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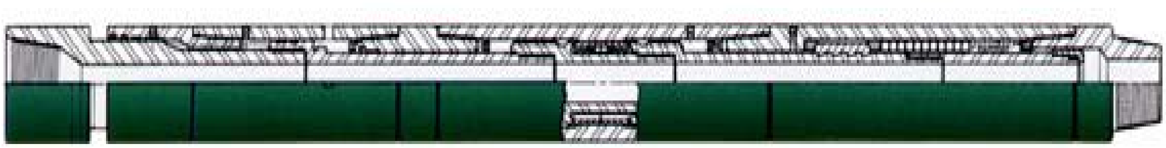

OPERATING MANUAL
DOUBLE ACTING
HYDRAULIC / MECHANICAL DRILLING JAR

Size	Series
4 3/4"	431
6 1/2"	428
6 3/4"	440
7"	441
7 1/8"	480
8"	411
9 1/2"	437

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Reviewed and Approved By: Signature: ____________________ Initials: __________ Date: ______________

OPERATING MANUAL

DOUBLE ACTING

HYDRAULIC / MECHANICAL DRILLING JAR

CONTENTS

1. DESCRIPTION

A drilling jar installed in the drilling string is immediately available to apply jarring action and release the stuck portion of the drill string.

The Griffith Double Acting Hydraulic/Mechanical Drilling Jar is designed for use during drilling operations to apply an intensified force either up or down against a stuck portion of the drill string.

The force or overpull required to free a stuck drill string must be applied in addition to the load already supported by the drilling rig and the drill pipe. This combined force often exceeds the safe tensile strength of the drill pipe, and sometimes the hoisting capacity of the drilling rig. This usually results in a costly and time consuming fishing operation.

The GRIFFITH DOUBLE ACTING HYDRAULIC/MECHANICAL DRILLING JAR was developed to incorporate the features of both hydraulic and mechanical drilling jars, without the inherent disadvantages of either type. Its unique design combines both a hydraulic time delay release and a mechanical latch mechanism, in one relatively short, double acting drilling jar. This tool provides several distinct advantages over conventional hydraulic or mechanical drilling jars.

- Hydraulic time delay allows the operator to vary the overpull applied, or slacked-off weight, then apply the drawworks drum brake. The jarring force is therefore easily controlled and damage to the hoisting equipment is prevented.

- A unique metering device eliminates the need to cool the jar during prolonged jarring. Jarring operations may continue indefinitely without a noticeable decrease in the hydraulic time delay.

- Mechanical latch mechanism prevents jar movement during normal drilling operations, eliminating unnecessary wear of internal components.

- Location in BHA is less restricted. The jar can be used in tension or compression within the limits of the latch setting.

- No safety collars or special handling procedures are required on the rig floor.

- Will not fire unexpectedly when drilling, or tripping in or out of the hole.

- Latch re-sets automatically, locking jar in neutral position.

- Linear action latch is not affected by torque.

- Double acting, jarring action (mechanical and hydraulic delay) in both up and down directions.

To jar up, tension is applied to the jar, stretching the drill string. When the jar releases, the energy stored in the stretched drill string accelerates the jar mandrel rapidly to its fully extended position. The sudden stop of the jar mandrel converts the kinetic energy of the moving mass of drill collars into an intense impact or jarring force. This impact force will vary depending on the actual operating conditions, but can reach eight times the initial overpull.

To jar down, weight is slacked off to apply compression force to the jar. When the jar releases, the drill string is allowed to drop free. When the jar reaches its fully closed position, an intense impact force is applied to the stuck portion of the drill string.

2. OPERATION

2.1. GENERAL

The Griffith Double Acting Hydraulic/Mechanical Jar must be installed in the drill string with the mandrel end up. Prior to make up, a suitable thread compound meeting A.P.I. Spec. 7, Appendix "F" (or equivalent industry standard) should be applied to the end connections.

Protect the mandrel sealing surface from possible damage during handling or storage. Never apply tongs, slips, chains or slings to this area.

Rig tongs should be applied immediately adjacent to the top and bottom connections to avoid breaking or torquing the jar body connections. All body connections are torqued to specification at the service center. Avoid breaking these connection at the rig.

The up and down latch release settings are marked on the jar before shipment. These settings should be recorded before the tool is run into the hole.

The Griffith Double Acting Hydraulic/Mechanical Jar is operated by simple up and down motion of the drill string. The intensity of the up-jarring force is directly proportional to applied tension. In the up-jarring mode, as the applied tension exceeds the up-latch setting, the mechanical latch releases and the hydraulic delay sequence begins. After a brief time delay, the jar mandrel is suddenly released and accelerates to the fully extended position.

In down-jarring mode, as the compression force applied to the jar exceeds the down-latch setting, the mechanical latch releases and the hydraulic delay sequence begins. After a brief time delay, the jar mandrel is suddenly released allowing the mandrel to move freely to the fully closed position.

2.2. PLACEMENT

Determining the ideal jar position in the bottom hole assembly, is a complex problem, where several factors must be considered. Some of these factors are:

- Anticipated type of sticking; differential or mechanical.
- Hole condition, trajectory, and inclination.
- Configuration of bottom hole assembly.
- Wall drag.
- Pump pressure.
- Buoyancy factor of drilling fluid.
- Planned range of weight on bit.
- Overpull available.
- Safe working strength of the drill pipe.
- Latch setting on the jar.

Although each situation and combination of factors is unique, there are some general guidelines that can be used to select the location of the jar:

- In zones where differential sticking is anticipated, locate the jar relatively high in the BHA, to minimize the chance of becoming stuck above the jar.
- Where mechanical sticking is more common, the jar may be located lower in the BHA, for increased jarring efficiency.
- The Griffith Double Acting Hydraulic/Mechanical Jar may be located in the drill string in either tension or compression but not at the transition point.
- Axial forces acting on the Griffith Jar while drilling, should not exceed 50% of the latch release settings. This will provide an adequate safety factor for normal load variations. Charts showing the recommended operating range for each size of jar are include in Section 4, "Operating Charts".

- For maximum jarring efficiency, the jar should be located as close as possible above the anticipated stuck point, but at least two drill collar lengths above the top stabilizer. This usually locates the jar below the transition point of the bottom hole assembly and therefore places the jar in compression.

- A sufficient number of drill collars and/or heavy weight drill pipe should be run above the jar, to provide the necessary mass to jar down.

- To avoid becoming stuck above the jar, the drill string above must not exceed the jar diameter.

- Avoid locating the jar at a crossover between BHA components of different diameters such as drill collars and heavy weight drill pipe. The jar should be placed a minimum of two joints above or below a cross over.

Although the drilling jar should be placed as close as possible above the anticipated stuck point, the jar should never be placed immediately above the top stabilizer. Whipping of the drill collars could create severe bending stresses on the jar if placed at this location. A minimum of two drill collar lengths should be placed between the jar and top stabilizer to:

- Minimize bending stresses in jar

- Minimize the risk of becoming stuck above the jar in sloughing formations

- Provide a clear target for a string shot if required.

DRILLING JAR PLACEMENT
RELATIVE TO STABILIZATION

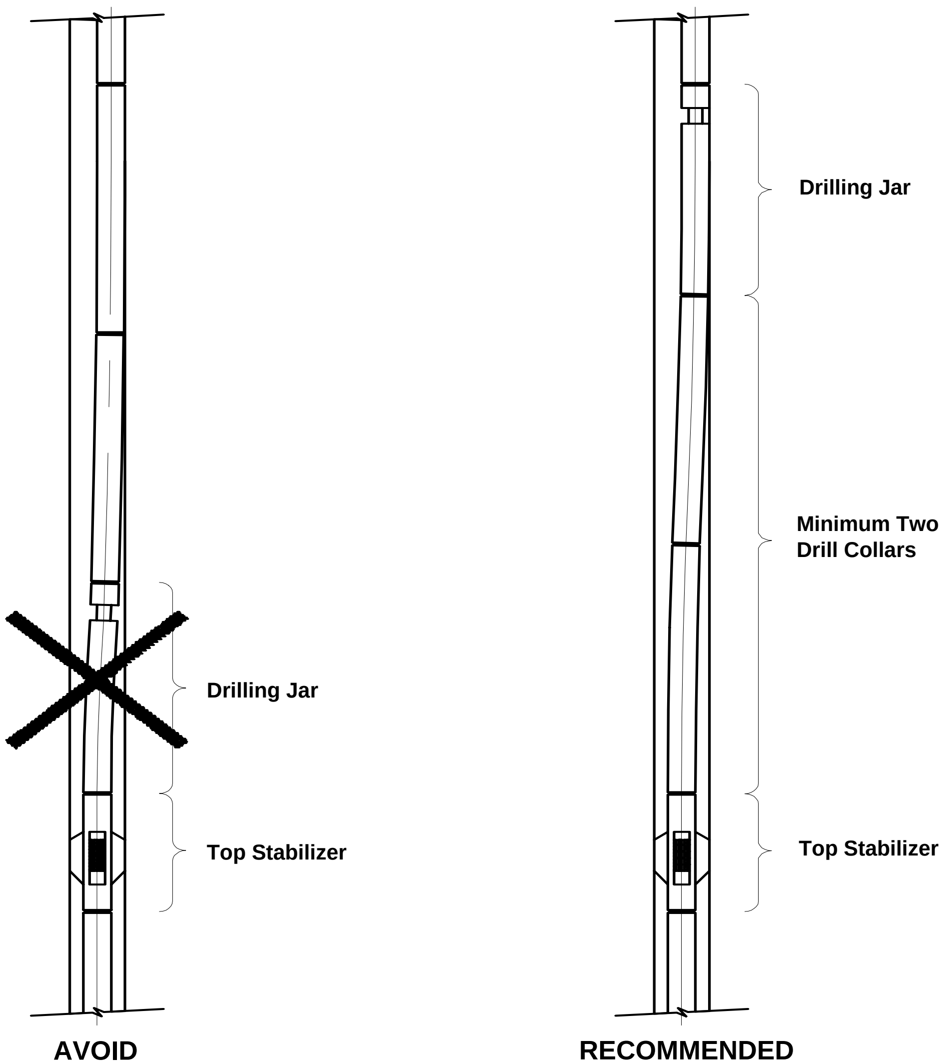


Figure 1

2.3. JARRING

Mechanical Latch Settings

The latch release force is adjusted to suit normal drilling requirements, at the time of assembly. On request, these settings can be changed for special applications.

The down release force is approximately 45% of the up release setting, but may be varied from 35% to 75% of the up release setting, if required.

To prevent the jar from releasing accidentally, the total force acting on the jar must be less than the latch settings.

Pump Open Force

If circulation is maintained while jarring, the pressure drop across the bit creates a force tending to extend the jar. The pump open force must be considered in the following calculations since it reduces the force required to jar up and increases the force required to jar down. The pump open force is calculated by multiplying the pressure drop across the bit by the pump open area. The pump open areas are listed for each size of jar in Section 5: Specifications - Double Acting Hydraulic/Mechanical Drilling Jars.

EXAMPLE: 6.50" Jar with 1,000 psi Bit Pressure Drop

Pump Open Area = 9.6 in²

Pump Open Force = 9.6 in² x 1,000 psi = 9,600 Pounds Force

Wall Drag

Additional force may be required to compensate for wall drag, especially in deviated holes. The amount of compensation should be determined from the weight indicator readings during tripping before the drill string became stuck.

Free String Weight

The free string weight is the weight of string above the jar. To determine the free string weight subtract the weight below the jar from the total string weight.

Jarring Up

The force applied (overpull) to the jar above free string weight, must be greater than the up latch setting but less than the recommended maximum load during hydraulic delay.

To determine the overpull above the free string weight, subtract the pump open force from the up latch setting

EXAMPLE: 6.50" Jar with 1,000 psi (6894 kPa) Bit Pressure Drop

	Imperial units	**Metric units**
Up Latch Setting =	90,000 lbs	40 000 daN
Maximum Load During Hydraulic Delay =	160,000 lbs	71 000 daN
Pump Open Force =	9,600 lbs	4 300 daN
Minimum Overpull Required =	90,000 - 9,600	40 000 - 4 300
=	80,400 lbs	35 700 daN
Maximum Recommended Overpull =	160,000 - 9,600	71 000 - 4 300
=	150,400 lbs	66 700 daN

To jar upward, apply the calculated overpull and set the drawworks brake. The mechanical latch will release and the delay sequence will begin. After the time delay of approximately 30 seconds, the jar will fire.

Lower the drill string until the weight indicator reads less than the free string weight, indicating that the latch has re-engaged. The jar is ready for another jarring cycle or to resume normal drilling operations.

Additional overpull may be required to compensate for wall drag above the jar, especially in deviated wells.

Jarring Down

The slack off weight required from the free string weight, must be greater than the down latch setting but less than the recommended maximum load during hydraulic delay.

EXAMPLE: 6.50" Jar with 1,000 psi (6894 kPa) Bit Pressure Drop

	Imperial units	**Metric units**
Down Latch Setting =	40,500 lbs	18 000 daN
Maximum Load During Hydraulic Delay =	160,000 lbs	71 000 daN
Pump Open Force =	9,600 lbs	4 300 daN
Minimum Slack Off From Free String Weight =	40,500 + 9,600	18 000 + 4 300
=	50,100 lbs	22 300 daN
Maximum Slack Off From Free String Weight =	160,000 + 9,600	71 000 + 4 300
=	169,600 lbs	75 300 daN

To jar downward, lower the drilling string until the calculated weight is slacked off, at which point the mechanical latch will release and the delay sequence will begin. After the time delay of approximately 30 seconds, the jar will fire. To re-latch the jar raise the drilling string until the weight indicator shows an increase above free string weight. This indicates the latch has re-engaged and that the jar is ready for another jarring cycle.

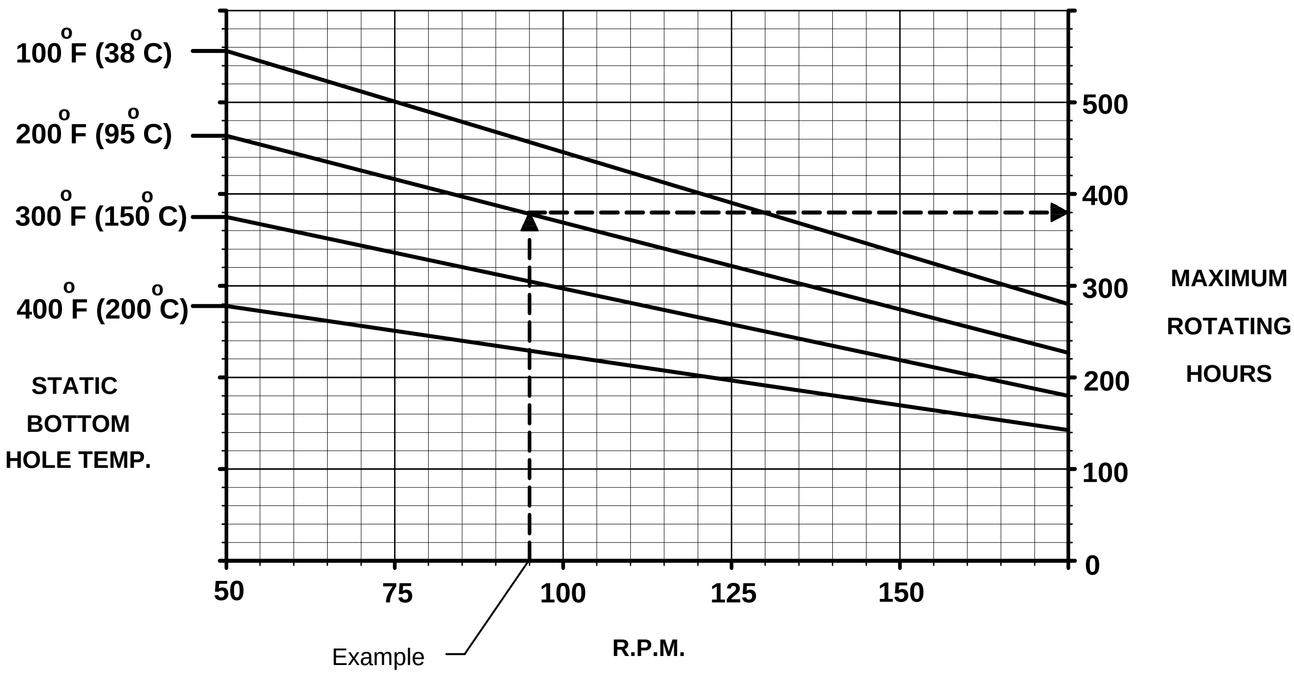
Additional slack off weight may be required to compensate for wall drag above the jar, especially in deviated wells.

Inspection

On each round trip the jar should be visually inspected for any indication of damage, excessive wear or leakage. When the jar is first removed from the hole a small quantity of drilling fluid may be noticed draining from the balancing ports. This condition is normal and does not indicate a problem.

2.4. MAXIMUM ROTATING HOURS

The chart shown below, indicates the maximum recommended rotating hours between servicing periods. This chart takes into consideration the rotating speed and static bottom hole temperature, assuming that the jar has only been used for short periods of light jarring totaling less than two hours. The jar should be serviced as soon as possible, following any continuous heavy jarring.



Example: 95 R.P.M. at 200°F = 380 HOURS

3. MAINTENANCE AND STORAGE

New tools are shipped painted. The threaded ends are chemplated with phosphate and coated with rust preventative coating. Thread protectors are installed to eliminate mechanical damage. The rust preventative coating must be removed using petroleum base solvent and a stiff bristle brush before the jar is installed into the drill string.

When the jar is to be laid down the following should be done:

1. Flush all drilling fluid from the bore and from the balancing chamber with fresh water.

2. Wash external surfaces of the tool.

3. Apply thread compound and protectors to the end connections.

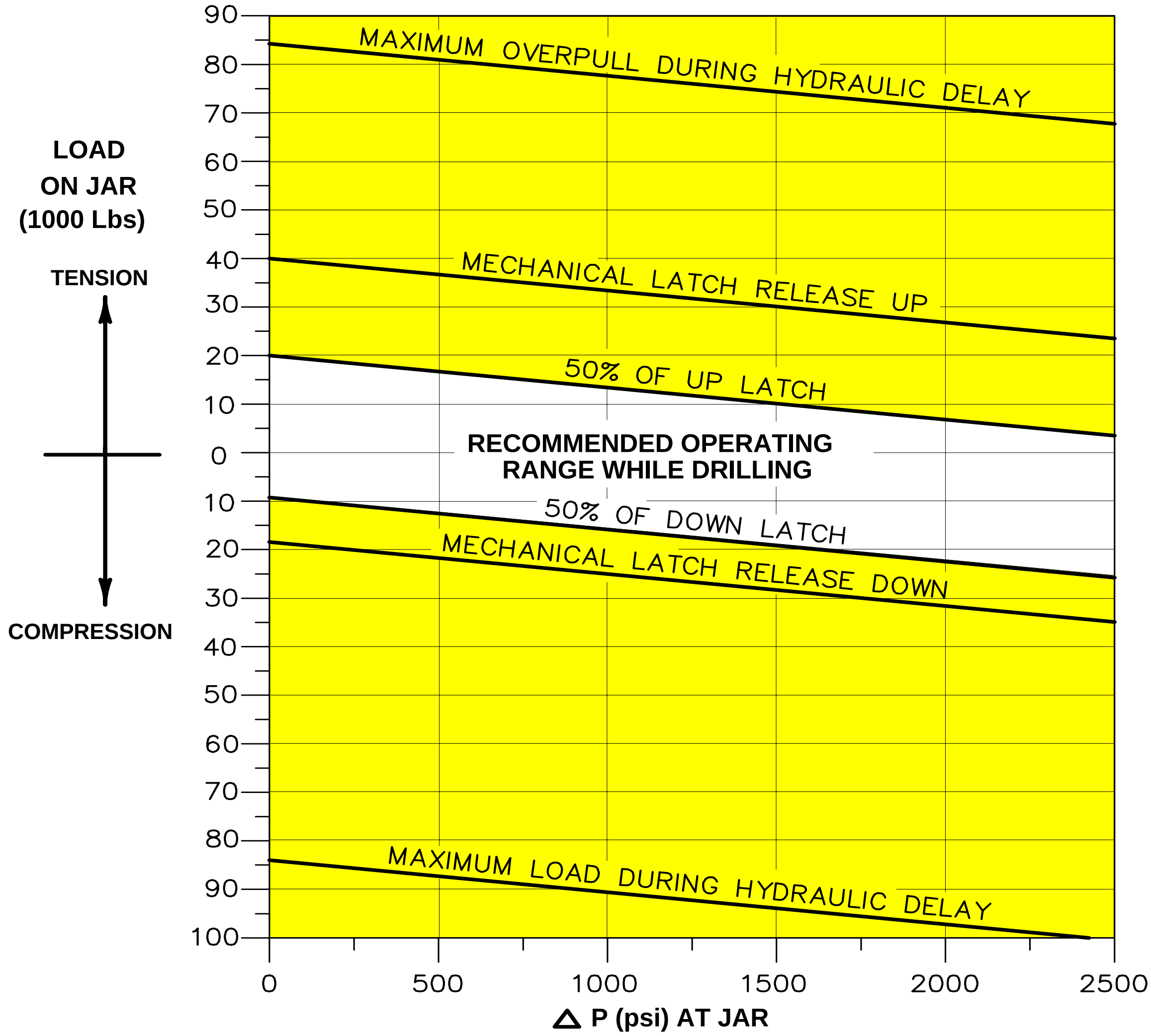
Tools stored horizontally should be rotated to a new position occasionally to prevent seals from setting and resultant fluid leakage.

4. OPERATING CHARTS

RECOMMENDED OPERATING RANGE

4 3/4" DOUBLE ACTING HYDRAULIC / MECHANICAL DRILLING JAR

SERIES 431

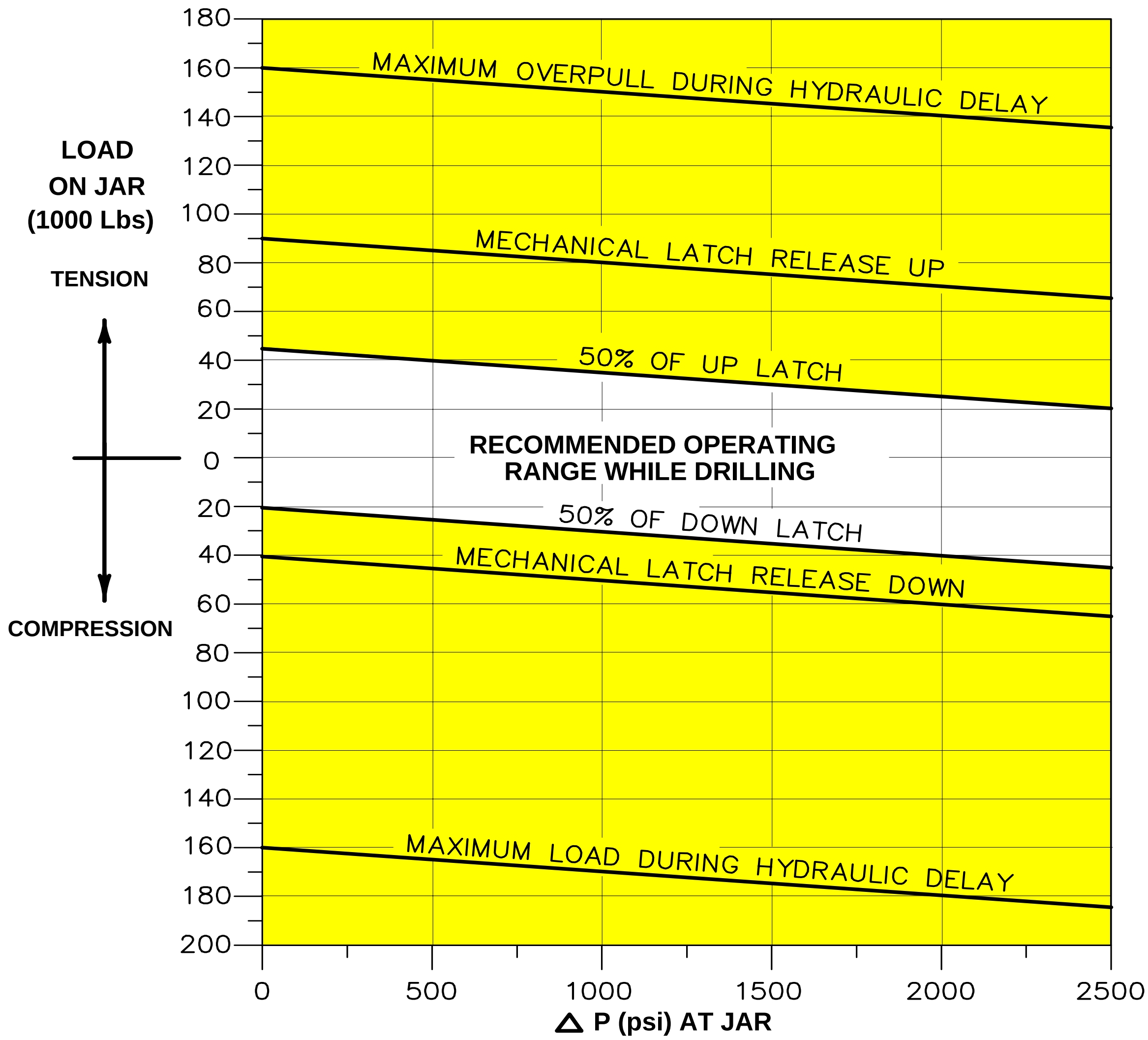


- If latch forces are not exceeded, jar will remain latched in the neutral position. To provide a safety factor during normal drilling activities, load on jar should not exceed fifty percent of up or down latch settings.
- Horizontal line from load on jar should intersect vertical line from pressure drop at jar within non-shaded area.
- Observe maximum loads during hydraulic delays (up and down).

RECOMMENDED OPERATING RANGE

6 1/2" GRIFFITH HYDRAULIC / MECHANICAL DRILLING JAR

SERIES 428

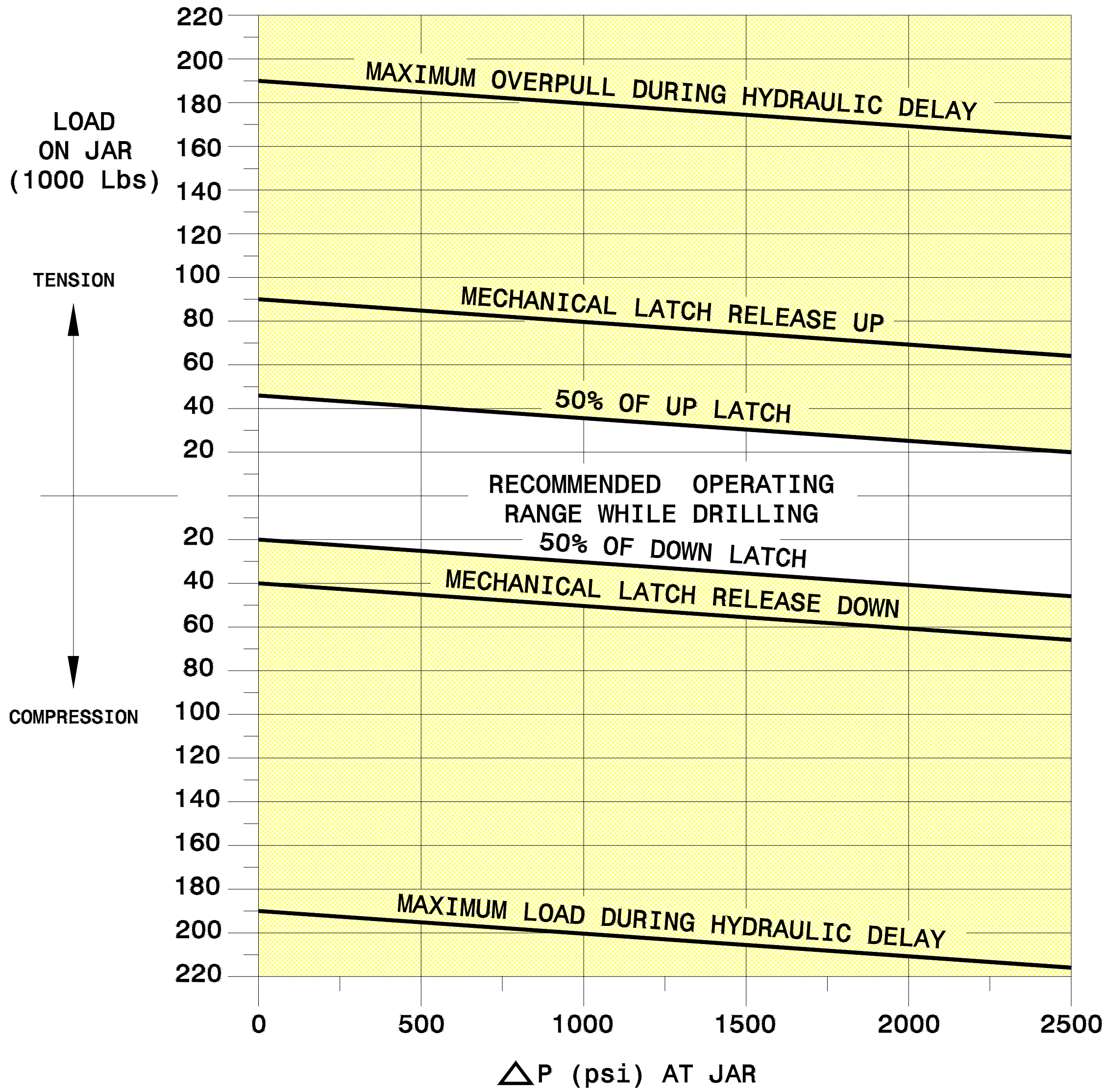


- If latch forces are not exceeded, jar will remain latched in the neutral position. To provide a safety factor during normal drilling activities, load on jar should not exceed fifty percent of up or down latch settings.
- Horizontal line from load on jar should intersect vertical line from pressure drop at jar within non-shaded area.
- Observe maximum loads during hydraulic delays (up and down).

RECOMMENDED OPERATING RANGE

6 3/4", 7" & 7 1/8” GRIFFITH HYDRAULIC / MECHANICAL DRILLING JARS

SERIES 440, 441 & 480

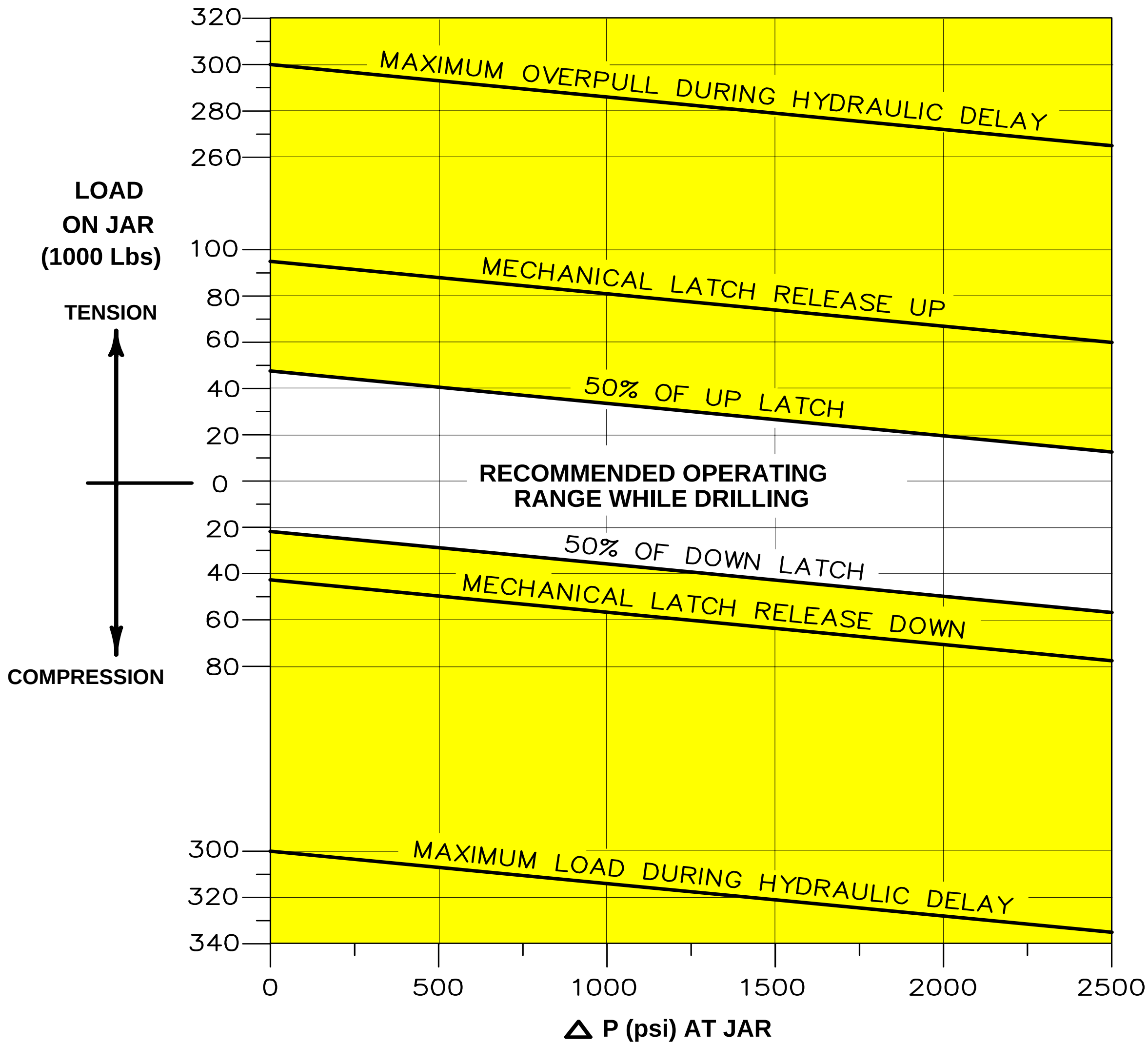


- If latch forces are not exceeded, jar will remain latched in the neutral position. To provide a safety factor during normal drilling activities, load on jar should not exceed fifty percent of up or down latch settings.
- Horizontal line from load on jar should intersect vertical line from pressure drop at jar within non-shaded area.
- Observe maximum loads during hydraulic delays (up and down).

RECOMMENDED OPERATING RANGE

8" GRIFFITH HYDRAULIC / MECHANICAL DRILLING JAR

SERIES 411

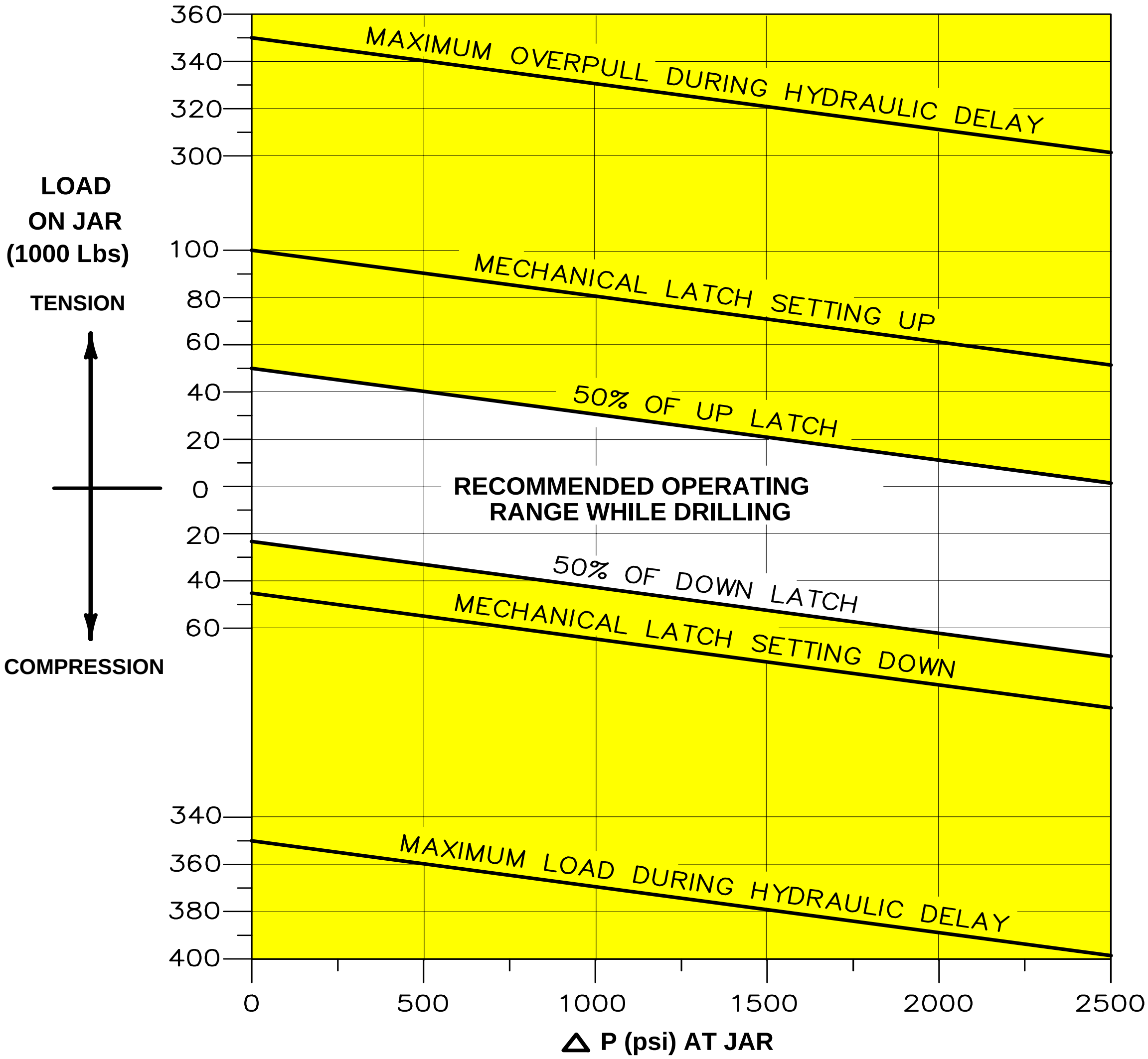


- If latch forces are not exceeded, jar will remain latched in the neutral position. To provide a safety factor during normal drilling activities, load on jar should not exceed fifty percent of up or down latch settings.
- Horizontal line from load on jar should intersect vertical line from pressure drop at jar within non-shaded area.
- Observe maximum loads during hydraulic delays (up and down).

RECOMMENDED OPERATING RANGE

9 1/2" GRIFFITH HYDRAULIC / MECHANICAL DRILLING JAR

SERIES 437



- If latch forces are not exceeded, jar will remain latched in the neutral position. To provide a safety factor during normal drilling activities, load on jar should not exceed fifty percent of up or down latch settings.
- Horizontal line from load on jar should intersect vertical line from pressure drop at jar within non-shaded area.
- Observe maximum loads during hydraulic delays (up and down).

5. SPECIFICATIONS

NOMINAL SIZE		inches	**4.75**	**6.25**	**6.50**	**6.75**	**7.00**	**7.12**	**8.00**	**9.00**	**9.50**
(+API DRILL COLLAR TOLERANCE)		(mm)	-121	-159	-165	-171	-178	-181	-203	-229	-241
SERIES			**431**	**442**	**428**	**440**	**441**	**480**	**411**	**444**	**437**
MAX. RECOMMENDED HOLE DIA.		**inches**	**7 7/8**	**9 7/8**	**9 7/8**	**12 1/4**	**12 1/4**	**12 1/4**	**17 1/2**	**26**	**26**
Hole openers not recommended.		(mm)	-200	-251	-251	-311	-311	-311	-445	-660	-660
ID		**inches**	**2.25**	**2.25**	**2.25**	**2.50**	**2.50**	**2.50**	**2.81**	**3.00**	**3.00**
		(mm)	-57	-57	-57	-64	-64	-64	-71	-76	-76
LENGTH (LATCHED)		**feet**	**19.8**	**22.5**	**22.5**	**23.0**	**23.0**	**23.0**	**22.5**	**23.0**	**23.0**
		(m)	(6.0)	(6.9)	(6.9)	(7.0)	(7.0)	(7.0)	(6.9)	(7.0)	(7.0)
WEIGHT		**lbs**	**850**	**2,000**	**2,100**	**2,250**	**2,450**	**2,450**	**3,100**	**4,600**	**5,200**
		(kg)	-390	-910	-950	-1,020	-1,110	-1,110	-1,410	-2,090	-2,360
STROKE UP (FREE STROKE)		**inches**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**
		(mm)	-152	-152	-152	-152	-152	-152	-152	-152	-152
STROKE DOWN (FREE STROKE)		**inches**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**
		(mm)	-152	-152	-152	-152	-152	-152	-152	-152	-152
PRESET RELEASE UP	**STD:**	**lb**	**40,000**	**90,000**	**90,000**	**90,000**	**90,000**	**90,000**	**95,000**	**100,000**	**100,000**
		(kN)	(180)	(400)	(400)	(400)	(400)	(400)	(420)	(440)	(440)
	MAX:	**lb**	**55,000**	**140,000**	**140,000**	**140,000**	**140,000**	**140,000**	**150,000**	**155,000**	**155,000**
		(kN)	(240)	(620)	(620)	(620)	(620)	(620)	(670)	(690)	(690)
PRESET RELEASE DOWN	**STD:**	**lb**	**18,000**	**40,500**	**40,500**	**40,500**	**40,500**	**40,500**	**42,800**	**45,000**	**45,000**
(TOLERANCE +/- 5%)		(kN)	(80)	(180)	(180)	(180)	(180)	(180)	(190)	(200)	(200)
	MAX:	**lb**	**27,000**	**63,000**	**63,000**	**63,000**	**63,000**	**63,000**	**67,500**	**69,800**	**69,800**
		(kN)	(120)	(280)	(280)	(280)	(280)	(280)	(300)	(310)	(310)
MAXIMUM LOAD		**lb**	**84,000**	**160,000**	**160,000**	**190,000**	**190,000**	**190,000**	**300,000**	**350,000**	**350,000**
DURING HYDRAULIC DELAY		(kN)	(370)	(710)	(710)	(850)	(850)	(850)	(1 300)	(1 600)	(1 600)
MAXIMUM TENSILE LOAD		**lb**	**362,000**	**755,000**	**755,000**	**823,000**	**823,000**	**1,000,000**	**1,000,000**	**1,225,000**	**1,225,000**
AFTER JARRING		(kN)	(1 600)	(3 400)	(3 400)	(3 700)	(3 700)	(4 400)	(4 400)	(5 400)	(5 400)
MAXIMUM TORSIONAL LOAD		**lb-ft**	**11,500**	**37,500**	**37,500**	**44,500**	**53,000**	**70,000**	**73,500**	**95,000**	**95,000**
(TO YIELD BODY CONNECTIONS)		(N.m)	(15 600)	(50 800)	(50 800)	(60 300)	(71 900)	(94 900)	(99 700)	(128 800)	(128 800)
TORSIONAL LOAD TO YIELD SPLINES		**lb-ft**	**28,500**	**62,000**	**62,000**	**74,500**	**74,500**	**100,000**	**102,000**	**136,000**	**136,000**
(REFERENCE ONLY)		(N.m)	(38 600)	(84 100)	(84 100)	(101 000)	(101 000)	(135 600)	(138 300)	(184 400)	(184 400)
PUMP OPEN AREA		**sq.in.**	**6.5**	**9.6**	**9.6**	**11.0**	**11.0**	**11.0**	**14.2**	**15.9**	**15.9**
		(sq.cm)	-42	-62	-62	-71	-71	-71	-92	-103	-103

Specifications subject to change without notice.