AP drilling jar in tension or in compression depends on hole inclination and the available bottomhole assembly weight. Table 4 below summarizes the basic differences encountered while drilling with the drilling jar in tension or in compression.

Hydra-Jar AP Tool in Tension

The Hydra-Jar AP 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 AP tool, always retaining sufficient weight above the Hydra-Jar AP tool to provide an effective Jar hammer.

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 AP tool to set during the drilling operation.

Enough difference between the WOB and the JTDW should be provided to prevent the Hydra-Jar AP tool from setting in the drilling operation. To avoid damaging or prematurely setting the Hydra-Jar AP 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

Placing Hydra-Jar AP Tool in Compression

The Hydra-Jar AP tool can be, and often is, run in compression. The advantages of running the drilling Jar in compression often outweigh the additional time it takes to avoid premature firing of the drilling Jar.

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

- Slowly lower the string as the bit approaches bottom.
- Continue to slowly lower string, allowing the Hydra-Jar AP tool to completely close and move through detent without causing an impact. Subsequent to this, 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 AP tool is run in compression, the guidelines below should be followed.

- Slowly raise string off bottom, allowing the Hydra-Jar AP tool to open and move through detent without causing an impact.
- When re-establishing the WOB after a connection or otherwise approaching hole bottom, total WOB should be applied slowly to allow the Hydra-Jar AP 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 AP tool without impact.

- In some cases, it is possible to be running the drilling jar in compression but never close or move the drilling jar through detent. The reason is the pump open force acting on the drilling jar is greater than the compression weight applied on the drilling jar.

Pump Open Force

The Pump Open Force (POF), sometimes referred to as the Jar extension force, is the force created by the circulating pressure acting on the exposed cross-sectional area of the lower mandrel of the drilling jar, see equation below.

POF = cross-sectional area of lower mandrel x Circulating Pressure at lower mandrel

The POF for a particular tool size can be determined using the differential pressure at the drilling jar, see Figure 20. If the value of the differential pressures at the drilling jar is not known, the differential pressure across the bit may be used as an approximate value.

If a drilling jar is in tension, the POF will help keep the tool extended while drilling. If the drilling jar is in compression but the POF is greater than the compression weight applied on the drilling jar, the drilling jar may stay extended while drilling.

If circulating while jarring, the POF will intensify the up-jar blow. However, the POF will dampen the down-jar blow. It is recommended, that circulation is stopped or slowed down and trapped pressure bled off, before attempting to jar down.

Procedure for Drilling with Hydra-Jar AP Tool in Compression

Lowering the Drill String

- Slowly lower the drill string to touch bottom and begin rotation. The weight indicator will read a slight reduction in string weight when the bit tags bottom.
- Gradually apply small increments (2,000 to 4,000 pounds) of WOB.
- After a period of 3 to 5 minutes, usually by the time WOB is reached, the drilling jar should close completely without creating a Jar impact.
- A slight movement of the rig weight indicator might be noticed as the drilling jar fully closes. At this point, desired WOB can be applied and normal drilling operations continued without any concerns of the drilling jar firing until coming off bottom.

Picking off Bottom

- Slowly pick up off bottom to 10,000 to 20,000 pounds. Rotate and work the pipe until the drilling jar drops open.

- The weight of the drill string below the drilling jar should be enough to pull the drilling Jar open.
- The pump open force can also help open or move the drilling Jar back through detent.
- A slight movement of the weight indicator should be observed as the drilling jar exits detent and drops open. This process might also take 3 to 5 minutes and should avoid a Jar impact.
- Normal connection or tripping procedures can continue at this point.
- When going back to bottom to begin drilling operations, the same procedures should be followed as in the procedure discussed in the section above "Lowering the Drill String".

Tripping out of the Hole

- For tripping in and out of the hole, caution should be taken if a ledge or enough hole drag is encountered.
- If a ledge or enough drag resistance is observed, follow the second step for "Picking off Bottom" to ensure the drilling jar fully opens again.
- If the hole is tight and the drill string is being worked up and down before a connection, make sure that the drilling jar is fully opened before setting your slips and unscrewing the kelly for a connection.
- If the drilling jar is still closed after unscrewing the kelly, it probably will drop back open from the weight of the drill string below the drilling jar. Although this movement of the tool is not considered an impact, it can cause enough recoil of the drill pipe to knock the slips out and risk dropping the drill string to bottom.
- Do not slack off more than six inches when setting the slips, as this may cock the drilling jar.

Procedure for Coring with a Hydra-Jar AP

For coring operations, the same procedures for drilling, tripping in and tripping out should be followed. The following considerations and options should also be considered:

- One option is to take the lower detent ring out of drilling jar so the tool will not be able to fire down. Normal up jarring functions of the drilling jar would not be altered. If this is not an option, then special care should be taken to prevent the drilling jar from firing and risking accidental loss of the core while coming off bottom.
- Many times in hard or consolidated formation, it is necessary to break the core loose from the formation before coming off bottom for a connection or tripping out of the hole. The best way to attempt to break the core is to let the core bit completely drill off before pulling off bottom.

- Many times the rotation and the washing effect of the pumps on the core will be sufficient to break the core loose. This can take several minutes of rotating on bottom without any WOB.
- Follow the “procedures in Picking off bottom” as discussed above when pulling off bottom.
- Continue pumping and slowly rotating after picking up off bottom and see if the core has broken loose from the formation.
- If the core is not loose, then attempt to pull up a little further and rotate in one spot while pumping to see if it will come loose. The drilling jar needs to be fully open before you attempt to pull hard to break the core loose.

Procedure for Operating Dual Drilling Jars

Situation 1. String becomes stuck with bit on bottom.
Jar situation – Lower drilling jar is closed and in compression.
– Upper drilling jar is open and in tension.

- Apply overpull load to lower drilling jar (up to maximum overpull at drilling jar).
- If drilling jar fires then slack off the equivalent weight of the weight below the upper drilling jar, pick up and continue up jarring using this procedure.
- If above fails to activate lower drilling jar, then slack off more weight enough to close the top drilling jar to cock it and then pick back up. Overpull upper drilling jar to maximum and wait until drilling jar fires. Continue to fire upper drilling jar until bottom drilling jar is hopefully activated.

Situation 2. String becomes stuck coming out of the hole.
Jar situation – Lower drilling jar in tension.

- From the time that BHA comes off bottom the weight below the bottom drilling jar will pull the tool open from its closed position. This might take up to 10 minutes depending on the hole angle and actual string weight below the lower drilling jar.
- Leaving the rig pumps on for a few minutes when pulling off bottom can also help lower the waiting time for the lower drilling jar to open as discussed in the previous “Pump Open Force” section.

Upper drilling Jar should be fully open and in tension.

- To jar down, slack off the equivalent of the weight below top drilling jar and allow time (3-4 minutes) for bottom jar to fire.
- If the drilling jar fires, repeat procedures as required.
- If above fails to achieve drilling Jar action, slack off more weight until upper drilling jar is activated to fire down.

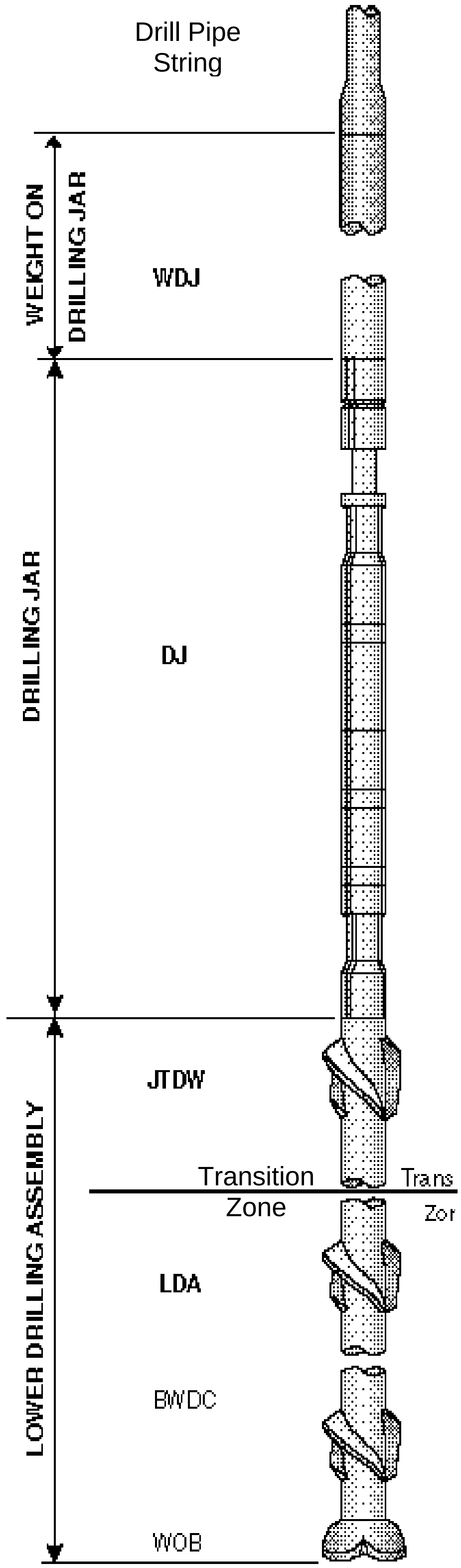
- When upper drilling jar fires, allow approximately 30 to 40 seconds before picking back up for the bottom drilling Jar to fire.
- If the bottom drilling jar does not fire, pick up enough weight to reset top drilling jar and immediately slacken off again until top drilling jar fires. Once again, wait for 30 to 40 seconds to see if bottom drilling jar fires.
- When both drilling jars are firing simultaneously, operate the drilling jars normally based on the maximum overpull at the top drilling jar.

Routine Drilling Operations with Dual Drilling Jars

- During normal drilling operation each time the BHA is picked up off bottom the lower drilling jar will open and therefore set to fire down when the BHA is lowered on bottom.
- Follow the same procedures described in the previous “Running the Hydra-Jar drilling jar in Compression Procedure” section to avoid the drilling jar from making a significant impact when resuming drilling operations.
- The upper drilling jar should remain in tension in most cases unless the amount of slack off applied to the drill string is equal or greater to the weight below the top drilling jar.
- In the event that the top drilling jar is closed and set to fire then any application of overpull to the system should be applied slowly. This will allow the upper drilling jar to fully extend or open without any significant impact.

Examples of Placement

Examples provided in Figure 14 through Figure 17 illustrate how to determine the position above the transition zone in the event that the Jar-Pact Program is not available.



No Angle

In the event that the Jar-Pact Program is not available, use the calculations below to place the Hydra-Jar AP 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- 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 5)	= 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 =	$\frac{\text{WDJ x BF}}{\text{WT of DC in LB/FT}}$	$\frac{10{,}000 \times 1.25}{90.6}$	= 138 ft
DC =	$\frac{\text{WDJ x BF}}{\text{WT per 30 FT of DC}}$	$\frac{10{,}000 \times 1.25}{2{,}718}$	= 5 dc
Lower Drilling Assembly (LDA)			
LB =	[JTDW + WOB] (BF)	[15,000 + 40,000] (1.25)	= 68,750 lb
FT =	$\frac{\text{[JTDW + WOB] (BF)}}{\text{WT of DC in LB/FT}}$	$\frac{[15{,}000 + 40{,}000]\ (1.25)}{90.6}$	= 759 ft
DC =	$\frac{\text{[JTDW + WOB] (BF)}}{\text{WT per 30 FT of DC}}$	$\frac{[15{,}000 + 40{,}000]\ (1.25)}{2{,}718}$	= 25 dc
Bit Weight Drill Collar (BWDC)			
BWDC=	Desired WOB (BF)	40,000 x 1.25	= 50,000 lb

Figure 14

Core Drilling

In the event that the Jar-Pact Program is not available, use the calculations below to place the Hydra-Jar AP 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) b/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 =	$\frac{\text{WDJ x BF}}{\text{WT of DC in LB/FT}}$	$\frac{10{,}000 \times 1.25}{90.6}$	=138 FT
DC =	$\frac{\text{WDJ x BF}}{\text{WT PER 30 FT OF DC}}$	$\frac{10{,}000 \times 1.25}{2{,}718}$	=5 DC
Lower Drilling Assembly (LDA)			
LB =	[JTDW + WOBC] (BF)	[18,000 + 20,000] (1.25)	=47,500 LB
FT =	$\frac{\text{[JTDW + WOBC] (BF)}}{\text{WT of DC in LB/FT}}$	$\frac{[18{,}000 + 20{,}000]\ (1.25)}{90.6}$	=524 FT
DC =	$\frac{\text{[JTDW + WOBC] (BF)}}{\text{WT per 30 FT of DC}}$	$\frac{[18{,}000 + 20{,}000]\ (1.25)}{2{,}718}$	=17 DC
Weight On Core Bit (WOCB)			
WOCB =	DESIRED WOB x BF	20,000 x 1.25	=25,000 LB

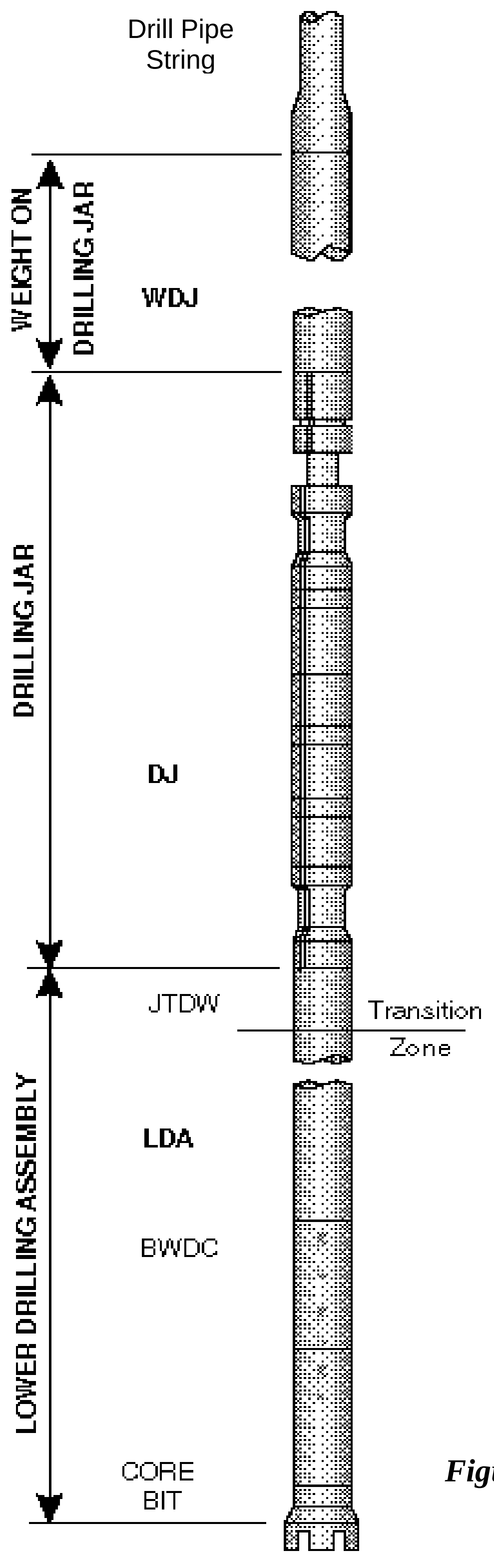
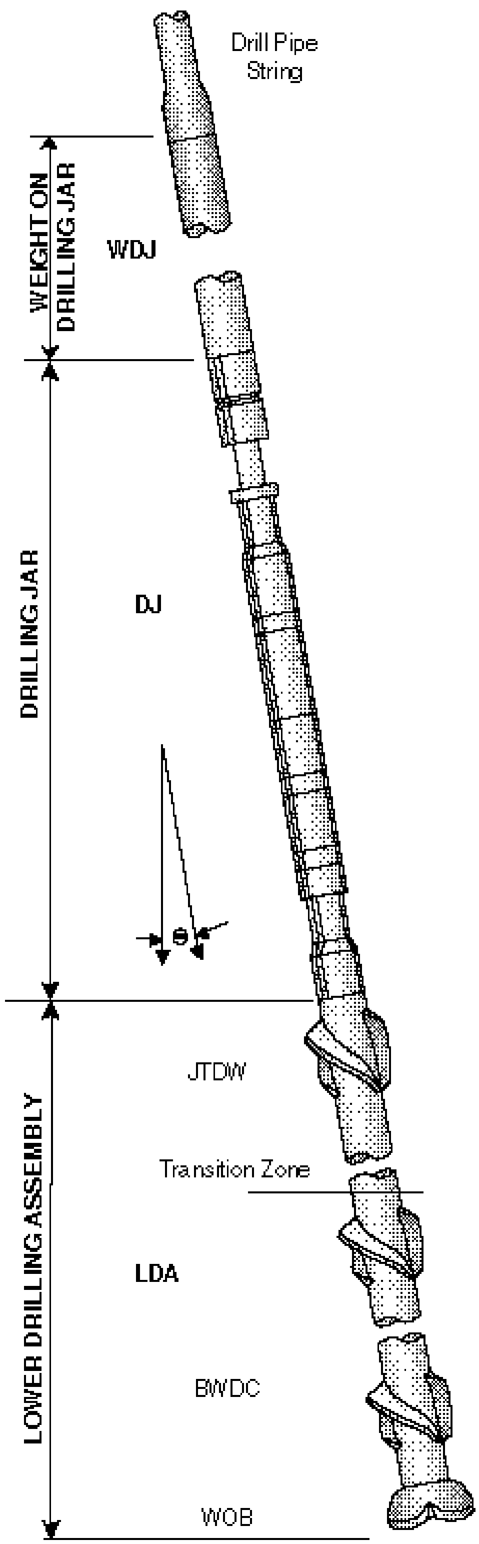


Figure 15

Directional Drilling



In the event that the Jar-Pact Program is not available, use the calculations below to place the Hydra-Jar AP 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

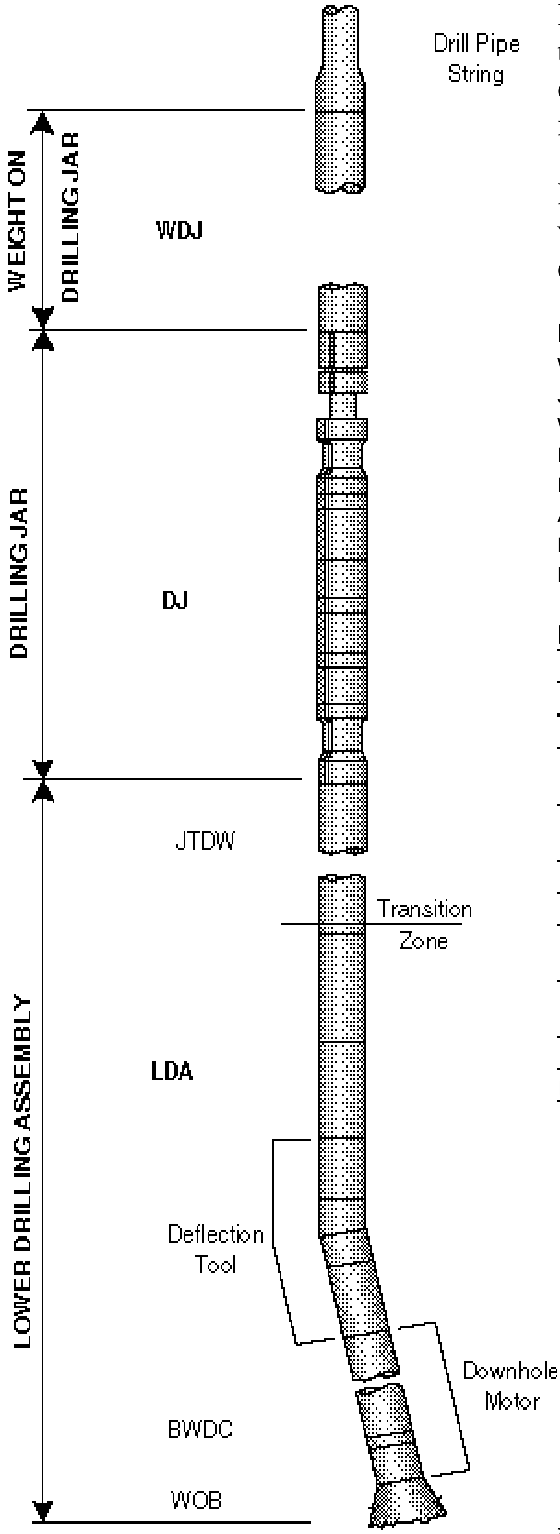
WOB - Weight on Bit (buoyed)	= 45,000 lb
JTDW - Jar Tension Drilling Weight (buoyed)	= 15,000 lb
WDJ - Weight on Drilling Jar (buoyed)	= 10,000 lb
DC - Drill collars - 6¼ x 2¼ (90.6 lb/ft in air)	= 2,718 lb (each)
Hole Angle	= 35°
AF - Hole Angle Factor	= 1.22
BF - Buoyancy Factor (13 lb/gal)	= 1.25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

Figure 16

Directional Drilling With Motor



In the event that the Jar-Pact Program is not available, use the calculations below to place the Hydra-Jar AP 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 2¾ (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 =	$\frac{\text{WDJ x BF}}{\text{WT of DC in LB/FT}}$	$\frac{10{,}000 \times 1.25}{90.6}$	= 138 FT
DC =	$\frac{\text{WDJ x BF}}{\text{WT per 30 FT of DC}}$	$\frac{10{,}000 \times 1.25}{2{,}718}$	= 5 DC
Lower Drilling Assembly (LDA)			
LB =	[JTDW + WOB] (BF) (AF)	[6,000 + 30,000] (1.25) (1.22)	= 54,900 LB
FT =	$\frac{\text{[JTDW + WOB] (BF) (AF)}}{\text{WT of DC in LB/FT}}$	$\frac{[6{,}000 + 30{,}000]\ (1.25)\ (1.22)}{90.6}$	= 606 FT
DC =	$\frac{\text{[JTDW + WOB] (BF) (AF)}}{\text{WT per 30 FT of DC}}$	$\frac{[6{,}000 + 30{,}000]\ (1.25)\ (1.22)}{2{,}718}$	= 20 DC
Bit Weight Drill Collar (BWDC)			
BWDC =	WOB (AF) (BF)	30,000 (1.25) (1.22)	= 45,750 LB

Figure 17

Section 4

Tables & Charts

Table 1
Hydra-Jar AP with Latch Specification

Tool Size OD (inches)	**4 3/4**	**6 1/2**	**8**
Safety-Lok Conversion Kit Number	H17147	H17146	H17148
Safety-Lok Release Load Up (lb)	40,000	80,000	85,000
Safety-Lok Release Load Down (lb)	18,000	40,000	40,000
Maximum Overpull (lb)	95,000	175,000	300,000
Tool Position When Latched, Open Stroke Length (inches)	12¾	12¾	12¾
Tool Overall Length (feet, inches), Latched	34' 4"	36' 3"	37" 8"
Total Stroke (inches)	25	25	25

Recommended Maximum Hole Size versus Tool Size

To avoid extensive fatigue damage, the recommended maximum hole size versus tool size is given in Table 2. **These numbers are guidelines to be used for planning purposes only**. Field experience in different formations and under different drilling conditions will ultimately dictate the maximum hole size that the tools can be used in, please check with a Schlumberger representative for your particular application.

Table 2
Recommended Maximum Hole Size versus Tool Size

Tool Diameter inches	**Maximum Hole Diameter inches (Vertical Hole)**	**Maximum Hole Diameter inches (Horizontal/Deviated Hole)**
3 3/8	5 7/8	7 7/8
4 1/4	6 3/4	8 3/4
4 3/4	7 7/8	9 7/8
5 1/8	8 3/4	10 5/8
6 1/4	9 7/8	10 5/8
6 1/2	10 5/8	12 1/4
7	12 1/4	14 3/4
7 1/4	12 1/4	14 3/4
7 3/4	12 1/4	17 1/2
8	17 1/2	22
8 1/4	17 1/2	22
8 1/2	17 1/2	26
9 1/2	26	30

Change out Recommendations

The Hydra-Jar AP tool should be changed out periodically for servicing. See Table 3, Change out Recommendations to determine recommended hours of use before servicing. These change out recommendations refers to the total hours in the hole before servicing the Jar (include drilling, circulating and jarring hours).

To use the information in Table 3 Change out Recommendations.

Step 1: Select the Hydra-Jar AP tool OD.
Step 2: Determine the drilling use.
Step 3: Select the hole size and note the corresponding hours.
Step 4: Determine the bottom hole 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 3
Change out Recommendations

	Tool OD inches (mm)																					
USE	**3-3/8 (86)**		**4-1/4 (108)**		**4-3/4 (121)**		**5-1/8 (130)**		**6-1/4 (159)**		**6-1/2 (165)**		**7, 7-1/4 (178, 184**		**7-3/4 (197)**		**8 (203)**		**8-1/4, 8-1/2 (210, 216)**		**9-1/2 (241)**	
	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs	Hole Size	Hrs
Rotating in vertical or build/drop section	4-3/4 (121) 5-7/8 (149)	150 150	5-7/8 (149) 6-1/8 (156) 6-3/4 (171)	150 150 150	6-1/8 (156) 6-3/4 (171) 7-7/8 (200)	200 150 150	6-3/4 (171) 7-7/8 (200) 8-3/4 (222)	150 150 100	8-3/8 (213) 8-3/4 (222) 9-7/8 (251)	300 200 200	8-3/4 (222) 9-7/8 (251) 10-5/8 (269)	300 200 150	9-1/2 (242) 9-7/8 (251) 12-1/4 (311)	300 200 150	9-7/8 (251) 10-5/8 (269) 12-1/4 (311)	200 150 150	9-7/8 (251) 10-5/8 (269) 12-1/4 (311) 17-1/2 (445)	300 250 200 150	10-5/8 (269) 12-1/4 (311) 17-1/2 (445)	250 200 150	12-1/4 (311) 17-1/2 (445) 26 (660)	250 150 100
Rotating in tangent or horizontal section	4-3/4 (121) 5-7/8 (149) 6-1/8 (156) 6-3/4 (171) 7-7/8 (200)	250 200 150 150 100	5-7/8 (149) 6-1/8 (156) 6-3/4 (171) 7-7/8 (200) 8-3/4 (222)	250 200 200 150 100	6-1/8 (156) 6-3/4 (171) 7-7/8 (200) 8-3/4 (222) 9-7/8 (251)	300 250 200 150 100	6-3/4 (171) 7-7/8 (200) 8-3/4 (222) 9-7/8 (251) 10-5/8 (269)	300 250 200 150 100	8-3/8 (213) 8-3/4 (222) 9-7/8 (251) 10-5/8 (269)	400 300 250 200	8-3/4 (222) 9-7/8 (251) 10-5/8 (269) 12-1/4 (311)	400 300 250 200	9-1/2 (242) 9-7/8 (251) 12-1/4 (311) 14-3/4 (376)	350 300 200 150	9-7/8 (251) 10-5/8 (269) 12-1/4 (311) 17-1/2 (445)	300 250 200 150	9-7/8 (251) 10-5/8 (269) 12-1/4 (311) 17-1/2 (445) 22 (560)	400 350 300 250 200	10-5/8 (251) 12-1/4 (311) 17-1/2 (445) 22 (560) 26 (662)	400 350 250 200 150	12-1/4 (311) 17-1/2 (445) 26 (660) 30 (764)	400 350 200 150

Recommended hours of use before servicing

	Tool OD inches (mm)										
Bottom Hole Temp	**3-3/8 (86)**	**4-1/4 (108)**	**4-3/4 (121)**	**5-1/8 (130)**	**6-1/4 (159)**	**6-1/2 (166)**	**7, 7-1/4 (178, 184)**	**7-3/4 (197)**	**8 (203)**	**8-1/4, 8-1/2 (210, 216)**	**9-1/2 (241)**
	Hours										
100-200°F 38-93°C	200	200	300	300	400	400	400	300	400	400	400
200-300°F 93-148°C	200	200	200	200	300	300	300	300	300	300	300
300-400°F 148-204°C	150	150	200	200	300	300	300	300	300	300	300
400-500°F 204-260°C	150	150	150	150	150	150	150	150	150	150	150
Fishing	100										
Milling	50										

Table 4
Differences between Drilling in Tension and in Compression

Hydra-Jar AP in Tension	Hydra-Jar AP in Compression
Neutral point below the drilling jar	Neutral point above the drilling jar
Drilling jar remains “open” and cocked for down jarring while drilling	Drilling jar remains “closed” and cocked for up jarring while drilling
No risk of premature firing of drilling jar when picking up off bottom	Drilling jar may fire prematurely if drillstring picked up off bottom too quickly
Pump Open Force will help extend the drilling jar open while drilling, and does not affect the WOB	Drilling jar needs to be slowly opened before tripping out the hole to prevent accidental firing
Used in low angle wellbores where the bottomhole assembly below the optimal drilling jar placement provides sufficient weight to drill	Unavoidable in highly deviated wellbores where the bottomhole assembly below the optimal drilling jar placement provides in-sufficient weight on bit to drill

Weight Correction Tables

The information contained in Table 5 and Table 6 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 5
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

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

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 6
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

Table 7
Hydra-Jar AP Tool Specification

OD inches (mm)	ID inches (mm)	Tool Joint Connection	Overall Length Extended ft in (mm)	Max. Detent Working Load lbf (N)	Tensile Yield Strength lbf (N)	Torsional Yield Strength lbf·ft (N·m)	Up Stroke inches (mm)	Down Stroke inches (mm)	Total Stroke inches (mm)	Tool Weight lb (kg)
3-3/8 (85.73)	1-1/2 (38.10)	2-3/8 API IF	24' 5" (7,442)	44,000 (195,712)	236,062 (1,050,004)	6,842 (9,276)	7 (178)	7 (178)	21 (533)	500 (227)
4-1/4 (107.95)	2 (50.80)	2-7/8 API IF	29' 10" (9,093)	70,000 (311,360)	377,871 (1,680,770)	15,381 (20,853)	8 (203)	7 (178)	25 (635)	800 (362)
4-3/4 (120.65)	2-1/4 (57.15)	3-1/2 API IF	29' 10" (9,093)	95,000 (422,560)	492,284 (2,189,679)	19,126 (25,930)	8 (203)	7 (178)	25 (635)	1,050 (476)
5-1/8 (130.18)	2-1/4 (57.15)	WT-38	29' 10" (9,093)	95,000 (422,560)	492,284 (2,189,679)	30,000 (40,650)	8 (203)	6-13/16 (173.08)	25 (635)	1,155 (524)
6-1/4 (158.75)	2-3/4 (69.85)	4-1/2 XH	31' 2" (9,499)	150,000 (667,200)	730,324 (3,248,481)	40,505 (54,915)	8 (203)	7 (178)	25 (635)	1,600 (725)
6-1/4 Mod (158.75)	2-3/4 (69.85)	4-1/2 XH	31' 2" (9,499)	150,000 (667,200)	964,207 (4,288,792)	50,757 (68,814)	8 (203)	7 (178)	25 (635)	1,600 (725)
6-1/2 (165.10)	2-3/4 (69.85)	4-1/2 API IF	31' 2" (9,499)	175,000 (778,400)	964,207 (4,288,792)	54,796 (74,290)	8 (203)	7 (178)	25 (635)	1,850 (839)
7 (177.80)	2-3/4 (69.85)	5 H-90	31' 6" (3,601)	230,000 (1,023,040)	1,179,933 (5,248,342)	67,396 (91,372)	8 (203)	8 (203)	25 (635)	2,600 (1,179)
7-1/4 (184.15)	2-3/4 (69.85)	5-1/2 H-90	31' 6" (3,601)	240,000 (1,067,520)	1,261,162 (5,337,600)	84,155 (114,093)	8 (203)	8 (203)	25 (635)	3,000 (1,360)
7-3/4 (196.85)	3 (76.20)	6-5/8 API REG	32' (9,754)	260,000 (1,156,480)	1,315,225 (5,850,121)	86,848 (117,744)	8 (203)	7 (178)	25 (635)	3,200 (1,451)
8 (203.20)	3 (76.20)	6-5/8 API REG	32' (9,754)	300,000 (1,334,400)	1,621,565 (7,212,721)	98,490 (133,528)	8 (203)	7 (178)	25 (635)	3,550 (1,610)
8-1/4 (209.55)	3 (76.20)	6-5/8 API REG	32' (9,754)	350,000 (1,556,800)	1,819,384 (8,092,620)	115,418 (156,478)	8 (203)	8 (203)	25 (635)	4,000 (1,814)
8-1/2 (215.90)	3 (76.20)	6-5/8 API REG	32' (9,754)	350,000 (1,556,800)	1,846,269 (8,212,205)	115,418 (156,478)	8 (203)	8 (203)	25 (635)	4,500 (2,041)
9-1/2 (241.30)	3 (76.20)	7-5/8 API REG	32' 6" (9,906)	500,000 (2,224,000)	1,654,172 (7,357,757)	152,802 (207,161)	8 (203)	8 (203)	25 (635)	5,600 (2,540)

Table 8
Hydra-Jar AP Tool and Accelerator Tool Weight Tables

Tool OD Inches (mm) Tool Joint Connection	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, 5-1/8 OD (130) WT-38	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 (215.90) 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 5 (1,814 5)	4,000 4 (1,814 4)										
25,000 (111,200)	5,000 6 (2,267 6)	5,000 5 (2,267 5)										
30,000 (133,440)	6,000 8 (2,721 8)	6,000 6 (2,721 6)										
40,000 (177,920)	8,000 10 (3,628 10)	8,000 8 (3,628 8)	8,000 5 (3,628 5)	This area represents insufficient drill collar weights that cause excessively high impact loads on jar and fishing tools.								
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)	This area represents excessive drill collar					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)	weights that diminish the efficiency of the jar acceleration effort							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'	3-3/8 OD (86) 1-1/2 ID (38) 732 lb 32 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) Max Min.	90 (400) 200 (890)	150 (667) 250 (1112)	180 (800) 300 (1334)	400 (1779) 650 (2981)	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)

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

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

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 9
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	(M) Amplification Factor	L Jar Load (LBF)	F Jar Blow (LBF)
3-3/8 x 1-1/2	2-3/8	6.65	—	—	3-3/8	24.4	2.93	44,000	128,920
4-1/4 x 2	2-7/8	6.87	—	—	4-1/4	37.5	4.36	70,000	305,200
		10.40					2.89	70,000	202,300
		13.30	3-1/2	26	—	—	1.56	95,000	148,200
4-3/4 x 2-1/4	3-1/2	15.50	3-1/2	26	—	—	1.34	95,000	127,300
		13.30	—	—	4-3/4	49.5	2.99	95,000	284,050
		15.50	—	—	4-3/4	49.5	2.56	95,000	243,200
		16.60	4-1/2	42	—	—	2.02	150,000	303,000
		20.00	4-1/2	42	—	—	1.68	150,000	252,000
6-1/4 x 2-3/4		16.60	5	50	—	—	2.41	150,000	361,500
	4-1/2	20.00	5	50	—	—	2.00	150,000	300,000
		16.60	—	—	6-1/4	83.9	4.04	150,000	606,000
6-1/2 x 2-3/4		20.00	—	—	6-1/4	83.9	3.35	150,000	502,500
		16.60	—	—	6-1/2	92.5	4.52	150,000	678,000
		20.00	—	—	6-1/2	92.5	3.71	150,000	556,500
	5	19.50	5	50	—	—	2.05	150,000	307,500
		19.50	—	—	6-1/2	92.5	3.80	150,000	570,000
		16.60	5-1/2	57	—	—	2.74	230,000	630,200
	4-1/2	20.00	5-1/2	57	—	—	2.28	230,000	524,400
7 x 2-3/4		16.60	—	—	7	110.5	5.31	230,000	1,221,300
		20.00	—	—	7-1/4	119.5	4.77	230,000	1,097,100
7-1/4 x 2-3/4		19.50	5-1/2	57	—	—	2.33	230,000	535,900
	5	19.50	—	—	7	110.5	4.53	230,000	1,041,900
		19.50	—	—	7-1/4	119.5	4.89	230,000	1,124,700
	4-1/2	16.60	—	—	7-3/4	136.1	6.56	260,000	1,705,600
7-3/4 x 3		20.00	—	—	7-3/4	136.1	5.45	260,000	1,417,000
		19.50	6-5/8	70	—	—	2.87	260,000	746,200
8 x 3	5	19.50	—	—	7-3/4	136.1	5.60	260,000	1,456,000
		19.50	—	—	8	150.5	6.36	260,000	1,653,600
		19.50	6-5/8	70	—	—	2.87	350,000	1,004,500
8-1/4 x 3	5	19.50	—	—	8-1/4	157.5	6.45	350,000	2,257,500
		19.50	—	—	8-1/2	172.5	7.07	350,000	2,474,500
8-1/2 x 3		21.90	6-5/8	70	—	—	2.55	350,000	892,500
	5-1/2	21.90	—	—	8-1/4	157.5	5.75	350,000	2,012,500
		21.90	—	—	8-1/2	172.5	6.29	350,000	2,201,500
		21.90	6-5/8	70	—	—	2.55	500,000	1,275,000
	5-1/2	21.90	—	—	9	191.9	7.00	500,000	3,500,000
9-1/2 x 3		21.90	—	—	9-1/2	216.6	7.90	500,000	3,950,000
	6-5/8	25.20	6-5/8	70	—	—	2.23	500,000	1,115,000
		25.20	—	—	9-1/2	216.6	6.86	500,000	3,430,000

Amplification Factor (M) = WT/FT HWDP *or* DC ÷ WT/FT *or* 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 9 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 9**. Find 4-1/2-16.60 LB/FT Drill Pipe and 6-1/4-90.6 LB/FT. Drill Collars for an Amplification Factor of 4.04.

With a jar load (L) of 150,000 LBF, jar blow (F) equals 4.04 x 150,000 or 606,000 LBF of Impact Jar Blow.

Hydra-Jar AP Tool Fishing Dimensions

Fishing Dimensions are used to determine the type and size of equipment needed to recover a Hydra-Jar AP tool part lost in the hole. Use Figure 18 in conjunction with Table 10. For fishing dimensions for the Latch see Figure 19 and Table 11.

Figure 18
Fishing Dimensions

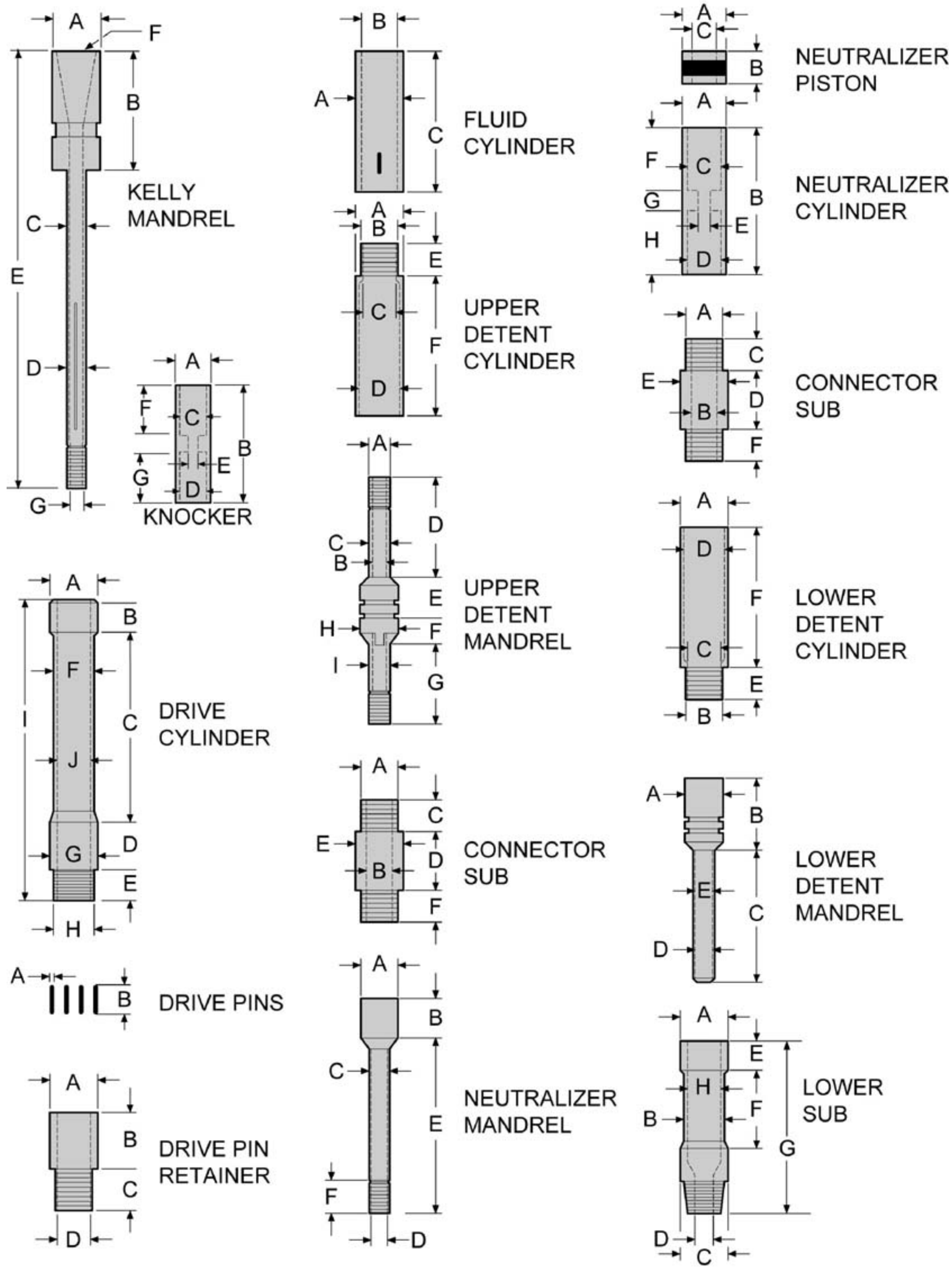


Table 10
Fishing Dimensions

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

Assembly Numbers	16577	15360	16790	20182042	17096	16293	16300	16334	16255	16257	16259	16316	16250
Tool OD inches (mm)	**3-3/8 (85.73)**	**4-1/4 (107.95)**	**4-3/4 (120.65)**	**5-1/8 (130.18)**	**6-1/4 (158.75)**	**6-1/2 (165.10)**	**7 (177.80)**	**7-1/4 (184.15)**	**7-3/4 (195.85)**	**8 (203.20)**	**8-1/4 (209.55)**	**8-1/2 (215.90)**	**9-1/2 (241.30)**
Tool ID inches (mm)	**1-1/2 (38.1)**	**2 (50.80)**	**2-1/4 (57.15)**	**2-1/4 (57.15)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**
Kelly Mandrel													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (129.99)	6-1/4 (158.75)	6-1/2 (165.10)	7 (7.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	16 (406.4)	22-5/16 (566.7)	27-5/16 (693.7)	32 (812.80)	23-3/8 (593.7)	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)	31-7/16 (852.47)
C	2-33/64 (63.9)	3-1/32 (76.84)	3-3/8 (85.73)	3 3/8 (85.725)	4-7/8 (123.8)	4-3/8 (111.13)	4-7/8 (123.83)	4-7/8 (123.83)	5-3/16 (131.76)	5-3/16 (131.76)	6 (152.40)	6 (152.40)	6-3/4 (171.45)
D	2-1/4 (57.15)	3 (76.20)	3-5/16 (84.14)	3 5/16 (84.15)	4-5/16 (109.54)	4-5/16 (109.54)	4-5/8 (117.48)	4-5/8 (117.48)	5-1/8 (130.18)	5-1/8 (130.18)	5-1/2 (139.70)	5-1/2 (139.70)	6 (152.40)
E	81-7/8 (2079.6)	103-3/8 (2625.7)	108-1/2 (2756.0)	113 3/16 (2874.98)	112 (2844.8)	119 (3022.6)	119-5/16 (3030.54)	119-5/16 (3030.54)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	112-13/16 (2865.4)	125-3/8 (3184.53)
F	2-3/8 I.F.	2-7/8 I.F.	3-1/2 I.F.	WT38	NC46	4-1/2 I.F.	4-1/2 I.F.	5 H-90	6-5/8 REG	6-5/8 REG	6-5/8 REG	6-5/8 REG	7-5/8 REG
G	1-1/2 (38.10)	2 (50.80)	2-1/4 (57.15)	2 1/4 (57.15)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
Knocker													
A	2-47/64 (69.5)	3-9/16 (90.49)	3-7/8 (98.43)	3-7/8 (98.43)	8 (203.2)	5-1/4 (133.4)	5-3/4 (146.05)	5-3/4 (146.05)	6-1/2 (165.10)	6-1/2 (165.10)	6-3/4 (171.45)	6-3/4 (171.45)	7-1/8 (180.98)
B	7-1/8 (180.98)	10-3/8 (263.53)	10-3/8 (263.53)	10-3/8 (263.53)	11-7/8 (301.63)	11-7/8 (301.63)	12-5/8 (320.68)	12-5/8 (320.68)	13-15/16 (354.01)	13-15/16 (354.01)	13-15/16 (354.01)	13-15/16 (354.01)	12 (304.80)
C	2-5/32 (54.8)	2-29/32 (73.8)	3-5/32 (80.2)	3-5/32 (80.20)	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 (131.45)	5-11/64 (131.45)	5-57/64 (149.48)
D	1-15/16 (49.2)	2-13/32 (61.1)	2-21/32 (67.5)	2-21/32 (67.50)	3-37/64 (90.9)	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 (105.92)	4-11/64 (105.92)	4-41/64 (117.73)
E	1-1/2 (38.10)	2 (50.80)	2-1/4 (57.15)	2-1/4 (57.15)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
F	1-15/16 (49.21)	5 (127.00)	5 (127.00)	5 (127.00)	5-7/8 (149.23)	5-7/8 (149.23)	6-3/8 (161.93)	6-3/8 (161.93)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/8 (155.58)
G	3-1/4 (82.55)	4-3/8 (111.13)	4-3/8 (111.13)	4-3/8 (111.13)	5 (127.00)	5 (127.00)	5-1/4 (133.35)	5-1/4 (133.35)	6-7/16 (163.51)	6-7/16 (163.51)	6-7/16 (163.51)	6-7/16 (163.51)	4-7/8 (123.83)
Drive Cylinder													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-5/16 (160.3)	6-1/2 165.10	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-9/16 (241.96)
B	8-3/8 (212.73)	7-7/8 (200.03)	7-7/8 (200.03)	10 (254.00)	6-5/16 (160.3)	7-7/8 (200.03)	9-5/16 (236.54)	9-5/16 (236.54)	7-7/8 (200.03)	7-7/8 (200.03)	9-7/8 (250.83)	9-25/32 (248.44)	13 (330.2)
C	13-17/32 (343.69)	22-3/4 (577.85)	22-3/4 (577.85)	18 (457.20)	23-1/16 (585.8)	24-1/2 (622.30)	22-63/64 (583.80)	22-63/64 (583.80)	20 (508.00)	20 (508.00)	18 (457.20)	18-3/32 (459.58)	25-1/2 (647.00)
D	3-3/8 (85.73)	9-3/8 (238.13)	9-3/8 (238.13)	9 13/16 (249.24)	13-5/8 (346.1)	16-1/2 (419.10)	8-3/64 (204.39)	8-3/64 (204.39)	21 (533.40)	21 (533.40)	13-41/64 (346.47)	13-11/16 (347.66)	15-1/8 (28.58)
E	3-3/4 (95.25)	4-7/8 (123.83)	5-15/32 (138.91)	6-1/32 (153.19)	5-7/8 (149.23)	5-7/8 (149.23)	5-53/64 (148.03)	5-25/32 (146.84)	7-13/32 (188.12)	7-13/32 (188.12)	7-23/64 (186.93)	7-5/16 (185.74)	8-1/64 (203.58)
F	3-1/8 (79.38)	3-5/8 (92.08)	4-1/8 (104.78)	4-1/2 (114.30)	5-7/8 (149.23)	5-1/2 (139.70)	6 (152.40)	6 (152.40)	6-1/2 (165.10)	6-1/2 (165.10)	7-1/2 (190.50)	7-1/2 (190.50)	8-3/4 (222.25)
G	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-5/16 (160.3)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-9/16 (241.96)
H	2-7/8 (73.03)	3-3/4 (95.25)	4-1/8 (104.78)	4 25/64 (111.53)	5-7/16 (138.1)	5-5/8 (142.88)	6-1/8 (155.58)	6-1/8 (155.58)	6-7/8 (174.63)	6-7/8 (174.63)	7-1/8 (180.98)	7-1/8 (180.98)	7-3/4 (196.85)
I	31-3/8 (796.93)	44-7/8 (1139.83)	44-7/8 (1139.83)	44 7/8 (1139.83)	48-7/8 (1241.4)	48-7/16 (1230.31)	48-7/8 (1241.43)	48-7/8 (1241.43)	48-7/8 (1241.43)	48-7/8 (1241.43)	48-7/8 (1241.43)	48-7/8 (1241.43)	52-7/8 (1343.03)
J	2-17/32 (64.26)	3-1/32 (77.03)	3-25/64 (86.23)	3 25/64 (86.23)	4-29/32 (124.6)	4-13/32 (111.760)	4-29/32 (124.62)	4-29/32 (124.62)	5-13/64 (132.2)	5-13/64 (132.2)	6-1/32 (153.20)	6-1/32 (153.20)	6-49/64 (171.84)
Drive Pins													
A	5/16 (7.94)	3/8 (9.53)	3/8 (9.53)	3/8 (9.53)	5/8 (15.8)	3/4 (19.05)	3/4 (19.05)	3/4 (19.05)	3/4 (19.05)	3/4 (19.05)	3/4 (19.05)	3/4 (19.05)	1 (24.1)
B	5 (127.00)	10 (245)	10 (245)	10 (245)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)	12 (304.8)
Drive Pin Retainer Sub													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-9/16 (141.29)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	10-17/64 (260.75)	6-1/8 (155.58)	7-1/32 (178.60)	7-9/16 (192.09)	8-57/64 (225.8)	8-7/8 (225.43)	8-59/64 (226.62)	8-61/64 (227.41)	10 (254.00)	10 (254.00)	10-3/4 (273.05)	10 (254.00)	10-7/32 (256.59)
C	3-3/4 (95.25)	5-1/4 (133.35)	4-31/32 (126.21)	4-15/16 (125.41)	5-61/64 (151.21)	6 (152.40)	6-61/64 (176.61)	6-29/32 (175.42)	6 (152.40)	6 (152.40)	5-61/64 (151.21)	5-29/32 (150.02)	8-7/32 (208.76)
D	2-7/8 (73.03)	3-1/32 (76.96)	3-11/32 (84.96)	3-11/32 (84.93)	4-21/64 (109.9)	4-21/64 (109.9)	4-21/32 (118.27)	4-21/32 (118.27)	5-1/4 (133.35)	5-1/4 (133.35)	5-5/8 (142.88)	5-5/8 (142.88)	6-1/16 (153.98)

Table 10 continued

Assembly Numbers	16577	15360	16790	20182042	17096	16293	16300	16334	16255	16257	16259	16316	16250
Tool OD	**3-3/8 (85.73)**	**4-1/4 (107.95)**	**4-3/4 (120.65)**	**5-1/8 (130.18)**	**6-1/4 (158.75)**	**6-1/2 (165.10)**	**7 (177.80)**	**7-1/4 (184.15)**	**7-3/4 (195.85)**	**8 (203.20)**	**8-1/4 (209.55)**	**8-1/2 (215.90)**	**9-1/2 (241.30)**
Tool ID	**1-1/2 (38.1)**	**2 (50.80)**	**2-1/4 (57.15)**	**2-1/4 (57.15)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**
Fluid Cylinder													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	2-3/4 (69.85)	3-5/8 (92.08)	4 (101.60)	4 (101.60)	5-1/4 (133.4)	5-29/64 (138.68)	5-7/8 (149.23)	5-7/8 (149.23)	6-5/8 (168.28)	6-5/8 (168.28)	6-7/8 (174.63)	6-7/8 (174.63)	7-5/16 (185.74)
C	55-5/8 (1412.88)	52-7/16 (1331.91)	51-1/8 (1298.58)	52-5/16 (1328.74)	64-5/8 (1641.5)	54-5/8 (1387.78)	55-15/16 (1420.81)	55-15/16 (1420.81)	60-3/4 (1543.05)	60-3/4 (1543.05)	60-3/4 (1543.05)	60-3/4 (1543.05)	60 (1524.00)
Upper Detent Cylinder													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	2-7/8 (73.03)	3-3/4 (95.25)	4-1/8 (104.78)	4-13/32 (111.92)	5-7/16 (138.1)	5-5/8 (142.88)	6-1/8 (155.58)	6-1/8 (155.58)	6-7/8 (174.63)	6-7/8 (174.63)	7-1/8 (180.98)	7-1/8 (180.98)	7-3/4 (196.85)
C	2-5/16 (52.91)	2-17/32 (64.26)	2-51/64 (70.87)	2-3/4 (69.85)	3-49/64 (95.6)	3-33/64 (89.41)	3-49/64 (95.65)	3-49/64 (95.65)	4-35/64 (115.57)	4-35/64 (115.57)	4-35/64 (115.49)	4-35/64 (115.49)	5-1/32 (127.79)
D	2-7/8 (73.03)	3-1/2 (88.9)	3-15/16 (100.0)	4-1/16 (103.19)	5 (127.00)	5 (127.00)	5-1/2 (139.70)	5-1/2 (139.70)	6-3/8 (161.93)	6-3/8 (161.93)	6-3/8 (161.93)	6-3/8 (161.93)	7-1/4 (184.15)
E	4-3/8 (111.13)	4-31/32 (126.21)	4-21/32 (126.21)	5-7/16 (138.11)	5-23/32 (145.3)	5-3/4 (146.05)	6-1/8 (155.58)	6-5/64 (154.38)	7 (177.80)	7 (177.80)	6-61/64 (176.61)	6-29/32 (175.42)	8-7/32 (208.76)
F	38-1/2 (977.90)	52-17/32 (1334.29)	52-17/32 (1334.29)	52 3/64 (1321.99)	54-19/32 (1386.7)	54-9/16 (1385.89)	54-5/8 (1387.48)	54-43/64 (1388.67)	54-7/8 (1393.83)	54-7/8 (1393.83)	54-59/64 (1395.02)	54-31/32 (1396.21)	57-29/32 (1470.82)
Upper Detent Mandrel													
A	2-1/64 (51.21)	2-1/2 (63.50)	2-3/4 (69.85)	2-3/4 (69.85)	3-11/16 (93.7)	3-7/16 (87.31)	3-1/2 (88.90)	3-1/2 (88.90)	4-1/2 (114.30)	4-1/2 (114.30)	4-1/4 (107.95)	4-1/4 (107.95)	4-3/4 (120.65)
B	1-1/2 (38.10)	2 (50.80)	2-1/4 (57.15)	2-1/4 (57.15)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
C	2-1/16 (52.40)	2-33/64 (64.01)	2-13/16 (71.4)	2-13/16 (71.4)	3-3/4 (95.3)	3-1/2 (88.9)	3-3/4 (95.25)	3-3/4 (95.25)	4.530 (115.06)	4.530 (115.06)	4-17/32 (115.09)	4-17/32 (115.09)	5 (127.00)
D	47-23/32 (1212.06)	48-7/16 (1230.31)	47-3/8 (1203.33)	47-3/8 (1203.33)	59 (1498.6)	49 (1244.60)	49-1/4 (1250.95)	49-1/4 (1250.95)	53-3/8 (1355.73)	53-3/8 (1355.73)	59-3/8 (1508.13)	59-3/8 (1508.13)	52-3/4 (1339.85)
E	2-5/8 (66.68)	5 (127.00)	5 (127.00)	5 (127.00)	5-1/4 (133.4)	5-1/2 (139.70)	5-1/2 (139.70)	5-1/2 (139.70)	6 (152.40)	6 (152.40)	3-1/2 (88.90)	3-1/2 (88.90)	5-5/8 (142.88)
F	2-3/16 (55.56)	2-7/8 (73.03)	2-7/8 (73.03)	2-7/8 (73.03)	3 (76.20)	3 (76.20)	2 (50.80)	2 (50.80)	3-1/2 (88.90)	3-1/2 (88.90)	1-1/2 (38.10)	1-1/2 (38.10)	2-7/8 (73.03)
G	14-23/32 (373.86)	18 (457.20)	18 (457.20)	18 (457.20)	20 (508.00)	20 (508.00)	20 (508.00)	20 (508.00)	21-9/16 (547.69)	21-9/16 (547.69)	21-9/16 (547.69)	21-9/16 (547.69)	22-1/16 (560.39)
H	2-21/32 (67.46)	3-3/8 (85.73)	3-3/4 (95.25)	3-3/4 (95.25)	4-3/4 (120.65)	4-3/4 (120.65)	5-3/8 (136.53)	5-3/8 (136.53)	6-1/8 (155.58)	6-1/8 (155.58)	6-1/8 (155.58)	6-1/8 (155.58)	7 (177.80)
I	2-1/16 (52.40)	2-33/64 (64.01)	2-3/4 (69.90)	2-3/4 (69.90)	3-1/2 (88.90)	3-1/2 (88.90)	3-3/4 (95.25)	3-3/4 (95.25)	4.530 (115.06)	4.530 (115.06)	4-17/32 (115.09)	4-17/32 (115.09)	5 (127.00)
Connector Sub													
A	2-7/8 (73.03)	3-3/4 (95.25)	4-1/8 (104.78)	4-7/16 (112.71)	5-7/16 (138.1)	5-7/8 (149.23)	6-1/8 (155.58)	6-1/8 (155.58)	6-7/8 (174.63)	6-7/8 (174.63)	6-7/8 (174.63)	6-7/8 (174.63)	7-3/4 (196.85)
B	2-11/32 (59.53)	2-63/64 (75.79)	3-3/8 (85.73)	3-3/8 (85.73)	4-7/16 (112.7)	4-1/2 (114.30)	4-1/2 (114.30)	4-1/2 (114.30)	5-1/2 (139.70)	5-1/2 (139.70)	4-7/8 (123.83)	4-7/8 (123.83)	5-3/8 (136.53)
C	3-3/4 (95.25)	4-31/32 (126.21)	4.969 (126.21)	5-1/8 (130.18)	5-45/64 (144.9)	5-7/8 (149.23)	5-53/64 (148.03)	5-25/32 (146.84)	6-1/2 (165.10)	6-1/2 (165.10)	6-13/32 (162.72)	6-23/64 (161.53)	6-63/64 (177.40)
D	8 (203.20)	7-1/16 (179.39)	7-1/16 (179.39)	6-47/64 (171.05)	9-15/32 (240.5)	9-1/8 (231.78)	9-7/32 (234.16)	9-19/64 (236.14)	10 (254.00)	10 (254.00)	10-11/64 (258.37)	10-17/64 (260.75)	9-13/32 (238.92)
E	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-9/16 (141.29)	6-5/16 (160.3)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (196.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
F	3-3/4 (95.25)	4-31/32 (126.21)	4.969 (126.21)	5-1/8 (130.18)	5-45/64 (144.9)	5-7/8 (149.23)	5-53/64 (148.03)	5-25/32 (146.84)	6-1/2 (165.10)	6-1/2 (165.10)	6-13/32 (162.72)	6-23/64 (161.53)	6-63/64 (177.40)
F	38-1/2 (977.90)	52-17/32 (1334.29)	52-17/32 (1334.29)	54-19/32 (1386.70)	54-9/16 (1385.89)	54-5/8 (1387.48)	54-43/64 (1388.67)	54-7/8 (1393.83)	54-7/8 (1393.83)	54-59/64 (1395.02)	54-31/32 (1396.21)	57-29/32 (1470.82)	
Neutralizer Mandrel													
A	2-1/4 (57.15)	2-7/8 (73.03)	3-5/16 (84.14)	3-5/16 (84.14)	4-1/8 (104.8)	4-3/8 (111.13)	4-3/8 (111.13)	4-3/8 (111.13)	5-1/4 (133.35)	5-1/4 (133.35)	4-3/4 (120.65)	4-3/4 (120.65)	5-1/4 (133.35)
B	7-21/32 (194.47)	7-7/16 (188.91)	7-1/8 (180.98)	7-1/8 (180.98)	8-11/16 (220.7)	7-1/16 (179.39)	8-9/32 (210.34)	8-9/32 (210.34)	8-5/8 (219.08)	8-5/8 (219.08)	6-1/2 (165.10)	6-1/2 (165.10)	9-1/8 (231.78)
C	2-1/16 (52.40)	2-33/64 (64.01)	2-49/64 (70.36)	2-49/64 (70.36)	3-3/4 (95.3)	3-1/2 (88.90)	3-3/4 (95.25)	3-3/4 (95.25)	4-17/32 (115.06)	4-17/32 (115.06)	4-17/32 (115.09)	4-17/32 (115.09)	5 (127.00)
D	1-1/2 (38.10)	2 (50.80)	2-1/4 (57.15)	2-1/4 (57.15)	2-3/4 (69.9)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
E	62-9/16 (1589.09)	85 (2159.00)	87-3/4 (2228.85)	87-3/4 (2228.85)	92-5/16 (2344.7)	93-15/16 (2386.00)	92-23/32 (2355.06)	92-23/32 (2355.06)	99-5/8 (2530.48)	99-5/8 (2530.48)	98-1/4 (2495.55)	98-1/4 (2495.55)	94-3/8 (2397.13)
F	2-13/32 (61.11)	3-11/16 (93.66)	3-11/16 (93.66)	3-11/16 (93.66)	4-1/8 (104.8)	4-1/4 (197.95)	4-27/64 (112.32)	4-27/64 (112.32)	5-3/32 (129.38)	5-3/32 (129.38)	5 (127.00)	5 (127.00)	5 (127.00)

Table 10 continued

Assembly Numbers	16577	15360	16790	20182042	17096	16293	16300	16334	16255	16257	16259	16316	16250
Tool OD	**3-3/8 (85.73)**	**4-1/4 (107.95)**	**4-3/4 (120.65)**	**5-1/8 (130.18)**	**6-1/4 (158.75)**	**6-1/2 (165.10)**	**7 (177.80)**	**7-1/4 (184.15)**	**7-3/4 (195.85)**	**8 (203.20)**	**8-1/4 (209.55)**	**8-1/2 (215.90)**	**9-1/2 (241.30)**
Tool ID	**1-1/2 (38.1)**	**2 (50.80)**	**2-1/4 (57.15)**	**2-1/4 (57.15)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**2-3/4 (69.85)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**	**3 (76.20)**
Neutralizer Piston													
A	2-47/64 (69.34)	3-39/64 (91.82)	3-63/64 (101.35)	3-63/64 (101.35)	5-1/4 (133.4)	5-23/64 (136.27)	5-47/64 (145.65)	5-47/64 (145.65)	6-31/64 (164.70)	6-31/64 (164.70)	6-31/64 (164.70)	6-31/64 (164.70)	7-23/64 (186.93)
B	3 (76.20)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)
C	2-5/64 (52.91)	2-17/32 (64.26)	2-51/64 (70.88)	2-51/64 (70.88)	3-3/4 (95.3)	3-33/64 (89.42)	3-49/64 (95.65)	3-49/64 (95.65)	4-35/64 (115.49)	4-35/64 (115.49)	4-35/64 (115.49)	4-35/64 (115.49)	5-1/64 (127.40)
Neutralizer Cylinder													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5 3/16 (131.76)	5-15/16 (134.9)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (195.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	28-5/8 (727.08)	45-1/4 (1149.35)	45-5/16 (1150.94)	45 5/16 (1150.94)	46-3/8 (1177.93)	46-3/8 (1177.93)	46-3/8 (1177.93)	46-3/8 (1177.93)	50-1/4 (1276.35)	50-1/4 (1276.35)	50-1/4 (1276.35)	50-1/4 (1276.35)	47 (1193.80)
C	2-3/4 (69.85)	3-5/8 (92.08)	4 (101.60)	4 (101.60)	5-1/4 (133.4)	5-3/8 (136.53)	5-3/4 (146.05)	5-3/4 (146.05)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	7-3/8 (187.33)
D	2-3/4 (69.85)	3-5/8 (92.08)	4 (101.60)	4 (101.60)	5-1/4 (133.4)	5-3/8 (136.53)	5-3/4 (146.05)	5-3/4 (146.05)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	7-3/8 (187.33)
E	2-3/16 (55.56)	3 (76.20)	3 (76.20)	3-1/4 (82.55)	4-1/2 (114.9)	4 (101.60)	5 (127.00)	5 (127.00)	4-3/4 (120.65)	4-3/4 (120.65)	5-1/2 (139.70)	5-1/2 (139.70)	6-1/2 (165.10)
F	12-13/16 (325.44)	21-3/4 (552.45)	21-3/4 (552.45)	20-5/8 (523.88)	21-3/16 (538.2)	22-5/16 (566.74)	21-3/16 (538.16)	20-1/8 (511.18)	24-1/8 (612.78)	24-1/8 (612.78)	23-1/8 (587.38)	23-1/8 (587.38)	22-1/2 (571.50)
G	3 (76.20)	1-3/4 (44.45)	1-13/16 (46.04)	4-1/6 (105.83)	4 (101.6)	1-3/4 (44.45)	4 (101.60)	4 (101.60)	2 (50.80)	2 (50.80)	4 (101.60)	4 (101.60)	2 (50.80)
H	12-13/16 (325.44)	21-3/4 (552.45)	21-3/4 (552.45)	20 5/8 (523.88)	21-3/16 (538.16)	22-5/16 (566.74)	21-3/16 (538.16)	20-1/8 (511.18)	24-1/8 (612.78)	24-1/8 (612.78)	23-1/8 (587.38)	23-1/8 (587.38)	22-1/2 (571.50)
Lower Detent Cylinder													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (195.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	2-7/8 (73.03)	3-3/4 (95.25)	4-1/8 (104.78)	4-13/32 (111.92)	5-1/4 (133.4)	5-5/8 (142.88)	5-3/4 (146.05)	5-3/4 (146.05)	6-7/8 (174.63)	6-7/8 (174.63)	6-7/8 (174.63)	6-7/8 (174.63)	7-3/4 (196.85)
C	2-5/64 (52.91)	2-17/32 (64.26)	2-51/64 (70.87)	2-25/32 (70.64)	3-49/64 (95.6)	3.520 (89.41)	3-49/64 (95.65)	3-49/64 (95.65)	4.550 (1115.57)	4.550 (1115.57)	4-35/64 (115.49)	4-35/64 (115.49)	5-1/32 (127.83)
D	2-49/64 (70.49)	3-1/2 (88.90)	3-7/8 (98.43)	4-1/32 (102.39)	5 (127.0)	5 (127.00)	5-1/2 (139.70)	5-1/2 (139.70)	6-3/8 (161.93)	6-3/8 (161.93)	6-3/8 (161.93)	6-3/8 (161.93)	7-1/4 (184.15)
E	4-3/8 (111.13)	431/32 (126.21)	4-31/32 (126.21)	5-61/64 (151.21)	5-45/64 (144.9)	5-3/4 (146.05)	6-1/8 (155.58)	6-5/64 (154.38)	7 (177.80)	7 (177.80)	6-61/64 (176.61)	6-29/64 (163.91)	8-7/32 (208.76)
F	31-5/8 (803.28)	52-17/32 (1334.29)	52-17/32 (1334.29)	52-27/64 (1331.52)	54-39/64 (1387.1)	54-9/16 (1385.89)	54-5/8 (1387.78)	54-43/64 (1388.67)	54-7/8 (1393.83)	54-7/8 (1393.83)	54-59/64 (1395.02)	54-31/32 (1396.21)	57-29/32 (1470.82)
Lower Detent Mandrel													
A	2-21/32 (67.46)	3-3/8 (85.73)	3-3/8 (85.73)	3-3/8 (85.73)	4-1/8 (104.8)	4-3/4 (120.65)	5-1/4 (133.35)	5-1/4 (133.35)	6-1/8 (155.58)	6-1/8 (155.58)	6-1/8 (155.58)	6-1/8 (155.58)	6-7/8 (175.63)
B	4-1/16 (103.19)	12 (304.80)	10-1/2 (266.70)	10-1/2 (266.70)	12-3/8 (314.33)	12-3/8 (314.33)	8-15/32 (215.11)	13-31/32 (354.81)	13 (330.20)	13 (330.20)	8-1/2 (215.90)	8-1/2 (215.90)	13-1/4 (336.55)
C	35-9/32 (896.14)	41-1/2 (1054.10)	42 (1066.8)	42 (1066.80)	42-3/8 (1076.3)	42 (1066.8)	45-29/32 (1166.12)	40-13/32 (1026.31)	41-3/4 (1060.45)	41-3/4 (1060.45)	40-1/4 (1022.35)	40-1/4 (1022.35)	43-5/8 (1108.08)
D	2-1/16 (52.40)	2-33/64 (64.01)	2-49/64 (70.36)	2-49/64 (70.36)	3-3/4 (95.25)	3-1/2 (88.90)	3-3/4 (95.25)	3-3/4 (95.25)	4-17/32 (115.09	4-17/32 (115.09	4-17/32 (115.09)	4-17/32 (115.09)	5 (127.00)
E	1-1/2 (38.10)	2 (50.80)	2-1/4 (57.15)	2-1/4 (57.15)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
Lower Sub													
A	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (195.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
B	3-1/8 (79.38)	3-3/4 (95.25)	4 (101.60)	4-3/16 (106.36)	5-3/8 (136.5)	5 (127.00)	5-1/2 (139.70)	5-1/2 (139.70)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	6-1/2 (165.10)	8-1/2 (215.90)
C	3-3/8 (85.73)	4-1/4 (107.95)	4-3/4 (120.65)	5-3/16 (131.76)	6-1/4 (158.75)	6-1/2 (165.10)	7 (177.80)	7-1/4 (184.15)	7-3/4 (195.85)	8 (203.20)	8-1/4 (209.55)	8-1/2 (215.90)	9-1/2 (241.30)
D	1-1/2 38.10	2 (50.80)	2-1/4 (57.15)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)	3 (76.20)
E	7-1/4 (184.15)	7-5/8 (193.7)	12-3/4 (323.85)	14-1/8 (358.78)	11-3/4 (298.45)	12-5/32 (308.9)	11-3/4 (298.45)	11-23/64 (288.53)	12 (304.80)	11-9/16 (293.68)	11-9/16 (293.68)	14-5/16 (363.5)	11-3/4 (298.45)
F	18 (457.20)	23-7/8 (606.4)	19 (482.6)	16-3/8 (415.93)	17-13/16 (452.44)	17-7/16 (442.9)	17-13/16 (452.44)	18-13/64 (462.46)	18 (457.20)	15-7/8 (4033.2)	18-7/16 (468.31)	19-13/64 (487.76)	18 (457.20)
G	41-1/2 (1054)	47-3/4 (1213)	47-3/4 (1213)	66-3/4 (1695)	48-7/8 (1241.4)	58 (1473)	58 (1473)	58 (1473)	50 (1270)	50 (1270)	50 (1270)	50 (1270)	50 (1270)
H	2-3/16 (55.56)	2-3/4 (69.85)	3 (76.20)	3 (76.20)	4 (101.60)	4 (101.60)	4 (101.60)	4 (101.60)	4-3/4 (120.65)	4-3/4 (120.65)	4-3/4 (120.65)	4-3/4 (120.65)	5-1/8 (130.18)

Fishing Dimensions are used to determine the type and size of equipment needed to recover a Latch tool part lost in the hole. Use Figure 19 in conjunction with Table 11.

Figure 19
Latch Fishing Dimensions

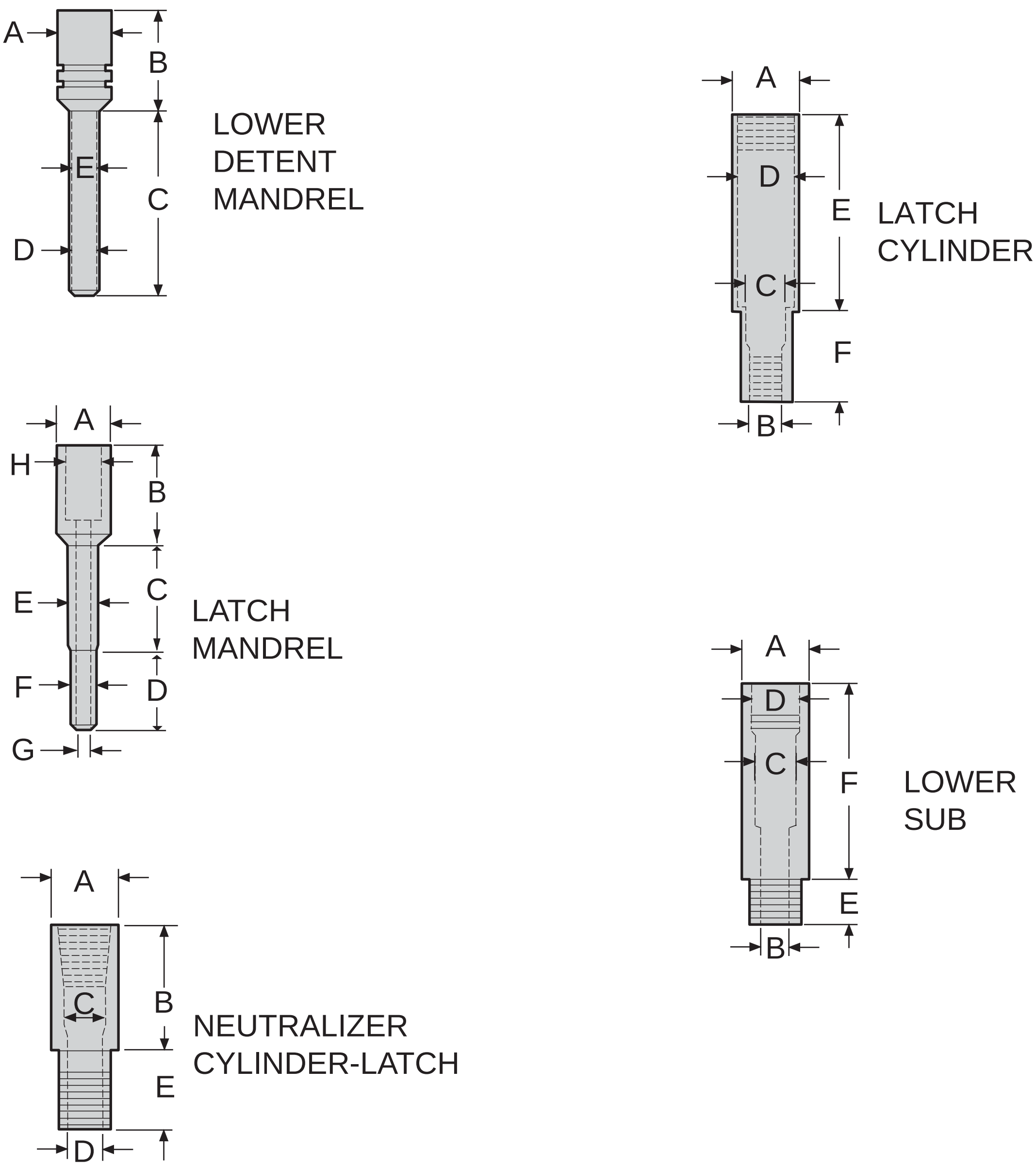


Table 11
Fishing Dimensions Latch

Assembly Number	H17147	H17146	H17148
Tool OD inches (mm)	**4 3/4 (120.65)**	**6 1/2 (165.10)**	**8 (203.20)**
Lower Detent Mandrel-Latch			
A	3 3/4 (95.25)	4 3/4 (120.65)	6 1/8 (155.58)
B	6 7/8 (164.63)	6 7/8 (164.63)	7 3/8 (180.69)
C	52 1/4 (1280.13)	55 3/4 (1365.88)	57 (1447.80)
D	2 12/16 (70.36)	3 1/2 (88.90)	4 17/32 (111.02)
E	2 1/4 (57.15)	2 3/4 (67.38)	3 (76.20)
Latch Mandrel			
A	3 5/16 (84.14)	4 5/16 (109.52)	5 1/4 (133.35)
B	7 15/16 (194.47)	6 11/16 (163.84)	7 7/16 (182.22)
C	30 13/16 (754.91)	31 4/7 (773.28)	30 1/16 736.53
D	30 1/2 (774.70)	29 3/4 (755.65)	30 1/2 (774.70)
E	3 3/32 (78.49)	3 13/16 (97.03)	4 13/16 (122.17)
F	2 49/64 (70.36)	3 1/2 (88.90)	4 1/2 (114.30)
G	2 1/4 (57.15)	2 3/4 (69.85)	3 (76.20)
H	2 21/32 (67.31)	3 11/32 (84.84)	4 19/64 (109.22)
Neutralizer Cylinder-Latch			
A	4 13/16 (122.24)	6 9/16 (166.69)	8 1/6 (204.79)
B	38 17/32 (978.92)	37 11/16 (957.07)	39 3/32 (987.55)
C	3 7/8 (98.43)	4 3/4 (120.65)	6 3/8 (161.93)
D	3 3/8 (85.73)	4 3/8 (111.13)	5 3/8 (136.63)
E	4 31/32 (125.98)	5 13/16 (147.83)	6 29/32 (181.10)
Assembly Number	**H17147**	**H17146**	**H17148**
Tool OD inches (mm)	**4 3/4 (120.65)**	**6 1/2 (165.10)**	**8 (203.20)**
Latch Cylinder			
A	4 13/16 (122.24)	6 9/16 (166.69)	8 1/6 (204.79)
B	2 51/64 (70.87)	3 33/64 (89.41)	4 35/64 (115.57)
C	3 3/16 (81.00)	4 (101.60)	5 (127.00)
D	4 (101.60)	5 31/64 (139.19)	6 3/8 (162.05)
E	35 1/2 (900.18)	35 1/4 (895.35)	35 1/4 (895.35)
F	5 (128.52)	5 1/4 (133.35)	5 1/4 (133.35)
Lower Sub			
A	4 13/16 (117.90)	6 9/16 (160.77)	8 1/16 (197.53)
B	2 1/4 (55.13)	2 3/4 (67.38)	3 (73.25)
C	3 (73.25)	3 7/8 (94.94)	4 3/4 (116.38)
D	4 1/32 (98.77)	5 1/8 (125.56)	6 29/64 (158.10)
E	3 7/8 (94.94)	4 3/8 (107.19)	4 7/8 (119.44)
F	40 1/8 (983.06)	39 5/8 (946.31)	43 1/8 (1056.56)

Figure 20
Pump Pressure Extension Load

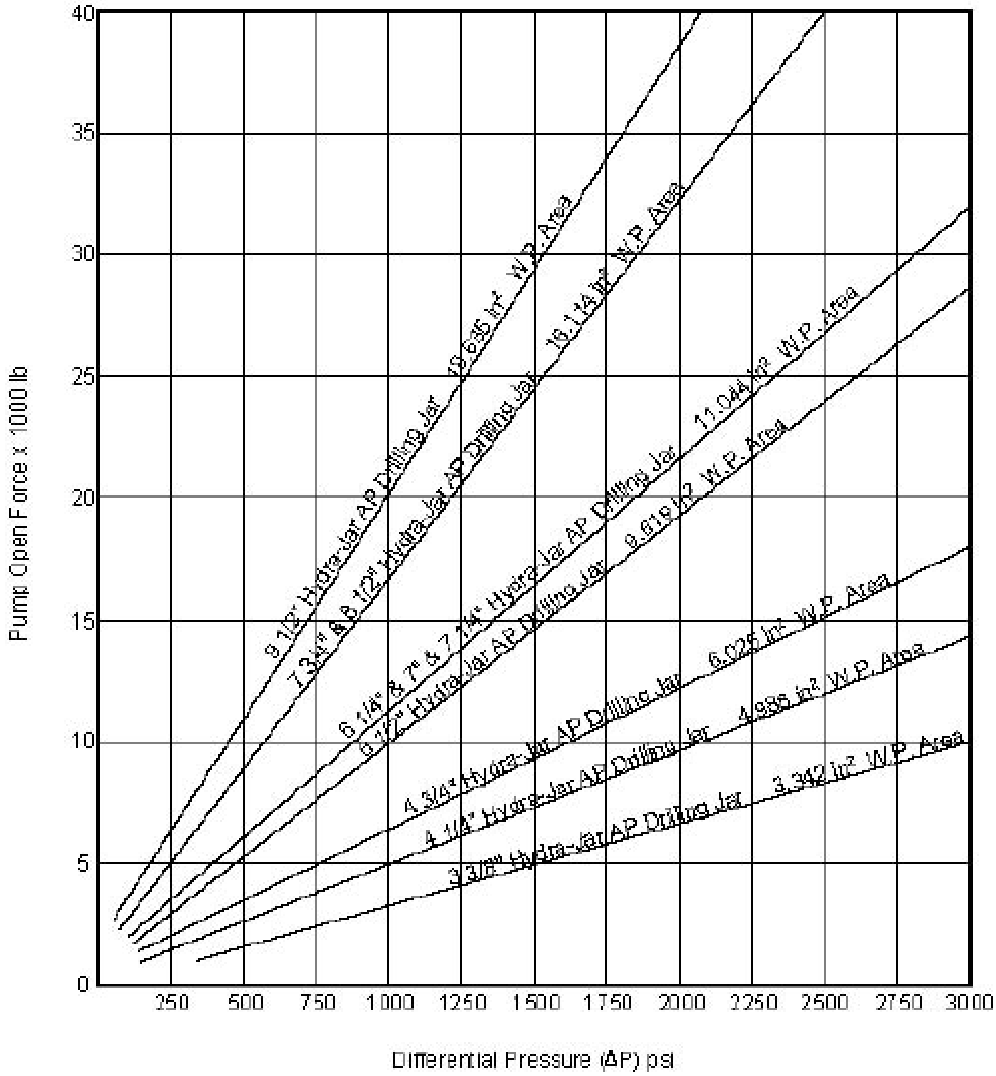
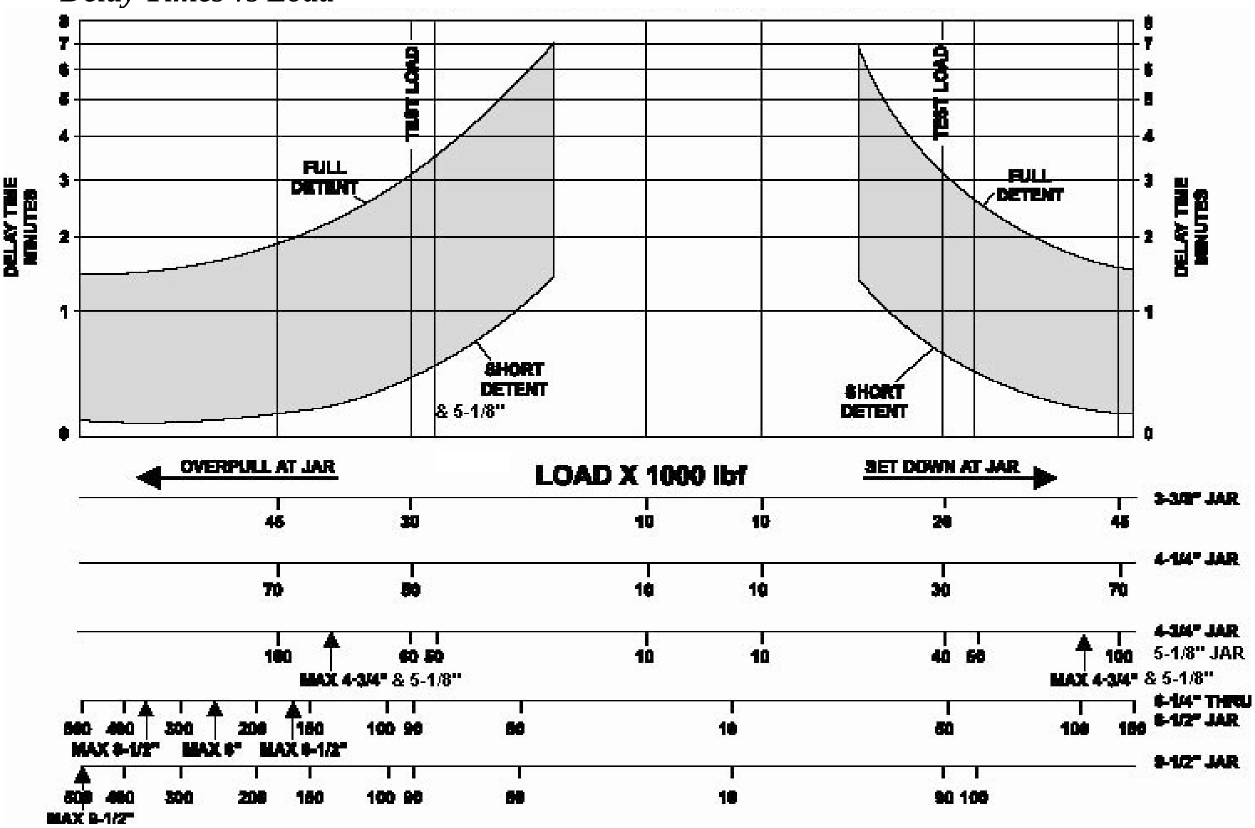


Figure 21
Delay Times vs Load



Full Detent

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

Short Detent

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

Delay Time

The time elapsed between cocking and firing the Hydra-Jar AP tool. Hole drag not accounted for in Figure 21.

Test Load

Functional test performed at service centers.

Schlumberger

P.O. Box 60068 • Houston, Texas 77205-0068
U.S. and Canada: 800-877-6484
Tel: 281-443-3370 • Fax: 281-233-5121
www.slb.com