



Tirupati

Forge Limited

**INNOVATING
MUNITIONS.
PROVIDING
AMMUNITION
SOLUTIONS.**

DEFENCE PRODUCTS

At Tirupati Forge Limited, we stand at the vanguard of innovation—leveraging advanced technology and proven expertise to deliver next-generation defence solutions.



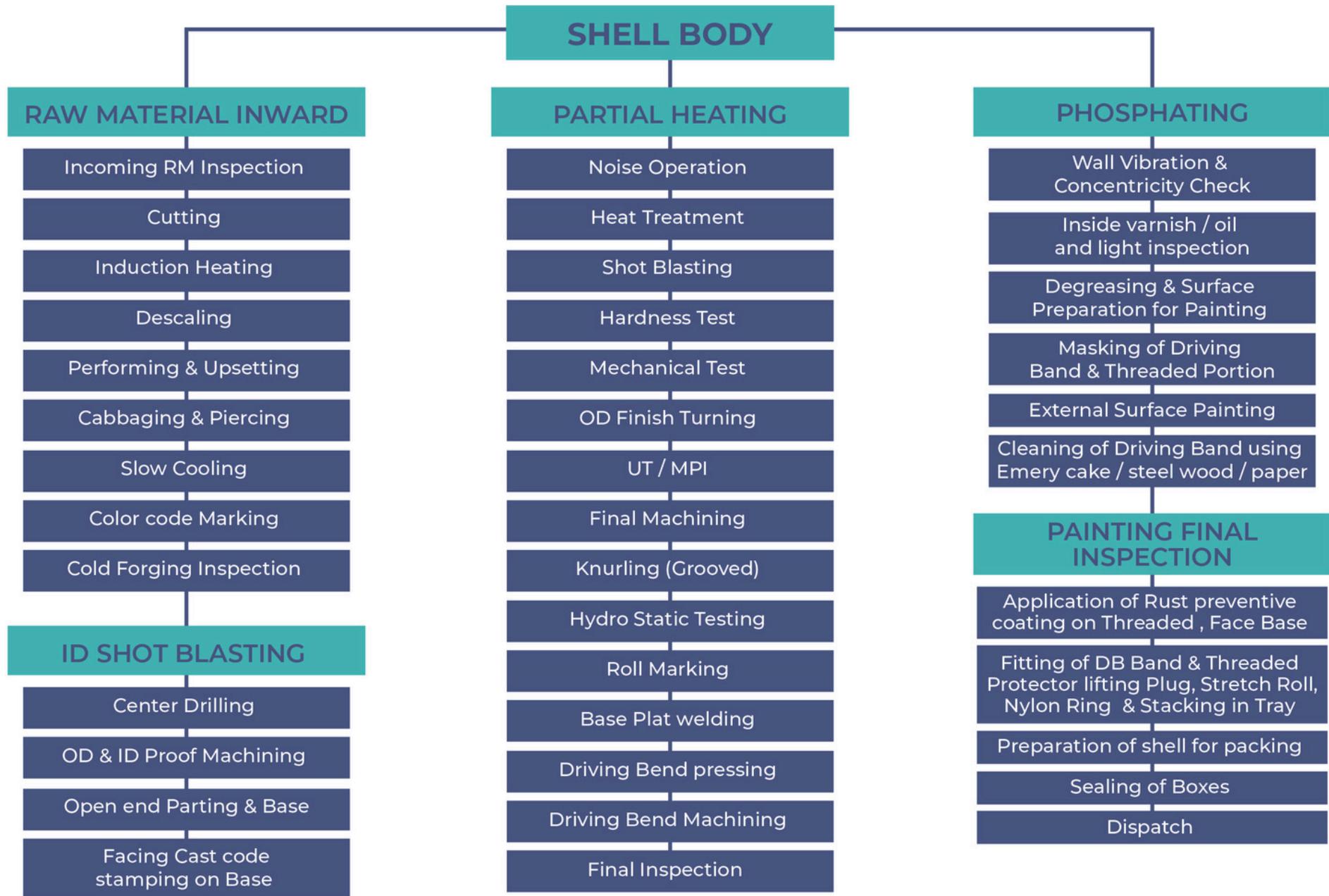
www.tirupatiforge.com

Forging Strength. Engineering Precision. Empowering Defence

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PROCESS FLOW CHART



ABOUT US

FORGING AHEAD FOR A BRIGHTER TOMORROW

Tirupati Forge Limited (TFL) is one of India's leading manufacturers and exporters of high-quality forged and machined components, proudly serving the Defence, BEML, Automotive, Railway, and global industrial sectors. Our advanced production facility spans over 25,000 square meters, integrating cutting-edge infrastructure for manufacturing, assembly, testing, and strict quality control. With a dedicated ammunition plant staffed by highly skilled professionals, we boast a production capacity of 150,000 shell bodies per year.

TFL plays a vital role in supporting our partners with tailored solutions—ranging from advanced munitions and artillery systems to sustainment services—ensuring readiness in today's evolving defence landscape. Our fully automated forging line, equipped with the latest robotic systems, enables the efficient production of Artillery and Mortar Ammunition under one roof.

From battlefield-tested munitions to next-gen manufacturing, TFL forges the future of defence.

COMMITTED TO QUALITY. TRUSTED FOR SAFETY

At Tirupati Forge Limited, quality is not just a standard—it's a promise. Our internal Quality Management System (QMS) is rigorously audited every year to ensure consistent performance, compliance, and continuous improvement. We are steadfast in our commitment to meeting—and exceeding—international standards, delivering products that reflect precision, reliability, and safety at every stage of production.



OUR FACILITIES

- ▶ Automatic Circular Sawing Machine – Precision cutting of billets & rounds up to 200 mm
- ▶ Robotic Forging Press Line (1500 Ton) – High-efficiency forging with robotic precision.
- ▶ Robotic Drawing Press Line (630 Ton) – Consistent shaping with advanced automation.
- ▶ Robotic Nosing Press Line (630 Ton) – Accurate nosing operation with robotic control.
- ▶ Induction Heater (1150 KVA) with Descaling Machine – Uniform heating with integrated descaling.
- ▶ Induction Heater (600 KVA) – Specialized for nosing operations.
- ▶ Fully SCADA-Controlled Heat Treatment (1550 Kg/Hr) – Automated, precise thermal processing.
- ▶ Shot Blasting Machine – External and internal cleaning of shells.
- ▶ CNC Shop with Doosan Machines – High-accuracy machining for critical components.
- ▶ Automatic Rotating Bending Machine – Precision bending for uniform results.
- ▶ Seam Welding Machine for Base Plate – Strong and reliable weld quality.
- ▶ Fully Automatic Phosphating Line – Uniform coating for wall thickness, including ID.
- ▶ Fully Automatic Marking Machines – Permanent, precise product identification.
- ▶ Automatic Paint Line with Dryer – High-quality surface finish with durability.
- ▶ Fully Automatic Ultrasonic Testing Machine – Advanced flaw detection for quality assurance.
- ▶ MPI Testing Machine – Inspection of OD up to 300 mm and length 1500 mm.
- ▶ In-house Chemical & Physical Testing Laboratory – Comprehensive material testing capabilities.
- ▶ Latest Tooling & Measuring Instruments – Ensuring precision at every stage.
- ▶ Customized Packing Solutions – Tailored as per customer requirements.



QUALITY CONTROL

- ▶ Spectrometer (Bruker) – Accurate chemical composition analysis.
- ▶ CMM – High-precision dimensional measurement.
- ▶ UTM (40T Capacity) – Reliable tensile and compression testing.
- ▶ Impact Testing (300J) – Toughness evaluation under dynamic load.
- ▶ Microscope (Olympus with Image Analyser) – Detailed microstructural examination.
- ▶ Digital Hardness Tester (Brinell) – Consistent hardness measurement.
- ▶ MPT – Magnetic particle testing for surface/subsurface defects.
- ▶ Ultrasonic Testing – Non-destructive internal defect detection.
- ▶ D.P. Test – Dye penetrant inspection for surface flaws.

PRODUCT

PORTFOLIO

Tirupati Forge Ltd. manufactures medium- and large-calibre artillery ammunition, with assembly and production capabilities among the region's most diverse and efficient. We deliver a comprehensive range of munitions built to stringent international standards, backed by continuous investments in production expertise and high-volume manufacturing capacity in India. Our output is supported by world-class local and international components and rigorous quality assurance at every stage.

- ▶ Artillery Ammunition Shell 105 mm IFG HE
- ▶ Mortar, Bomb 120 mm Empty Body
- ▶ 122 Mm Empty Projectile
- ▶ Shell Body 125 mm
- ▶ Artillery Ammunition Shell 130 mm HE
- ▶ Artillery Ammunition Shell 152 HE
- ▶ Artillery Ammunition Shell 155 mm HE M107
- ▶ Artillery Ammunition Shell 155 mm HE ERFB BT/BB
- ▶ Artillery Ammunition Shell 155 mm HE L15A1

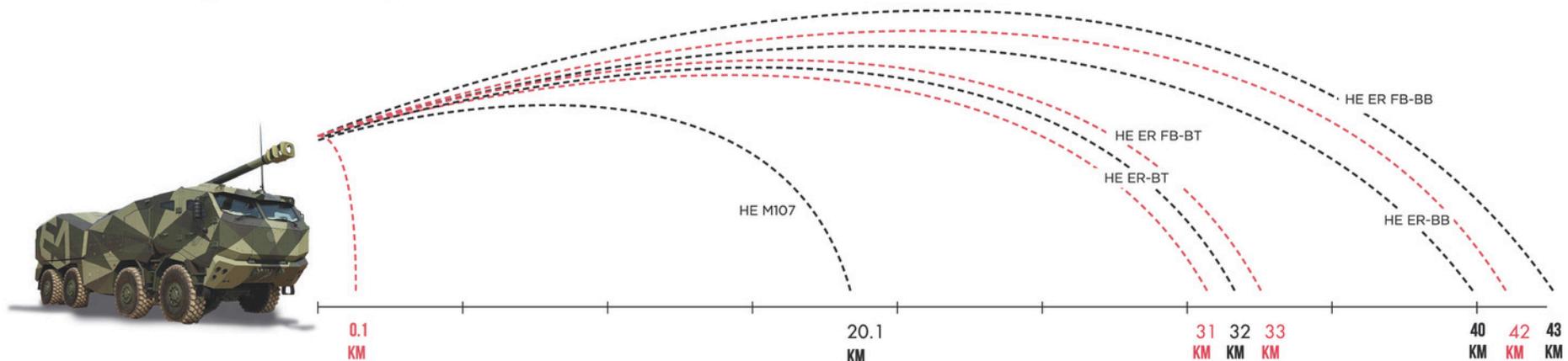


155 mm artillery ammunition from Tirupati Forge Ltd. is compatible with a wide range of modern 155 mm guns and howitzers used worldwide. Engineered for effectiveness against infantry, light armour and fortified positions, our 155 mm portfolio delivers flexibility, reliability and ease of use across training and combat operations. Manufactured to rigorous quality standards, these rounds are ready to serve the Indian defence forces and international customers with consistent performance and full traceability.

TECHNICAL DATA

TYPE OF ROUND	HE M107	HE M77B	HE ERFB BT	HE ERFB BB
Type	High Explosive (HE)	High Explosive (HE)	High Explosive (HE) 155	High Explosive (HE)
Caliber (mm)	155	155	155	155
Maximum Range (kM)	18	24	30	38
Length without fuze (mm)	605	729	843	862
Max. Chamber Pressure (Mpa)	385	440	445	445
Weight without Fuze (mm) App.	42	41.5	42 to 45	45 to 47
Type of guiding ring	Copper	Copper	Copper	Copper
Shell Life (year)	10	10	10	10
Operating Temperature	-2°C to +60°C	-2°C to +60°C	-2°C to +60°C	-2°C to +60°C
Packing pcs on one wooden pallet	12	12	12	12
Diamention of wooden pallet (mm)	885 x 1065 x 580	905 x 1065 x 560	1135 x 995 x 585	1130 x 965 x 565

Note: Above figures are only for reference.



CUTTING

FULLY AUTOMATIC CIRCULAR SAWING MACHINE

- **CUTTING CAPACITY:**
75 to 200 mm rounds / RCS of various grades
- **CUTTING SPEED:**
Up to 60 pieces/hour at 100% utilization
- **GRADES:**
Carbon Steel | Alloy Steel | Stainless Steel
- **MACHINE QUANTITY:**
1



INDUCTION HEATING

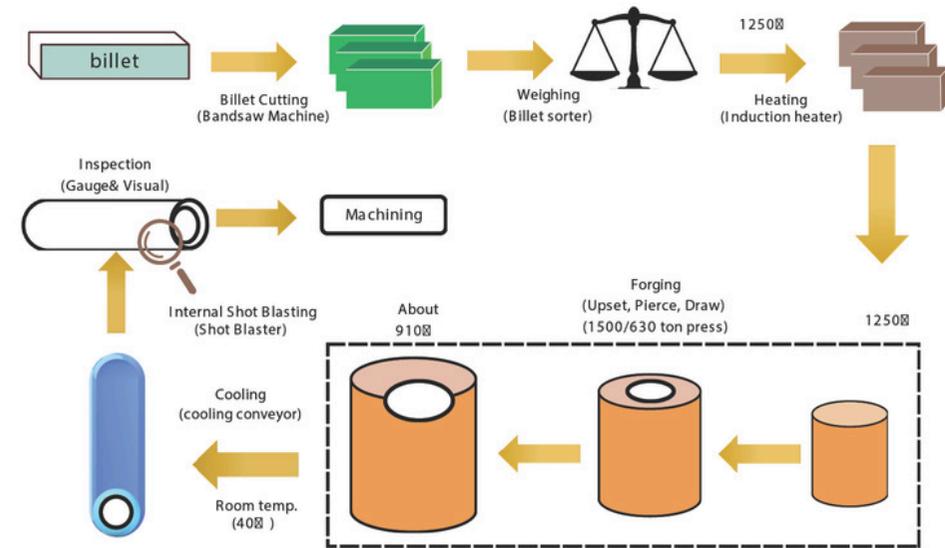
Efficient billet heating for forging, ensuring uniform temperature, optimized efficiency, and superior process control.

- **CAPACITY:**
1150 kW (2600 kg/hour)
- **COIL SIZE:**
75, 100, 125, 140, 150, 180, 200, 250 mm round & RCS
- **Surface-Core Temperature Difference:**
100 C max
- **Heating Temperature:**
Up to 1300 C
- **Process Output:**
25-50 pieces/hour, billets remain separate for the next process
- **Design Feature:**
Temperature variation ± 50 C for precise and uniform heating



FORGING

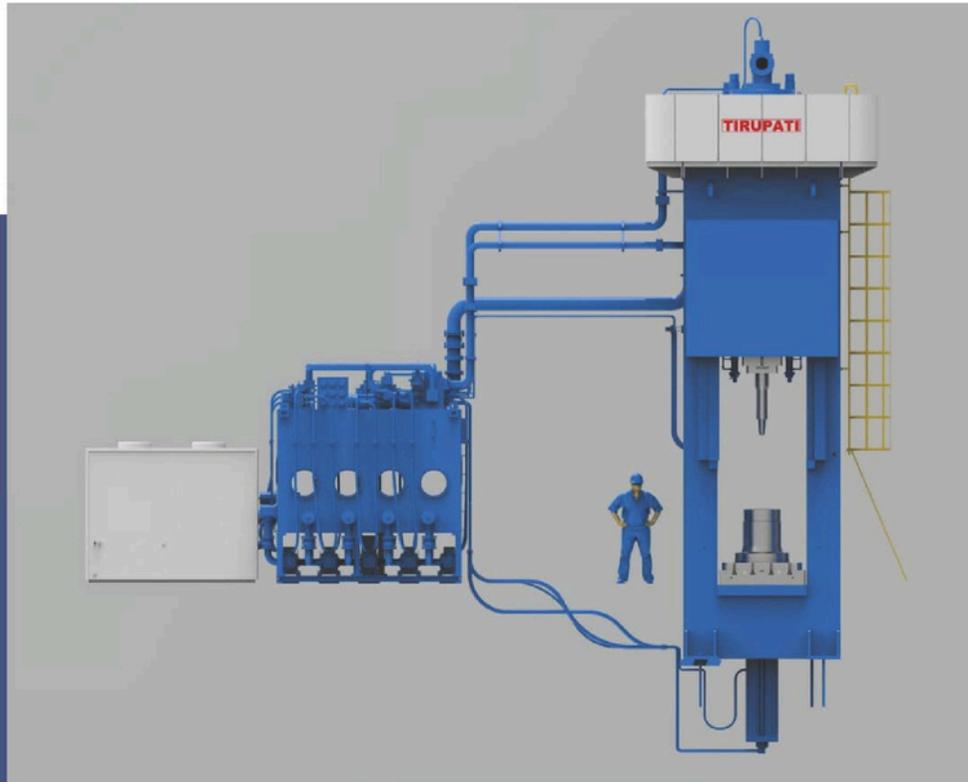
At Tirupati Forge Ltd., the manufacturing of shell forgings is carried out through a carefully controlled process, starting with the selection and heating of high-quality billets. The billets undergo upsetting, piercing, and hollow forging to achieve the precise shape required. Each forging is then subjected to precision machining and heat treatment to ensure accurate dimensions, superior strength, and long-lasting durability. Rigorous inspection and testing are performed at every stage, with surface finishing applied to enhance performance and reliability in the most demanding applications.



MACHINE OUTLINE

Automatic Hydraulic Extrusion Press

- **CAPACITY:**
1500 Ton (Upsetting) + 630 Ton (Drawing)
- **Production Capacity:**
30 pcs/hour
- **Frame:**
Pre-stressed steel plate design



1500 Ton (Upsetting & Piercing)

TOOLING

Tool centering method to minimize wear of perishable parts (piercing punches)

- **Piercing Tool Life:**
500–1500 pieces per tool
- **Quick Hydraulic Clamping Device:**
Enables easy die change



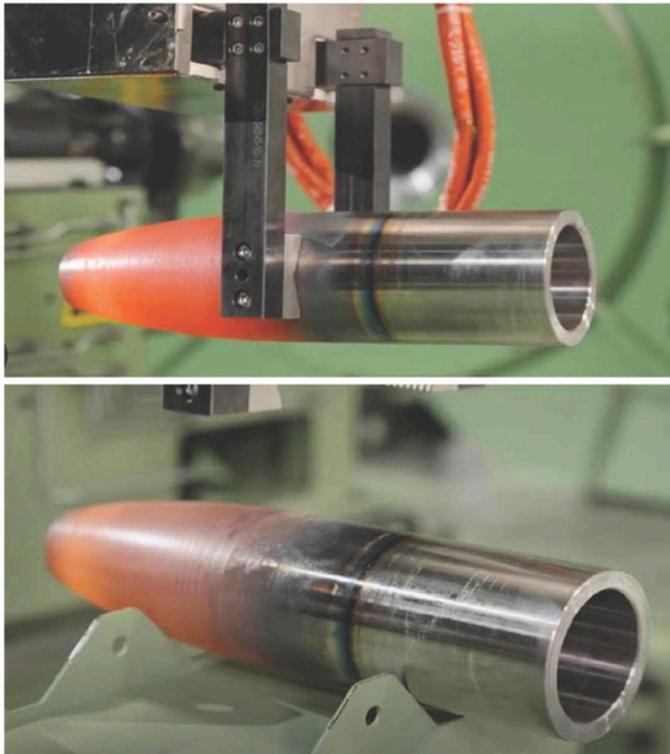
630 ton (drawing)



Tooling

NOSING PRESS

- **Capacity:**
630 Ton
- **Production Capacity:**
60 pcs/hour
- **Frame:**
Pre-stressed steel plate design
- **Process Outline:**
Heating the mouth of forged shell body to 150–1100 C for nosing operation



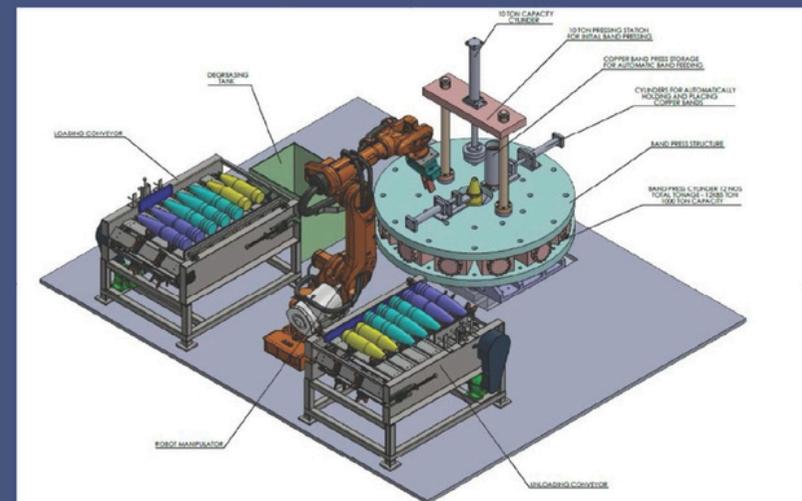
WORK FLOW



ROTATING BAND PRESS

The Rotating Band Press is a specialized machine used in the manufacturing of medium to large-calibre ammunition shells. It is designed to fit a copper driving band securely around the shell body, which engages with the rifling inside a gun barrel to impart spin, ensuring stability and accuracy during flight. The press applies controlled high-pressure force to shrink-fit or swage the copper band onto the projectile without causing any deformation, maintaining the integrity and precision of each shell.

- **Application:**
Pressing copper driving bands onto projectile shells
- **Pressing Force:**
300–1000 metric tons
- **Shell Diameter Range:**
105 mm – 155 mm (varies with calibre)
- **Copper Band Thickness:**
2 mm – 10 mm (depending on projectile size)
- **Copper Band Width:**
10 mm – 100 mm
- **Stroke Length:**
200 mm – 600 mm
- **Ram Speed:**
10 – 50 mm/sec (adjustable)
- **Hydraulic Pressure:**
Up to 350 bar (5,000 psi)
- **Control System:**
PLC controlled with pressure, stroke, and position monitoring



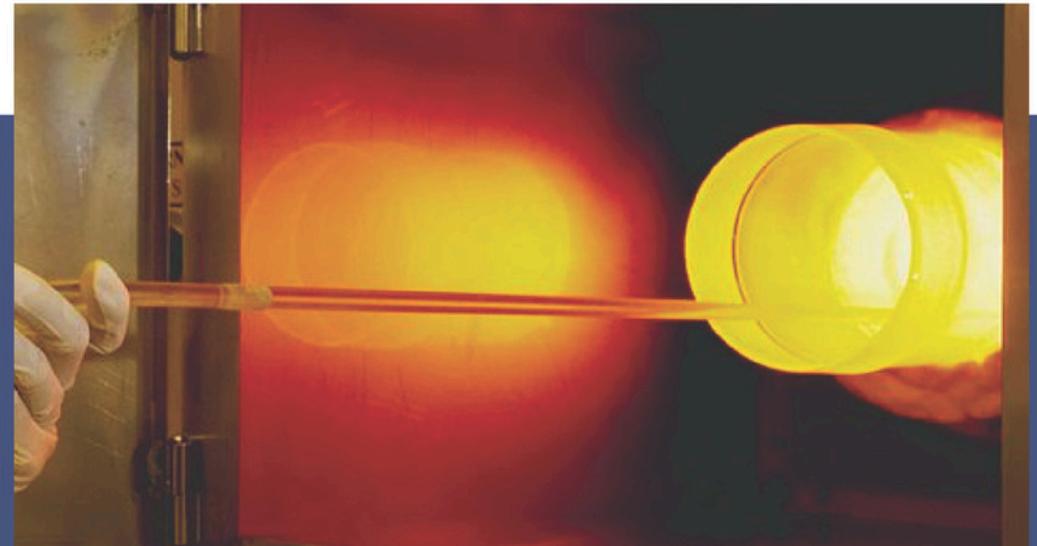
HEAT TREATMENT

OFFERED LINE

- Zero-gravity loading system for green shells
- Electrically heated, energy-efficient austenizing furnace
- Water quench tank with automated quenching and water cooling via cooling towers
- Oil quench tank with automated quenching, fire safety system, oil cooling via duplex heat exchangers, and oil agitation system
- Primary wash tank
- Secondary wash tank

SALIENT FEATURES OF THE CONTINUOUS HEAT TREATMENT SYSTEM

- Flexible operation with either water quench or oil quench
- Very high energy efficiency with low specific power consumption
- Consistent properties across all heat-treated shells
- Fully automated operation from shell loading to tempered and cooled output



HEAT TREATMENT PROCESS

- Power-and-free conveyor with specially designed hangars holds 4 × 155 mm shells per hangar.
- Each hangar is loaded by a zero-gravity manipulator and travels inside the austenizing furnace every 8 minutes.
- Austenizing Furnace: 19 locations, total in/out time 152 minutes (2 hours 32 minutes).
- Every 8 minutes, 4 shells are quenched in water or oil, depending on requirements.
- After washing, shells move to the tempering furnace.
- Tempering Furnace: 24 stations, total in/out time 192 minutes (3 hours 12 minutes).
- Post-tempering, shells are cooled first by air and then by mist cooling.
- Shells can undergo hardness testing and other quality operations after tempering.
- System operation is fully PLC and SCADA controlled.
- Output shells exhibit consistent, high-quality properties.

CNC MACHINING FACILITIES

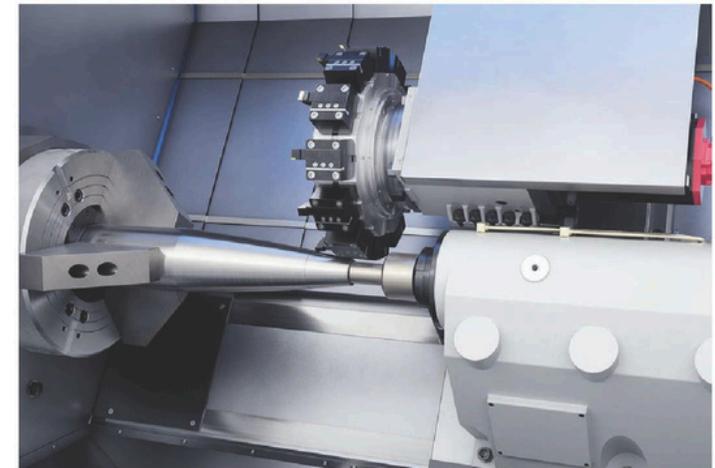
- Tirupati Forge Ltd. offers a single-point source for all manufacturing processes under one roof, including Forging, Hydraulic Extrusion, Machining, and Packing.
- Facility includes a state-of-the-art Application Technology Centre at par with international standards.
- Design, development, testing, and logistics departments support end-to-end production.
- CNC shop designed with environment-friendly ambient to ensure a pollution-free workspace.
- Strong operational capability and SWOT advantages place the facility in a comfortable win-win situation.

SUPPORTING EQUIPMENT

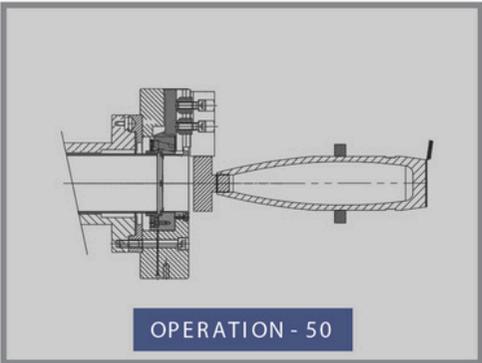
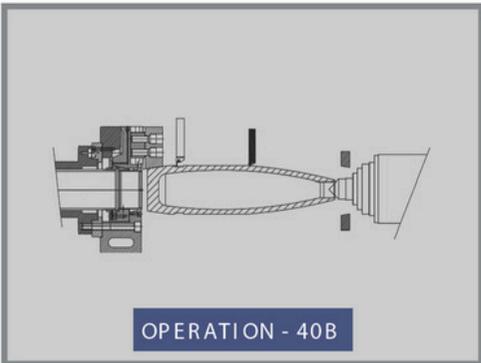
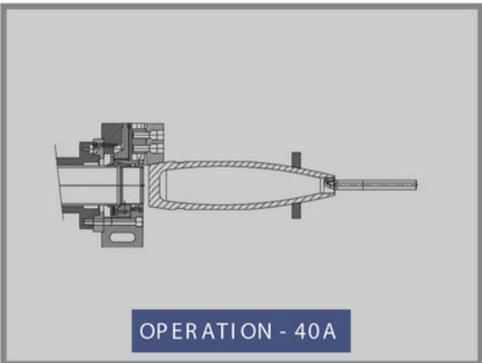
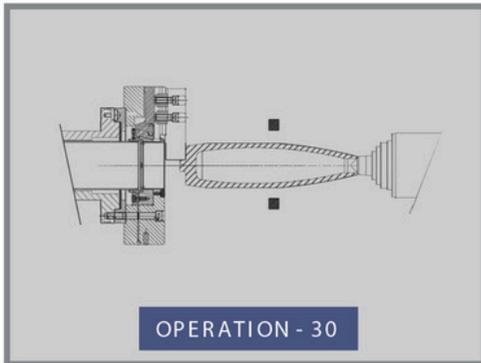
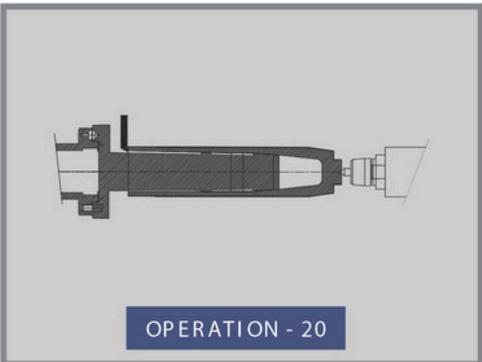
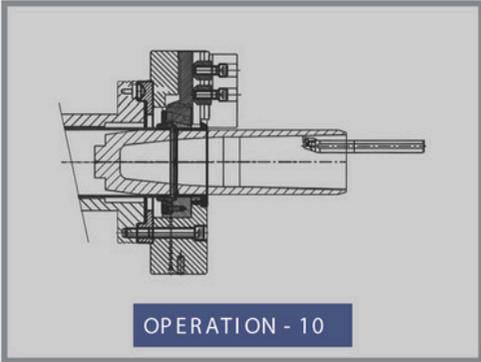
- Latest tooling and fixtures
- Fully automatic rotating band machine
- Fully automatic SPM knelling machine
- Double-head seam welding machine for base plates
- Digital machines for wall thickness measurement
- Latest measuring instruments for precision

CNC MACHINES

- Doosan CNC GT3100L
- Doosan CNC GT3100LM
- Doosan CNC P4100LC
- VMC (Vertical Machining Centre)



CNC OPERATION



155 mm Artillery Shells

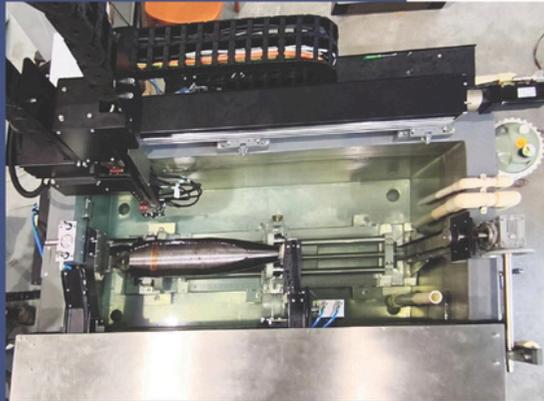


SHOT BLASTING MACHINE

- ▶ **Application:** Internal and external blasting of bombshells
- ▶ **Max. Workpiece Size:** 155 mm diameter × 605–850 mm length
- ▶ **Max. Shell Weight:** 75 kg
- ▶ **Shell Mouth:** 40 mm
- ▶ **Auxiliary / Satellite Table:** 8 Nos.
- ▶ **Indexing Table:** 1 No.
- ▶ **Station:** Twin blasting station
- ▶ **Blasting Nozzles:** 4 Nos. (2 per station)
- ▶ **Nozzle Movement:** Mechanical
- ▶ **Nozzle Size:** 10 mm
- ▶ **Blasting Pot:** 300 liters × 4 Nos.
- ▶ **Production Capacity:** 35–40 shells/hour
- ▶ **Dust Collector:** Automatic pulse jet type
- ▶ **Total Filter Area:** 1404 sq. ft.
- ▶ **Dust Collector Capacity:** 6000 CFM
- ▶ **Control Panel:** RITTAL
- ▶ **PLC:** Siemens S7-1500



ULTRASONIC TESTING (UT)



Immersion Tank: Equipped with shell rotating mechanism for full coverage

3-Axis Gantries with Gimbal: Movement along X, Y, Z, and A axes

Probe Arrangement: 5-probe cluster + 1 side-face inspection probe

Motion Control System: Ensures precise probe positioning

Multi-Channel Ultrasonic Pulsar/Receiver: For high-resolution testing

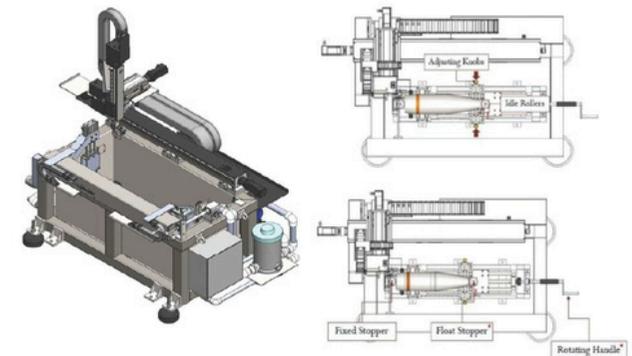
Immersion Probes: Specially designed probe holders for accurate placement

Data Acquisition & Analysis Software: For real-time evaluation

Computer System: Integrated for monitoring and reporting

INSPECTIONS PERFORMED

- Normal
- 45° Axial (FWD)
- 45° Axial (REV)
- 45° Transverse (FWD)
- 45° Transverse (REV)
- Side Face (end-face inspection)



PHOSPHATING PROCESS

The phosphating process provides a corrosion- and wear-resistant coating on empty shell bodies using manganese or heavy zinc phosphating. Fully automated, the process ensures consistent quality, high efficiency, and strict adherence to customer standards, delivering reliable protection and surface preparation for subsequent treatments.

BENEFITS OF PHOSPHATING

- Corrosion protection in combination with paints, polymer films, oils, or waxes
- Corrosion protection even without subsequent treatment
- Improved anti-friction properties: break-in, wear resistance, anti-galling, and reduced coefficient of friction
- Strong adhesion for subsequent painting or other organic coatings



PROCESS OVERVIEW

- 1. CLEANING / DEGREASING:** Alkaline or solvent-based cleaners remove oils, grease, and contaminants, followed by thorough rinsing.
- 2. DERUSTING / PICKLING (IF NECESSARY):** Mineral acid immersion removes rust or mill scale, followed by rinsing. Minimal for new machined shells.
- 3. SURFACE ACTIVATION:** Conditioning rinse (often with titanium salts) refines the metal surface to promote uniform crystalline structure and better corrosion resistance.
- 4. PHOSPHATING:** Immersion in heated manganese or zinc phosphate solution forms the protective coating.
- 5. RINSING:** Multiple water rinses remove excess phosphating solution and loose sludge.
- 6. POST-TREATMENT / SEALING:** Porous phosphate coating is sealed to maximize protective properties.
- 7. DRYING:** Shells are dried in ovens, preparing them for subsequent processes like painting.

PAINTING

The painting process for shell bodies is a multi-stage, industrial procedure designed to ensure maximum durability and corrosion resistance under harsh conditions. The automated process includes meticulous surface preparation, multi-layer coating, and precision drying, while key areas such as the driving band are left unpainted. Raw, machined shell bodies are carefully prepared to guarantee optimal adhesion and long-lasting protection.



PAINTING PROCESS

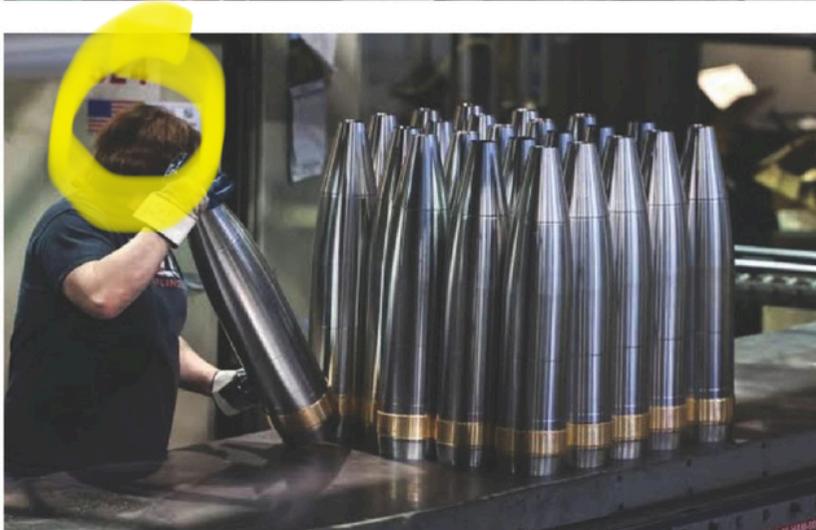
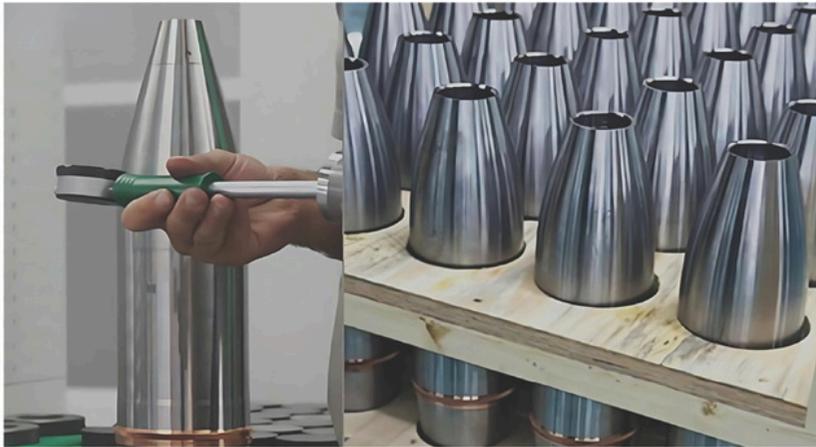
- 1. WASHING:** Shells are thoroughly cleaned to remove machining fluids, dirt, and contaminants.
- 2. ZINC PHOSPHATING:** Automated chemical process immerses shells in a zinc phosphate solution, creating a crystalline conversion coating that protects steel from rust and provides a textured surface for primer adhesion.
- 3. DRYING:** Phosphate-coated shells are dried in an oven or dryer to remove all moisture before painting.

PAINT APPLICATION

- 1. MASKING:** Protective covers or tape are applied to specific areas, such as the driving band, before painting.
- 2. PRIMER COAT:** Corrosion-resistant primer, often red oxide alkyd-based enamel, is applied uniformly.
- 3. TOPCOAT:** Exterior color, such as olive drab or buff enamel, is applied over the primer to provide final protection and identification.
- 4. INTERIOR VARNISHING:** Inside cavity coated with black varnish (excluding threaded areas) to seal the surface.
- 5. DRYING AND CURING:** Painted shells are dried and cured using conversion ovens to ensure a durable, high-quality finish.

INSPECTION

A critical, multi-stage process to ensure each projectile is free of defects and meets stringent specifications for safety, reliability, and performance. The process combines automated and manual tests to verify dimensional accuracy, material integrity, and overall quality.



KEY INSPECTION STAGES

01. Visual and dimensional inspection
02. Surface finish check
03. Threading inspection
04. Markings verification
05. Non-destructive testing (NDT)
06. Ultrasonic testing (UT)
07. Magnetic particle inspection (MPI)
08. Radiography (X-ray)
09. Material and strength testing
10. Chemical composition
11. Mechanical properties
12. Fracture toughness
13. Hydraulic pressure testing
14. Qualification and functional checks
15. Ballistic qualification
16. Environmental testing
17. Impact tests
18. Documentation and traceability
19. Final certification

PACKING

PACKING OF SHELLS

Multiple projectiles are grouped on specialized wooden or metal pallets, called unit loads, designed for secure transport and handling. The packaging features sturdy crates or pallets, protective elements to prevent damage, and full compliance with military specifications.

PALLETIZED UNIT LOAD PACKAGING

The main method for packaging shells for transport and storage involves creating a multi-round unit load on a sturdy pallet. The exact configuration may vary depending on the manufacturer and the type of

PALLET TYPES

- Wooden pallets
- Metal pallets

PROTECTIVE CONTAINERS

Used to safeguard shells during handling and shipping.

PROTECTIVE ELEMENTS

- Lifting plugs
- Rotating band covers
- Honeycomb construction to prevent damage

COMPLIANCE

All packaging adheres to military specifications for safe and stable transport of heavy projectiles.





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