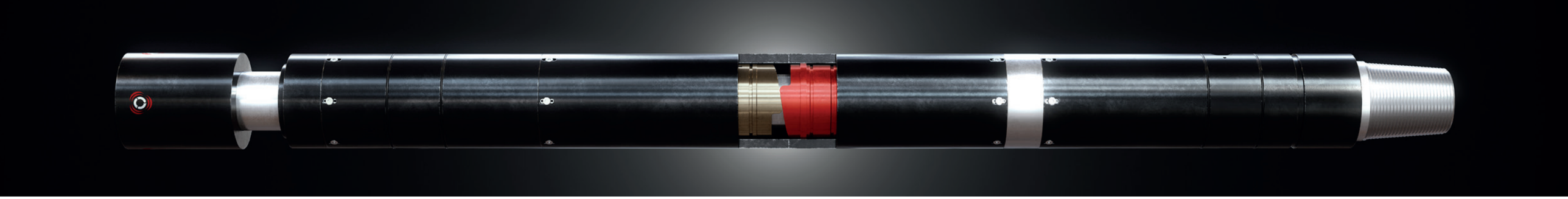
ROTOJAR®

Product Specification

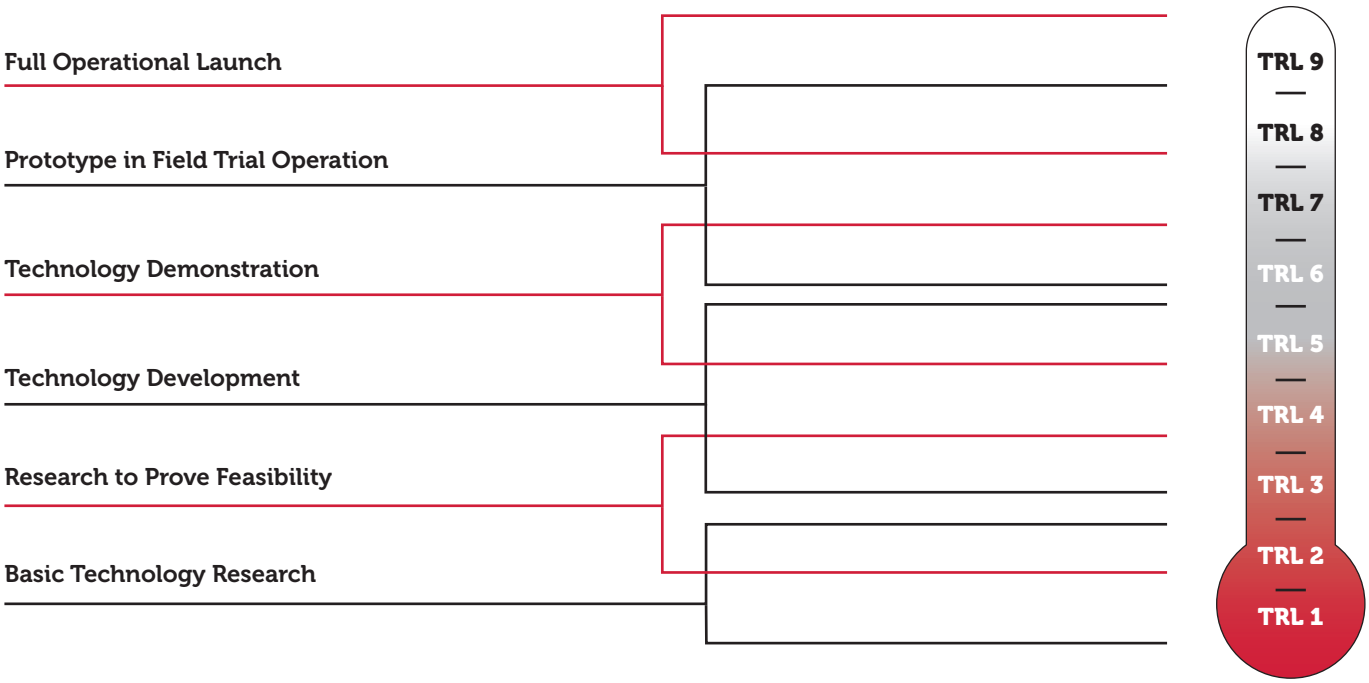


Feature	Benefit	Impact
Combination of strong tensile pull and high rate impact	A constant and intense energy delivered to the stuck-object	RotoJar delivers a **massive total** combined tension and impact energy to the stuck-object resulting in **fast and efficient recovery**
	The ultimate bond breaking technique of "Hold and Hit"	Applying a strong tensile load whilst **simultaneously** inducing a force-pulse, **significantly improves** the chances of breaking the bonds which cause the object to be stuck
	More Impacts-Per-Minute (IPM) than any other extraction technology	RotoJar's **super high-rate** impact with its **constant tension** delivers more area under the curve than any other impact device, resulting in a **massive increase** in delivered 'Impulse' to the stuck-object

Infinitely variable impact rate	Resonant (harmonic) drill-string excitation	RotoJar's ability to induce **resonance** promotes significant **beneficial** drill-string behaviour:
		• **Lower** input **forces** can achieve far **higher** output **gains**
		• Sinusoidal **excitation** (whipping) of the drill-string may be induced, resulting in:
		  • **Speedy** breaking of bonds
		  • **Increased freedom** from differential sticking
		  • **Excitation**, agitation and mobilisation of **settled solids**
		• Axial Excitation, resulting in:
		  • **Larger** axial impulse
		  • **Stronger** linear shearing force at the stuck-point bond

	Solid particle liquefaction	**Beneficial vibration** induces a solid-to-liquid transition of the solid particles within the region of the stuck object. This phenomenon **reduces the shear strength** of the solid causing it to **behave like a liquid**, allowing the stuck-object to be withdrawn easily from debris. This negates the "bridging" phenomenon that often prevents impact jars from being successful, particularly when the sticking mechanism is a granular material, whereby a single large impact can compound the problem by packing-off of the material
	Improved wellbore stability	**RotoJar** is capable of delivering very **low magnitude impacts** allowing the operator to apply a **little-and-often** approach to the removal of the stuck-object. A **traditional jar** delivers a single large impact causing a large **pressure surge** often resulting in greater **hole instability**; this can be avoided and actively managed through the flexible operating capability of the RotoJar
	An effective approach to slip-and-bind	**High frequency/ low amplitude** jarring of a drill-string stuck in shale or clay using the RotoJar, will contribute to the **rapid withdrawal** of stuck pipe from these types of collapse, due to the nature of the bind these formations/rock types hold over the drill-string
	More Impacts-Per-Minute (IPM) than any other extraction technology	The high rate of impact from the RotoJar operating at maximum speed delivers **30,000 impacts per hour** compared to the typical rate of 12 impacts per hour from a conventional jar firing once every 5 minutes.
Drill-pipe rotational decoupling	During the operation of RotoJar, the drill-pipe is un-splined from the stuck-object at the RotoJar, therefore allowing free rotation of the drill-string above the stuck point	**Rotation** of the drill-pipe whilst jarring: • **Eliminates** the static friction between the drill-pipe and the wellbore resulting in a significant increase in force delivery to the jar • Improves **hole cleaning** and **cuttings mobilisation** • **Improves** drill-pipe to casing **lubrication** due to increased fluid movement • **Enhances** drill-pipe **cooling** at contact with casing, due to moving fluid
Requires no re-cocking of the jar between impacts	Continuous, non-stop, upward jarring action requires no cessation between impacts, unlike conventional jars	The stuck-object is **continually** moved by the **constant impacting** action, ensuring the sticking bonds do not re-establish as can happen during the re-cocking down-time of conventional jars
	No removal of the tensile load between impacts	**Constant** application of tensile **force** between jarring impacts ensures the **dynamic coefficient** of friction is maintained once the stuck-object is **mobilised**
	No axial reversal of the drill-string	Problems associated with re-cocking of a **conventional jar** are mitigated. (Conventional jars require the application of a force in the **opposite** direction to the jarring force following **every** impact, potentially forcing the stuck-object to become **more stuck)**
Circulation ports	Flow ports may be opened at the RotoJar allowing free forward or reverse circulation of fluids above the stuck point	Circulation of fluid through RotoJar whilst stuck: • **Reduces** the static **friction** between the drill-pipe and the wellbore, resulting in a significant **increase** in force delivery to the jar • Improves **hole cleaning** and **cuttings mobilisation** • **Improves** drill-pipe to casing **lubrication** due to increased fluid movement • **Enhances** drill-pipe **cooling** at contact with casing, due to moving fluid • Enables improved **well control** capability
Traditional linear jar, inbuilt	RotoJar incorporates a traditional linear hydraulic jar feature allowing conventional up and down jarring.	Inclusion of the conventional jar within the RotoJar: • Provides **operators** with **flexibility** in operational **decision-making** during a stuck-object incident • Provides **redundancy** in the event of non-performance of the RotoJar function to remove the stuck-object • Enables improved **integration** with **3rd party** equipment.

Technical Specification		
OUTSIDE DIAMETER	8.00 (203.2)	in (mm)
INSIDE DIAMETER	3.00 (76.2)	in (mm)
LENGTH	40.0 (12)	ft (m)
CONNECTION (BOX x PIN)	6 5/8 REG	API
OPERATING OVERPULL RANGE	0 - 1000 (450)	KLbf (TONNES)
ROTARY JARRING SPEED RANGE	0 - 125	RPM
IMPACT RATE	0 - 500 0 - 8 HZ	IMPACTS-PER-MINUTE (IPM) Hz
TRIGGERING FORCE	50 - 150 (20 - 65)	KLbf (TONNES)
BODY TORSIONAL YIELD	100 (135)	KLbf.ft (N-m)
MAXIMUM TEMPERATURE	302 (150)	°F (°C)
TECHNOLOGY READINESS LEVEL	7	TRL



Alternative specifications and sizes available on request. Specification may be subject to revision at any time by RotoJar Ltd. NS-1 Certification Pending.

For further information, please contact Dr Peter B Moyes, Founder and Chairman at peter.moyes@rotojar.com