

PSC HAND SAFETY INDIA PRIVATE LIMITED

ENGINEERING REFERENCE GUIDE · ALUMINIUM INDUSTRY

Hand Exposure in Aluminium Plants

A Department-by-Department Engineering Guide to Identifying and Reducing Hand
Exposure Across All Areas of Primary and Secondary Aluminium Production

EDITION

First Edition — 2026

SCOPE

Primary Production · FRP · Extrusion · Support

CHAPTERS

22 Departments Covered

DOCTRINE

Engineer the Hand Out of the Hazard™

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PUBLICATION DETAILS

TITLE

Hand Exposure in Aluminium Plants — A Department-by-Department Engineering Guide to Identifying and Reducing Hand Exposure Across All Areas of Primary and Secondary Aluminium Production

PUBLISHER

PSC Hand Safety India Private Limited
3rd Floor, Founta Plaza, Suryabagh
Visakhapatnam, Andhra Pradesh — 530020, India
handsafetyfirst.in · pschandsfree.com

BRAND IDENTITY

Hand Safety First® is a registered trademark and a PSC Hand Safety Brand.
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EDITION

First Edition — 2026
All content is current as of the date of publication. Specific product part numbers, pricing, and specifications should be confirmed with PSC Hand Safety India before procurement.

FIELD EVIDENCE

Field observations cited in this guide were made during site assessments at aluminium manufacturing facilities in India. Plant and operator identities are not disclosed in any content of this publication. Sector categories and qualitative descriptions are used throughout.

TECHNICAL NOTE

This guide presents engineering interface concepts and representative PSC product recommendations. It is not a substitute for site-specific risk assessment, regulatory compliance review, or professional engineering advice. All interface selections should be validated against the specific task, equipment geometry, and exposure conditions at the plant in which they are to be used.

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Foreword

Every hand injury in an aluminium plant has a moment before it — a moment when the hand is in the wrong place and the hazard is present. This guide is about that moment: what created it, why the hand was there, and what engineering interface could have placed a boundary between the hand and the hazard.

PSC Hand Safety India has conducted assessments across aluminium plants in India — in cast houses, rolling mills, finishing lines, scalper areas, annealing bays, and scrap yards. The pattern that emerges from those visits is consistent: workers in well-run, well-managed operations — ISO 45001 certified, active permit-to-work systems, mandatory PPE — are still placing their hands in hazard zones because no purpose-designed tool has been provided for the task that is forcing the hand there. An improvised bent rod for ingot guidance. A bare hand on a suspended scrap coil. A direct-hand contact on a rolling mill strip near active nip rolls. The absence of the right tool is the engineering gap. PPE is the residual control after the engineering gap has not been closed.

This guide documents 22 departments of an aluminium plant — from the carbon plant and alumina supply through to the despatch bay — with the same structure in each chapter: why the hand is there, what the current field interface is, what the engineering objective should be, and what a representative PSC interface looks like for that task. The field observations are real. The engineering principles are drawn from field experience, not from generic hazard taxonomy.

The guide is intended to be used at the plant — taken into the department, walked through the checklist, and used to identify where the engineering gap exists in that specific facility. It is not a compliance document. It is a field tool for engineers and safety professionals who want to ask the right question: not "are gloves in place?" but "why is the hand there at all — and what would remove the need for it to be there?"

That question — "why is the hand there?" — is the beginning of every engineering control. This guide is structured around it.

PSC Hand Safety India Private Limited

Hand Safety Engineering Controls · Visakhapatnam · 2026

Engineer the Hand Out of the Hazard™ · The Last 300 mm Rule™

How to Use This Guide

This guide is organised by production department — one chapter per operational area of the aluminium plant. Each chapter follows a consistent structure that can be worked through sequentially or used selectively for a specific task assessment. The structure is designed to support a plant walkdown: take the relevant chapter into the department and use the checklist as a starting point for conversation with the team.

1 · DEPARTMENT OVERVIEW

A field-oriented description of the department — what the work involves, where the hand exposure pattern is concentrated, and what distinguishes this department from others in the book.

2 · MAJOR EQUIPMENT

Six key equipment items or locations in the department, each with a description of how workers interact with that equipment and where hand exposure is generated during normal operation.

3 · TASK FLOW DIAGRAM

A single-page visual of the departmental work cycle, showing each major step and the primary hand exposure type at each transition. Use as a quick orientation before a walkdown.

4 · CURRENT FIELD INTERFACES

The tools and methods actually observed in use in the field — not what the procedure says, but what workers reach for when a task requires them to interact with the equipment or material.

5 · SCENARIOS (4 PER CHAPTER)

Each scenario addresses one task with five fields: why the hand is there, current interface, exposure type, engineering objective, and representative PSC interface. Designed to be read at the task location.

6 · NON-ROUTINE & MAINTENANCE

Shutdown and maintenance tasks where hand exposure is highest but frequency is lowest. These tasks are often not covered in routine hazard assessments — this section is specifically for maintenance teams.

7 · QUICK ASSESSMENT CHECKLIST

Seven to eight questions designed to identify whether the engineering gap exists in this specific department at this specific plant. Questions are based on observed behaviour, not procedure documentation.

8 · PSC INTERFACE PORTFOLIO

Representative PSC products for this department — with part numbers, sizes, and the specific scenario or maintenance task each interface addresses. Contact PSC to validate selection before procurement.

THREE CORE DOCTRINES APPLIED THROUGHOUT THIS GUIDE

Engineer the Hand
Out of the Hazard™

The Last 300 mm
Rule™

No Slogging Without
the Tool™

Contents

FRONT MATTER

<i>Title Page</i>	i
<i>Publication Details & Imprint</i>	ii
<i>Foreword</i>	iii
<i>How to Use This Guide</i>	iv

SECTION 1 · PRIMARY ALUMINIUM PRODUCTION

Chapter 01 Alumina Supply, Raw Materials & Pot Lining	1
Chapter 02 Carbon Plant — Anode Production	2
Chapter 03 Rodding Shop	3
Chapter 04 Potroom — Reduction Cells	4
Chapter 05 Metal Tapping & Crucible Operations	5
Chapter 06 Cast House — Melting & Holding Furnaces	6
Chapter 07 DC Casting	7

SECTION 2 · ALUMINIUM PROCESSING & ROLLING

Chapter 08 Scalper & Ingot Milling	8
Chapter 09 Hot Rolling Mill	9
Chapter 10 Cold Rolling Mill	10
Chapter 11 Finishing Lines	11
Chapter 12 Annealing & Heat Treatment	12

SECTION 3 · PLANT-WIDE SUPPORT & SPECIALIST PROCESSES

Chapter 13 Extrusion — Billet Handling & Die Shop	13
Chapter 14 Scrap Handling & Coil Bay	14
Chapter 15 Foil Rolling & Foil Processing	15
Chapter 16 Surface Treatment & Coating Lines	16
Chapter 17 Quality Control & Inspection Laboratory	17
Chapter 18 Roll Shop	18
Chapter 19 Mechanical Maintenance	19
Chapter 20 Electrical & Instrumentation Maintenance	20
Chapter 21 Utilities & Services	21
Chapter 22 Material Handling, Logistics & Despatch	22

APPENDICES

Appendix A <i>PSC Engineering Interface Master</i>	A-1
Appendix B <i>The Last 300 mm Rule™ — Field Reference</i>	B-1
Appendix C <i>Department Hand-Exposure Assessment Register</i>	C-1
Appendix D <i>Glossary</i>	D-1

Interpretation Notes

EVIDENCE BASIS

Practices and exposure points in this guide may be identified as:

Observed	Directly noted during PSC Hand Safety India plant assessments at aluminium manufacturing facilities.
Reported	Described by plant personnel or industry practitioners during assessments, site visits, or technical discussions.
Representative	Identified through task and equipment analysis as a credible exposure that may occur in comparable operations. Not every practice described should be interpreted as having been directly observed at every facility.

SEVERITY INDICATORS

HIGH and MEDIUM indicators are qualitative screening classifications based primarily on credible injury consequence and exposure frequency. They do not replace the plant's approved risk matrix, task risk assessment, or statutory assessment process. Where a site-specific risk assessment produces a different classification, the site assessment takes precedence.

CONTROL HIERARCHY

Recommendations in this guide should be considered in the following order of preference wherever practicable:

1	Eliminate the need for the task or for direct hand contact.
2	Automate, isolate, or remotely control the interaction.
3	Introduce a purpose-designed engineering interface that replaces the direct hand interaction.
4	Apply task-specific PPE for unavoidable residual exposure.

SPECIALIST CONTROLS

Electrical clearance, confined-space entry, respiratory protection, process-safety, and all other specialist controls referenced in this guide must be established by the plant's competent authority under its applicable procedures, standards, and statutory requirements. PSC Hand Safety India's authority is limited to the engineering-interface recommendations within this guide.

CHEMICAL GLOVE SELECTION

Where chemical-resistant gloves are recommended in this guide, the specific glove material, thickness, and grade must be validated against the actual chemical compound, concentration, temperature, and contact duration present at the task location, using manufacturer permeation and degradation data. References to glove materials in this guide are indicative only and require site-specific validation before adoption.

1

SECTION ONE

Primary Aluminium Production

- Chapter 01 — Alumina Supply, Raw Materials & Pot Lining
- Chapter 02 — Carbon Plant — Anode Production
- Chapter 03 — Rodding Shop
- Chapter 04 — Potroom — Reduction Cells
- Chapter 05 — Metal Tapping & Crucible Operations
- Chapter 06 — Cast House — Melting & Holding Furnaces
- Chapter 07 — DC Casting

2

SECTION TWO

Aluminium Processing & Rolling

- Chapter 08 — Scalper & Ingot Milling
- Chapter 09 — Hot Rolling Mill
- Chapter 10 — Cold Rolling Mill
- Chapter 11 — Finishing Lines
- Chapter 12 — Annealing & Heat Treatment

3

SECTION THREE

Plant-Wide Support & Specialist Processes

- Chapter 13 — Extrusion — Billet Handling & Die Shop
- Chapter 14 — Scrap Handling & Coil Bay
- Chapter 15 — Foil Rolling & Foil Processing
- Chapter 16 — Surface Treatment & Coating Lines
- Chapter 17 — Quality Control & Inspection Laboratory
- Chapter 18 — Roll Shop
- Chapter 19 — Mechanical Maintenance
- Chapter 20 — Electrical & Instrumentation Maintenance
- Chapter 21 — Utilities & Services
- Chapter 22 — Material Handling, Logistics & Despatch

Alumina Supply, Raw Materials & Pot Lining

This chapter identifies where workers' hands enter hazard zones during alumina and raw material handling and pot lining operations — alumina unloading and transfer, additive handling, pot lining installation, pot relining, and bath material management — and presents engineered interfaces for each identified exposure point.

CHEMICAL — CAUSTIC

DUST — ALUMINA

CRUSH

LACERATION

BURNS — CHEMICAL

1 DEPARTMENT OVERVIEW

Alumina supply, raw materials handling, and pot lining are the upstream support functions for primary aluminium smelting. Alumina arrives at the smelter by ship, rail, or truck and is transferred through unloading stations, silos, and conveyor systems to the pot feeding system that delivers it to the reduction cells. Raw materials — aluminium fluoride, cryolite, and other bath additives — are handled in the same material transfer infrastructure. Pot lining installation and relining are the most physically intensive operations in the primary aluminium department, involving large refractory components, molten bath contamination residue, and high-voltage equipment isolation in the pot shell.

The hand exposure in raw materials and pot lining work differs from other aluminium plant departments in one important respect: the chemical hazard is from dry caustic alumina dust and bath material rather than from liquid process chemistry. Alumina is abrasive and mildly alkaline — sustained skin contact causes progressive drying and cracking of the skin surface that creates chronic hand exposure distinct from the acute chemical burns of the cast house or anodising departments. Bath material (cryolite, aluminium fluoride, and electrolyte scale) contains fluoride compounds that cause both acute chemical burns and chronic fluoride absorption through skin contact. Pot lining relining generates the most intensive combination of these chemical exposures alongside the mechanical hazards of demolition and heavy component installation.

2 MAJOR EQUIPMENT & LOCATIONS

ALUMINA UNLOADING AND TRANSFER SYSTEM

Ship, rail, or truck unloading stations, pneumatic transfer lines, and storage silos for alumina supply to the pot room. Conveyor belt transfer and pneumatic transfer generate alumina dust in the handling area. Workers interact with the system for blockage clearance, sampling, and maintenance.

RAW MATERIAL STORAGE AND BATCHING

Storage silos and batching systems for aluminium fluoride, cryolite, and other bath additives. Additive bags are handled manually during small-batch preparation. Additive dust is fluoride-bearing and requires skin and respiratory protection during all close-approach handling.

POT FEEDING SYSTEM

Automated point feeders deliver alumina to each reduction cell through the pot superstructure. Feeder maintenance, crust punch maintenance, and feed tube blockage clearance require access to the top of the reduction cell — at potroom temperature and in proximity to the molten bath surface.

POT LINING — CATHODE BLOCK INSTALLATION

New pot lining requires installation of cathode carbon blocks, collector bars, ramming paste, and refractory brickwork in the empty pot shell. Workers handle heavy cathode blocks (200–500 kg each) by crane, and apply ramming paste by hand or pneumatic rammer between the blocks.

POT RELINING — SPENT LINING DEMOLITION

Spent pot lining removal is one of the most hazardous operations in primary aluminium production. The spent lining contains residual bath material, sodium and fluoride compounds, and reactive carbon that reacts with water. Workers use pneumatic tools to break and remove the spent cathode blocks and refractory from the pot shell.

BATH MATERIAL HANDLING — CRUST AND FREEZE

Bath crust from the reduction cell surface and freeze material (solidified electrolyte) must be handled during cell maintenance and relining preparation. Bath material contains cryolite and aluminium fluoride at concentrations that cause acute skin and eye irritation and chronic fluoride exposure with sustained contact.

3 RAW MATERIALS & POT LINING CYCLE — TASK FLOW & EXPOSURE POINTS**RAW MATERIALS & POT LINING CYCLE****ALUMINA RECEIPT & TRANSFER TO SILO**

Alumina unloaded · transferred by conveyor or pneumatic to storage

DUST — ALUMINA · CRUSH — CONVEYOR

RAW MATERIAL BATCHING & ADDITIVE HANDLING

Bath additives batched · fluoride materials handled

CHEMICAL — FLUORIDE DUST · ERGONOMIC

POT FEEDING — POINT FEEDER MAINTENANCE

Point feeders serviced · feed tubes cleared

BURNS — POTROOM TEMPERATURE · CHEMICAL

POT LINING — CATHODE BLOCK INSTALLATION

New cathode blocks installed in pot shell by crane

SUSPENDED LOAD · CRUSH · CHEMICAL — RAMMING PASTE

POT RELINING — SPENT LINING DEMOLITION

Spent cathode blocks and refractory broken out by pneumatic tools

CHEMICAL — SPENT LINING · DUST · VIBRATION

BATH MATERIAL HANDLING — CRUST & FREEZE

Bath crust and freeze material handled during cell maintenance

4 CURRENT FIELD INTERFACES OBSERVED

The interfaces below reflect standard working practice in primary aluminium smelter raw materials and pot lining operations across the industry.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — bath material and spent lining handling	Bath crust, freeze material, and spent lining contain cryolite, aluminium fluoride, and sodium compounds at concentrations that cause acute skin irritation and chronic fluoride absorption. Workers handle these materials without adequate chemical-resistant gloves in many pot relining operations — relying on heavy work gloves that provide mechanical protection but no chemical barrier for the fluoride compounds in the bath material.
Bare hands — ramming paste application between cathode blocks	Ramming paste applied between cathode blocks during pot lining contains coal tar pitch — a carcinogenic compound that absorbs through skin. Workers apply ramming paste by hand or use pneumatic rammers but contact the fresh paste during trimming and shaping operations without chemical-resistant gloves.
Bare hands — alumina sampling from conveyor and silo	Alumina sampling from the conveyor transfer or silo base involves reaching into the alumina stream or silo discharge to collect a representative sample. Alumina dust at close range in the sampling zone creates chronic skin exposure — alumina is mildly alkaline and abrasive at dust concentrations in the sampling zone.
Improvised tools — spent lining material clearing from pot shell	During pot relining, spent lining material that has broken into irregular pieces must be cleared from the pot shell. Workers use improvised bars and shovels to clear spent material that is contaminated with reactive sodium compounds from the cathode. The irregular geometry of broken spent lining creates laceration hazards from sharp fracture edges alongside the chemical exposure.

ENGINEERING OBJECTIVE — ALUMINA SUPPLY, RAW MATERIALS & POT LINING

Provide chemical-barrier gloves appropriate to the specific chemical hazard — fluoride compounds in bath material, coal tar pitch in ramming paste — for all raw material and pot lining handling, and purpose-designed long-handled tools for spent lining clearance that maintain stand-off from reactive spent cathode material.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH Spent Pot Lining Demolition — Pneumatic Breaking and Manual Clearing CHEMICAL — REACTIVE SPENT LINING · DUST · VIBRATION · LACERATION					
WHY THE HAND IS THERE Spent pot lining removal requires breaking the spent cathode carbon blocks and refractory from the pot shell using pneumatic chisels and bars. The spent lining is contaminated with sodium metal compounds and cyanide compounds formed during electrolysis — both reactive with water. Workers breaking and clearing spent lining are in close contact with the contaminated material for extended periods during the relining operation.		CURRENT FIELD INTERFACE Pneumatic tools held by hand for spent lining demolition — standard practice. Workers clear broken spent lining pieces by hand using bars and shovels, with hands in direct contact with the fluoride and sodium-contaminated material. Dust generated during demolition contains fluoride compounds, cyanide compounds, and carbon particles. Standard work gloves used for demolition provide mechanical protection only — no fluoride chemical barrier.		EXPOSURE TYPE Chemical burns and chronic fluoride absorption from direct contact with spent lining containing sodium and fluoride compounds. Acute cyanide toxicity risk from spent lining cyanide compound contact with skin or mucous membranes. Vibration white finger from prolonged pneumatic tool use. Laceration from sharp fracture edges of broken spent cathode carbon blocks. Dust inhalation of fluoride and cyanide compound dust during demolition.	
ENGINEERING OBJECTIVE Demolish and clear spent pot lining using fluoride-chemical-barrier gloves for all contact with spent material, and long-handled clearing tools that maintain stand-off from the reactive spent lining material during manual clearing operations.			REPRESENTATIVE INTERFACE Fluoride-barrier chemical gloves (nitrile or neoprene rated for fluoride compounds) for all spent lining contact operations. PSC Load-It with S-Head (4–6 ft) for pushing and clearing broken spent lining pieces from the pot shell — avoids direct hand contact with reactive spent material. Defined water exclusion protocol around spent lining — reactive sodium compounds in spent lining react violently with water.		
"During spent pot lining demolition, are the gloves in use rated as a chemical barrier for fluoride and sodium compounds — not only as mechanical protection for the demolition task?"					
HIGH Cathode Block Installation — Crane Guidance and Ramming Paste Application SUSPENDED LOAD · CRUSH · CHEMICAL — COAL TAR PITCH					
WHY THE HAND IS THERE New cathode carbon blocks (200–500 kg each) are lowered into the pot shell by crane and positioned on the refractory bed. Workers guide each block during crane descent and confirm correct positioning before the crane slack is released. After each block is seated, ramming paste — containing coal tar pitch — is applied to the joints between blocks by hand or pneumatic rammer. Trimming of excess paste brings hands into sustained contact with the coal tar pitch compound.		CURRENT FIELD INTERFACE Bare hand guidance of cathode blocks during crane descent in the confined pot shell. Workers reach into the pot shell to guide the block into its joint position while the block is still suspended. Ramming paste trimming and shaping by bare hand — coal tar pitch absorbs through skin and is classified as a Group 1 carcinogen. Heavy work gloves used for block handling do not provide chemical barrier for the coal tar pitch component of the ramming paste.		EXPOSURE TYPE Crush between the cathode block and the pot shell wall if the block swings during crane descent in the confined pot shell geometry. Carcinogenic skin absorption from sustained coal tar pitch contact during ramming paste trimming and application. Burns from hot pot shell components if the relining follows immediately after cell shutdown with residual heat in the shell.	
ENGINEERING OBJECTIVE Guide cathode blocks into the pot shell using a stand-off tool rather than bare hands in the confined shell geometry — and use chemical-barrier gloves rated for coal tar pitch during all ramming paste contact operations.			REPRESENTATIVE INTERFACE PSC LoadGuider Anti-Tangle Tagline for block swing control during crane descent into the pot shell. PSC Load-It (S-Head, 4 ft) for block lateral guidance in the pot shell from outside the block-to-shell crush zone. Coal tar pitch chemical-barrier gloves (neoprene or butyl rubber rated for PAH compounds) for all ramming paste handling.		
"During cathode block installation, are workers guiding the blocks with a stand-off tool — and during ramming paste trimming, are the gloves rated as a chemical barrier for coal tar pitch, not only as mechanical protection?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Pot Point Feeder Maintenance — Access at Potroom Temperature	
BURNS — POTROOM TEMPERATURE · CHEMICAL · CRUSH					
WHY THE HAND IS THERE Point feeder maintenance — clearing blocked feed tubes, replacing feeder components, and adjusting feed rates — requires access to the top of the reduction cell through the superstructure. The potroom ambient temperature around the cell is elevated, and the cell superstructure and feeder components retain heat from the cell operating temperature. Workers access the feeder system from above the cell, with the molten bath below and the superstructure components at elevated temperature around the working position.		CURRENT FIELD INTERFACE Workers approach the cell superstructure by opening the superstructure access points and reaching into the feeder area. Feed tube blockage clearance uses long rods — but the rod grip position may bring hands into the temperature zone of the cell superstructure. Component replacement in the feeder mechanism requires handling parts that are at cell ambient temperature.		EXPOSURE TYPE Burns from contact with cell superstructure components at elevated temperature during feeder maintenance. Chemical exposure from alumina and bath material dust at the feeder maintenance position. Crush from the cell superstructure access cover if it falls during maintenance access. Electrical exposure from the HV bus bar system if the clearance distance is breached during feeder access.	
ENGINEERING OBJECTIVE Perform point feeder maintenance using tools with adequate reach to keep grip hands outside the thermal zone of the cell superstructure, and with defined electrical clearance from the cell HV bus bar system throughout the maintenance approach.			REPRESENTATIVE INTERFACE Long-handled feeder clearing tool for feed tube blockage clearance — reach positions grip hand below the superstructure thermal zone. Defined electrical minimum approach distance from HV bus bar marked on the superstructure access procedure. Heat-resistant arm and hand protection for all component replacement in the feeder mechanism area.		
"During point feeder maintenance, is the electrical minimum approach distance from the HV bus bar system confirmed before the maintenance worker accesses the cell superstructure — and is the clearance physically marked on the access route?"					

MEDIUM	Bath Material Handling — Crust and Freeze Material at Cell Maintenance CHEMICAL — FLUORIDE · BURNS — HOT MATERIAL · LACERATION		
WHY THE HAND IS THERE Bath crust from the reduction cell surface and freeze material (solidified electrolyte from around the cell walls) must be handled during cell maintenance, metal tapping preparation, and relining preparation. Bath crust is removed from the cell surface using pneumatic tools or by hand, and freeze material is broken and cleared from the cell ledge. Both materials contain cryolite and aluminium fluoride — fluoride compounds that cause acute skin irritation and chronic fluoride absorption with repeated contact.	CURRENT FIELD INTERFACE Workers handle bath crust and freeze material using bare hands or standard work gloves during cell maintenance and relining preparation. Standard work gloves provide mechanical protection but no fluoride chemical barrier. Bath crust may retain heat from the cell surface — hot bath material in contact with bare skin or inadequate gloves causes burns in addition to the fluoride exposure.	EXPOSURE TYPE Fluoride chemical burns and chronic fluoride absorption from sustained contact with bath crust and freeze material containing cryolite and aluminium fluoride. Burns from hot bath crust if the material is handled before it has cooled below safe touch temperature. Laceration from sharp edges of irregular broken freeze material pieces during manual clearing. Fluoride dust inhalation during pneumatic crust breaking.	
ENGINEERING OBJECTIVE Handle bath crust and freeze material using fluoride-barrier chemical gloves for all direct contact, and confirm material temperature before bare-hand-adjacent approach when handling material removed from the active cell surface.		REPRESENTATIVE INTERFACE Fluoride-chemical-barrier gloves (nitrile or neoprene rated for fluoride compounds) for all bath material contact. PSC Load-It with S-Head for pushing and clearing broken freeze material pieces — avoids direct hand contact with sharp-edged, fluoride-bearing freeze material. Temperature confirmation before close approach to freshly removed bath crust.	

"Are the gloves used for bath crust and freeze material handling rated as a chemical barrier for fluoride compounds — and is a separate glove specification in place for bath material contact compared to general mechanical work gloves used elsewhere in the potroom?"

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Alumina conveyor belt jam clearance	Blocked alumina conveyor cleared; belt under tension; drive drum nip zone present; alumina dust at high concentration in jam zone	HIGH	Crush · Dust · Nip Point	PSC Position & Reach · PSC Retrieval Interfaces
Silo and transfer line blockage clearance	Blockages cleared from alumina silo outlet or pneumatic transfer line; confined silo access; bulk alumina flowability; possible rat-holing collapse during clearance	HIGH	Crush · Confined Space · Dust	PSC Position & Reach Interfaces
Cathode collector bar extraction during relining	Collector bars extracted from spent cathode blocks during demolition; bars at elevated temperature; heavy bar weight; confined pot shell geometry	HIGH	Burns · Crush · Chemical	PSC Load Control · PSC Position & Reach
Pot shell cleaning after lining removal	Pot shell interior cleaned of residual spent lining and bath material residue after block removal; confined shell geometry; reactive sodium compound residue; fluoride contamination on shell surfaces	HIGH	Chemical · Confined Space · Dust	PSC Position & Reach · PSC Retrieval Interfaces
Point feeder component replacement	Individual feeder components replaced on the cell superstructure; components at cell ambient temperature; confined superstructure geometry; HV bus bar in proximity	HIGH	Burns · Electrical · Crush	PSC Position & Reach Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ During spent pot lining demolition and clearance, are the gloves in use rated as a chemical barrier for fluoride and sodium compounds — not only as mechanical protection?
- ☐ During ramming paste application and trimming, are chemical-barrier gloves rated for coal tar pitch used — not standard work gloves?
- ☐ During cathode block crane installation in the pot shell, is a stand-off tool used for lateral block guidance — keeping workers outside the block-to-shell crush zone?
- ☐ During point feeder maintenance, is the electrical minimum approach distance from the HV bus bar confirmed and physically marked before the maintenance worker accesses the superstructure?
- ☐ Are bath crust and freeze material handling gloves specified separately from general potroom mechanical gloves — rated for fluoride compounds, not only for mechanical protection?
- ☐ During conveyor belt jam clearance in the alumina transfer system, is a belt tension release confirmed before any tool or hand approach to the jammed material?
- ☐ During silo blockage clearance, is a confined space entry procedure followed — including flowability collapse risk assessment before any worker approach to the silo outlet?

Contact PSC Hand Safety India for application-specific interface guidance.

8 PSC ENGINEERING INTERFACE PORTFOLIO — ALUMINA SUPPLY, RAW MATERIALS & POT LINING

POSITION & REACH INTERFACES — POT LINING & RAW MATERIAL HANDLING

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Cathode block lateral guidance in pot shell during crane installation — worker outside block-to-shell crush zone. Spent lining and freeze material clearing from pot shell and cell surface. Alumina conveyor jam clearance from outside the nip zone.	4 ft, 6 ft	PSC-LIT-S006 / S010	2 · Maint.
RETRIEVAL PSC Long-Reach Pickup Tool	Spent lining piece retrieval from pot shell floor during relining. Freeze material piece handling from cell ledge — avoids direct hand contact with fluoride-bearing freeze material.	6 ft	PSC-ST	1 · 4 · Maint.

LOAD CONTROL & STRIKING INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for cathode blocks during crane installation in pot shell. Swing control for collector bar extraction during relining. Heavy component crane control in confined pot shell geometry.	25 ft, 30 ft	PSC-LGTC-25 / -30	2 · Maint.
STRIKING PSC FingerSaver™	Holding wedges, drifts, and alignment pins during cathode block installation hardware driving. Collector bar extraction driving operations during pot relining.	350 mm, 850 mm	PSC-FS-350 / -850	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — FLUORIDE COMPOUNDS IN BATH MATERIAL REQUIRE CHEMICAL-BARRIER GLOVES, NOT MECHANICAL GLOVES

The gloves used for most potroom mechanical work protect against abrasion and impact. They do not provide a chemical barrier against fluoride compounds in bath material, spent lining, and aluminium fluoride additive dust. These are different hazards requiring different glove specifications.

Cryolite and aluminium fluoride — present in bath crust, freeze material, spent lining, and raw material additives — cause chronic fluoride absorption through skin with repeated unprotected contact. This absorption does not produce immediate visible injury; the effects are cumulative over years of exposure. A mechanical work glove rated for abrasion provides no barrier against fluoride ion absorption through the glove material. The engineering control is a glove material specification that has been selected for fluoride chemical barrier properties — nitrile or neoprene rated for fluoride compounds — used for all tasks where bath material contact is expected, in addition to whatever mechanical protection level the task also requires.

1 DEPARTMENT OVERVIEW

The carbon plant produces the prebaked anodes that supply carbon to the aluminium reduction cells. Anode production is a thermal, chemical, and mechanical process — coal tar pitch binder is blended with calcined petroleum coke to form the green anode paste, pressed and vibrated into the anode form, baked in ring furnaces at 1,100–1,200°C, and then rodded with aluminium stubs using cast iron thimbles poured at 750–800°C. The hand exposure in the carbon plant combines the chemical carcinogen hazard of coal tar pitch with the high-temperature hazard of baking furnace and rodding operations, and the heavy mechanical hazard of large anode handling by crane and forklift.

Coal tar pitch — the binder used in anode paste — is classified as a Group 1 human carcinogen by the IARC. Skin contact during green anode paste handling, rodding station operations, and spent anode butt treatment is the primary occupational health exposure in the carbon plant. The standard gloves used for anode handling in many operations — heavy leather or canvas work gloves — do not provide a chemical barrier against coal tar pitch carcinogen absorption through the glove material. This is the defining engineering gap in the carbon plant from a hand exposure standpoint.

2 MAJOR EQUIPMENT & LOCATIONS

GREEN PASTE PLANT — MIXER AND FORMER

Calcined petroleum coke and coal tar pitch are blended in heated mixers and formed into green anodes by vibration compaction or pressing. Workers interact with the former for paste sample collection, former cleaning, and blockage clearance. Fresh green paste is at 150–180°C and contains coal tar pitch at full concentration.

ANODE BAKING FURNACE (RING FURNACE)

Ring furnaces bake green anodes to 1,100–1,200°C over a controlled temperature cycle. The furnace pits are sequentially loaded with green anodes and filler coke, baked, and unloaded after cooling. Loading and unloading require crane handling of large anode stacks and management of hot filler coke.

FILLER COKE HANDLING

Filler coke (calcined petroleum coke used to pack around the anodes in the baking furnace pit) must be added and removed at each pit cycle. Hot filler coke removal after baking generates dust and heat. Workers interact with filler coke during pit loading and hot coke removal after baking.

RODDING STATION — STUB AND THIMBLE CASTING

Baked anodes are connected to steel stubs using cast iron thimbles poured at 750–800°C. Workers position the anode under the rodding crane, align the steel stub, and manage the thimble casting operation. Hot cast iron thimbles and the associated splash and spatter present burn hazards. The rodded anode handling area is at elevated temperature from the casting operation.

ANODE ASSEMBLY AND TRANSFER

Assembled anodes (anode body with cast thimble and steel stub) are transferred by crane to the potroom for cell installation. Anode assembly is the heaviest crane handling operation in the carbon plant — assembled anodes weigh 800–1,200 kg each. Workers guide anode assemblies during crane transfer and potroom installation.

SPENT ANODE BUTT TREATMENT

Spent anodes returned from the reduction cells carry a coating of bath material (cryolite and electrolyte residue) on the anode butt. The bath material must be cleaned from the butt before the butt is returned to the paste plant as recycled carbon. Bath material cleaning generates fluoride dust and requires direct contact with the fluoride-bearing residue on the spent anode surface.

3 ANODE PRODUCTION CYCLE — TASK FLOW & EXPOSURE POINTS**ANODE PRODUCTION CYCLE****GREEN PASTE MIXING & FORMING**

Coke and pitch blended · green anode formed at 150–180°C

BURNS — HOT PASTE · CHEMICAL — COAL TAR PITCH

BAKING FURNACE LOADING

Green anodes loaded into ring furnace pit with filler coke

SUSPENDED LOAD · CRUSH · DUST — COKE

BAKING CYCLE — 1100–1200°C

Anodes baked · filler coke managed through cycle

BURNS — FURNACE · DUST — HOT COKE

BAKED ANODE UNLOADING

Baked anodes removed from furnace pit after cooling cycle

SUSPENDED LOAD · BURNS — RESIDUAL HEAT · CRUSH

RODDING — STUB ALIGNMENT & THIMBLE CAST

Steel stub aligned · cast iron thimble poured at 750–800°C

BURNS — MOLTEN IRON SPLASH · CHEMICAL — PITCH

SPENT ANODE BUTT TREATMENT

Returned spent anodes cleaned of bath material residue

4 CURRENT FIELD INTERFACES OBSERVED

The interfaces below reflect standard working practice in carbon plant and anode production operations at primary aluminium smelters.

CURRENT INTERFACE	ENGINEERING LIMITATION
Standard work gloves — green paste and rodding station handling	Coal tar pitch in green paste and in the rodding station environment is a Group 1 carcinogen. Heavy leather or canvas work gloves used in most carbon plant operations provide mechanical protection but not a chemical barrier against coal tar pitch carcinogen absorption through the glove material. Workers handling fresh green paste, cleaning formers, and working at the rodding station have sustained skin-adjacent exposure to coal tar pitch compounds through glove materials that do not resist PAH absorption.
Bare hands or work gloves — spent anode butt bath material cleaning	Spent anode butts carry bath material (cryolite and electrolyte residue) containing fluoride compounds. Workers cleaning the butt surface by mechanical scraping or water jetting have hands in close proximity to fluoride-bearing residue. Work gloves provide mechanical protection only — no fluoride chemical barrier for the bath residue on the spent butt surface.
Bare hand reach — filler coke sampling and quality check after baking	After the baking cycle, filler coke from the furnace pit must be sampled for quality and managed during pit unloading. Hot filler coke at residual temperature after baking generates heat and petroleum coke dust. Workers reach into the filler coke mass for sampling or quality checking with bare hands or inadequate gloves.
Improvised tools — former and paste plant cleaning	Green paste formers and paste plant equipment must be cleaned of adhering paste between production runs. Workers use improvised scrapers and bars to clear fresh or cured paste from former surfaces — fresh paste at 150–180°C, cured paste at ambient but with full coal tar pitch concentration. Improvised scraper handles provide inadequate stand-off from the coal tar pitch-bearing paste surface during cleaning.

ENGINEERING OBJECTIVE — CARBON PLANT — ANODE PRODUCTION

Specify coal tar pitch chemical-barrier gloves for all carbon plant operations where pitch contact is possible — paste plant, rodding station, and spent butt handling — and fluoride-barrier gloves for spent anode bath material removal. Provide purpose-designed long-handled tools for former cleaning and filler coke management that maintain stand-off from hot and chemically hazardous materials.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH Green Paste Handling — Coal Tar Pitch Carcinogen Contact at Forming Station CHEMICAL — COAL TAR PITCH (CARCINOGEN) · BURNS — HOT PASTE · ERGONOMIC					
WHY THE HAND IS THERE Green anode paste at 150–180°C is loaded into the vibration compactor or press former. Workers collect paste samples from the mixer outlet, observe the forming process through the former access, clear paste blockages from the former feed, and clean adhering paste from the former surfaces between runs. Each of these tasks involves close contact with green paste containing coal tar pitch at full concentration.		CURRENT FIELD INTERFACE Standard leather or canvas work gloves used for all paste plant operations. These gloves do not provide a chemical barrier against polycyclic aromatic hydrocarbons (PAHs) in coal tar pitch — PAHs absorb through leather and canvas glove materials. Workers therefore have sustained skin-adjacent PAH exposure during all paste contact tasks despite wearing gloves. Paste at forming temperature adds a burn risk to the carcinogen exposure.		EXPOSURE TYPE Carcinogenic PAH absorption through inadequate glove materials during sustained green paste contact. Burns from fresh green paste at 150–180°C if paste contacts bare skin during blockage clearance or former cleaning. Ergonomic strain from sustained awkward posture during former cleaning with short-handled improvised tools. Dust from dry paste and petroleum coke in the paste plant environment.	
ENGINEERING OBJECTIVE Use coal tar pitch chemical-barrier gloves — neoprene or butyl rubber rated for PAH compound resistance — for all tasks involving green paste contact in the paste plant, including paste sampling, former cleaning, and blockage clearance.			REPRESENTATIVE INTERFACE Coal tar pitch chemical-barrier gloves (neoprene or butyl rubber rated for PAH resistance) for all green paste operations. PSC Load-It with custom Scraper Head for former surface cleaning — adequate stand-off keeps grip hand outside the hot paste contact zone. Defined paste temperature confirmation before close-approach cleaning — no bare-skin approach to paste above the defined safe-touch threshold.		
<i>"Are the gloves used for green paste handling rated as a chemical barrier for polycyclic aromatic hydrocarbons — confirmed by testing against actual coal tar pitch, not assumed from the general glove specification?"</i>					
HIGH Rodding Station — Thimble Casting and Hot Assembly Handling BURNS — MOLTEN IRON SPLASH · CHEMICAL — COAL TAR PITCH · SUSPENDED LOAD					
WHY THE HAND IS THERE The rodding station casts molten iron thimbles at 750–800°C around the steel stub seated in the baked anode. Workers position the anode assembly under the rodding crane, align the steel stub in the anode collar, and monitor the thimble casting. After casting, the assembled anode must be moved by crane while the thimble is still at elevated temperature. Coal tar pitch vapour in the rodding station environment adds carcinogen exposure to the thermal hazard.		CURRENT FIELD INTERFACE Workers approach the anode positioning zone under the rodding crane for stub alignment and anode seating confirmation — in proximity to the thimble casting point. After casting, anode assemblies are guided by crane with hands near the hot thimble. Molten iron thimble casting generates spatter — the standard approach does not provide a defined exclusion zone from the casting point for guidance workers during pouring.		EXPOSURE TYPE Burns from molten iron spatter during thimble casting. Burns from the hot assembled anode thimble during post-cast crane guidance. Carcinogenic PAH absorption from coal tar pitch vapour and pitch residue in the rodding station environment — anode collar area contains residual pitch compounds. Crush from the heavy anode assembly during crane positioning.	
ENGINEERING OBJECTIVE Define a physical exclusion zone from the thimble casting point during pouring — guidance workers position outside this zone during the casting sequence, returning for anode crane guidance only after casting is confirmed complete and the immediate spatter zone is clear.			REPRESENTATIVE INTERFACE Defined casting exclusion zone marked on the rodding station floor — no worker within the zone during molten iron pouring. Anti-Tangle Tagline for anode assembly swing control during crane transfer after rodding. Heat-resistant arm protection and full face shield for all rodding station proximity work. Coal tar pitch chemical-barrier gloves for all anode handling in the rodding station area.		
<i>"During thimble casting, is there a defined and enforced exclusion zone from the casting point that keeps all workers outside the molten iron spatter radius — or does current practice allow guidance workers to remain adjacent to the casting point during pouring?"</i>					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH	Spent Anode Butt Bath Material Removal — Fluoride Exposure CHEMICAL — FLUORIDE · DUST · LACERATION		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	ENGINEERING OBJECTIVE	REPRESENTATIVE INTERFACE	
	"Are the gloves used for spent anode butt bath material removal rated as a fluoride chemical barrier — and is a combined chemical glove specification in place that addresses both coal tar pitch PAH exposure on the anode surface and fluoride exposure from the bath material coating?"		
MEDIUM	Baking Furnace Pit Loading and Filler Coke Management SUSPENDED LOAD · BURNS — HOT COKE · DUST		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	ENGINEERING OBJECTIVE	REPRESENTATIVE INTERFACE	
	"During baking furnace pit loading, is the anode crane guidance performed using a stand-off tool from outside the pit edge — or does the current guidance method require the worker to be adjacent to the pit rim in the crane swing zone?"		

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Green paste former and vibrator maintenance	Former and vibrator mechanism accessed for maintenance; fresh paste residue on former surfaces; coal tar pitch in paste residue; hot former components if maintenance follows production	HIGH	Chemical — PAH · Burns · Pinch	PSC Striking & Alignment · PSC Position & Reach
Baking furnace pit cover and flue maintenance	Furnace pit cover removed for maintenance; pit at residual baking temperature; heavy pit cover component; confined pit geometry	HIGH	Burns · Crush · Confined Space	PSC Load Control · PSC Position & Reach
Rodding station casting ladle maintenance	Casting ladle serviced between rodding campaigns; ladle at residual molten iron temperature; refractory lining of ladle accessed for inspection and repair	HIGH	Burns — Hot Metal · Chemical · Confined Space	PSC Position & Reach Interfaces
Filler coke conveyor and silo maintenance	Coke conveyor belt jam clearance and silo outlet maintenance; petroleum coke dust at high concentration; conveyor nip points; silo confined access	HIGH	Dust · Crush · Nip Point	PSC Position & Reach · PSC Retrieval Interfaces
Spent butt crusher and screening maintenance	Crusher and screen maintained for spent butt carbon recycling; sharp carbon fragments in crusher housing; heavy crusher jaw components; coal tar pitch residue on all crusher surfaces	HIGH	Laceration · Chemical · Crush	PSC Striking & Alignment · PSC Position & Reach

7 QUICK ASSESSMENT CHECKLIST

- ☐ Are the gloves used for green paste handling rated as a chemical barrier for polycyclic aromatic hydrocarbons — not standard leather or canvas work gloves?
- ☐ During thimble casting at the rodding station, is a defined and enforced exclusion zone maintained around the casting point — keeping all guidance workers outside the molten iron spatter radius?
- ☐ Are the gloves for spent anode butt bath material removal rated as a fluoride chemical barrier — with a combined specification addressing both PAH exposure and fluoride exposure?
- ☐ During baking furnace pit anode loading, is crane guidance performed using a stand-off tool from outside the pit edge — not bare hand guidance from inside the swing zone?
- ☐ Is filler coke quality sampling after baking performed using a long-handled sampling tool — not a bare hand reach into the hot coke mass?
- ☐ During paste former cleaning, is a purpose-designed scraper tool used for paste removal — with adequate reach to keep grip hands outside the hot paste contact zone?
- ☐ Are carbon plant glove specifications reviewed and validated against the actual chemical compounds in use — coal tar pitch PAH content and bath fluoride concentrations — not assumed from generic glove category descriptions?

Contact PSC Hand Safety India for application-specific interface guidance.

8 PSC ENGINEERING INTERFACE PORTFOLIO — CARBON PLANT — ANODE PRODUCTION

POSITION & REACH INTERFACES — CARBON PLANT MATERIAL HANDLING

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Spent anode butt bath material pushing and clearing after mechanical scaling. Filler coke management during furnace pit loading. Anode lateral guidance during crane placement in furnace pit and rodding station.	4 ft, 6 ft	PSC-LIT-S006 / S010	1 · 3 · 4
POSITION & REACH PSC Load-It® Scraper Head (Custom)	Green paste former cleaning — stand-off from hot paste surface during paste removal. Keeps grip hand outside the coal tar pitch contact zone and the hot paste thermal zone.	3–4 ft	Custom — PSC	1 · Maint.
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving spent anode butt bath material fragments and filler coke pieces. Sample collection from hot and chemically contaminated material at stand-off.	6 ft	PSC-ST	3 · Maint.

LOAD CONTROL & STRIKING INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for anode stacks during furnace pit loading and unloading. Swing control for assembled anodes during post-rodding crane transfer to the potroom.	25 ft, 30 ft	PSC-LGTC-25 / -30	4 · Maint.
STRIKING PSC FingerSaver™	Holding drifts and wedges during carbon plant hardware installation. Spent butt crusher jaw alignment and maintenance impact operations.	350 mm, 850 mm	PSC-FS-350 / -850	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — COAL TAR PITCH IS A GROUP 1 CARCINOGEN. STANDARD WORK GLOVES DO NOT PROVIDE A CHEMICAL BARRIER AGAINST IT.

Leather and canvas work gloves protect against abrasion and mechanical impact. They do not provide a barrier against polycyclic aromatic hydrocarbon absorption from coal tar pitch. Carbon plant glove specifications must be based on PAH barrier testing, not on mechanical protection classification alone.

Coal tar pitch is listed as a Group 1 human carcinogen by the International Agency for Research on Cancer — the highest classification of carcinogenic evidence. Workers handling green paste, working in the rodding station, and cleaning spent anode butts have sustained skin-adjacent contact with PAH compounds through the standard work gloves used in most carbon plant operations. The engineering control is not a different mechanical glove — it is a chemical-barrier glove material (neoprene or butyl rubber) that has been tested for resistance to PAH penetration and confirmed to provide an adequate barrier at the contact durations and concentrations present in the specific task.

This specification must be task-specific and validated against the actual pitch in use, not inferred from generic glove category ratings.

1 DEPARTMENT OVERVIEW

Ask the audience how many baked anodes their potroom consumes per day. In a typical 250,000-tonne-per-year smelter, the answer is between 600 and 900 anodes — every single day, 365 days a year, with no process break. Each of those anodes must be received, rodded, despatched to the potroom, recovered as a spent butt, cleaned, and its stub assembly returned for repair. That cycle generates more repetitive manual load interaction than almost any other department in the plant. Ask when anyone last mapped the number of hand-to-load contacts that cycle requires per shift. The answer is almost always: never.

The Rodding Shop is the anode assembly and recovery hub of a primary aluminium smelter. It receives baked carbon anode blocks from the Carbon Plant or an external supplier, assembles them onto cast iron stub and yoke structures, and despatches the completed rodded anode assemblies to the potroom for installation in reduction cells. In the reverse direction, spent anode butts return from the potroom after partial consumption, and the Rodding Shop separates the residual carbon from the stub assembly, cleans the stub, and returns it for re-use in the next assembly cycle.

The bath crusher area — typically co-located with the Rodding Shop — receives spent anodes with frozen electrolyte crust adhering to butt faces and stub surfaces. This crust is broken by mechanical and manual means, and cleaned stubs are returned for the next rodding cycle. Throughout this sequence the anode assembly — a carbon block weighing 800–1,200 kg suspended from a stub that may weigh 150–300 kg — is the primary load being moved, and the bell grab or overhead crane is the primary lifting device. Workers interact with that load at every transfer point in the cycle.

The hand exposure pattern in the Rodding Shop has a single recurring characteristic: large, abrasive, irregularly shaped loads are moved repeatedly by crane through confined transfer sequences, and workers are required to guide, position, hook, unhook, and steady those loads at every stage. The process requires an interface between the worker and the suspended load at each of those points. Where no engineered interface exists, workers fabricate one from available steel bar. That fabricated rod — unrated, unguarded, and without a designed grip or head — is the most commonly observed handling interface in Rodding Shops across the industry. Its prevalence is not a reflection of worker behaviour. It is a reflection of the absence of purpose-designed alternatives.

2 MAJOR EQUIPMENT & LOCATIONS

BELL GRAB & OVERHEAD CRANE

The primary lifting device for anode assemblies throughout the Rodding Shop. The bell grab clamps the stub yoke and lifts the full assembly. Workers guide the bell grab onto the stub and release it at the destination — both operations performed close to a suspended, loaded crane hook.

RODDING MACHINE

The assembly station where the baked carbon block is joined to the cast iron stub using thermite welding or mechanical clamping. The anode block is positioned under the stub, aligned, and held during the joining process. Workers interact with both components during alignment and with the completed assembly during transfer.

HOOING / UNHOOKING STATION

The transfer point where rodded anode assemblies are loaded onto the potroom transport system and spent anode butts are received on return. Every assembly passing through requires a hook engagement and a hook release while the load is suspended — the highest-frequency manual interaction point in the Rodding Shop.

BATH CRUSHER

Receives spent anode butts with frozen electrolyte crust adhering to carbon and stub surfaces. Crust is broken using crow bars and mechanical scrapers before the stub can be returned. Workers are close to heavy, abrasive, chemically contaminated surfaces throughout the cleaning sequence.

STUB REPAIR SHOP

Receives stub assemblies for inspection, straightening, cladding repair, and requalification. Stubs are moved by crane and handled individually during inspection and repair work including welding, grinding, and dimensional checking — all involving close hand interaction with heavy cast iron components.

BAKED ANODE STORAGE & TRANSFER

Baked anodes arrive in rail wagons or on flatbed vehicles and are unloaded using overhead cranes and spreader beams. Anode blocks are dense, abrasive, and have no designed carry point. Workers guide the crane hook and spreader into position and maintain separation between adjacent blocks during stacking.

3 ANODE CYCLE — PROCESS FLOW & EXPOSURE POINTS

ANODE CYCLE — PROCESS FLOW & EXPOSURE POINTS

CARBON PLANT

Baked anodes produced or received

CRANE LIFT · SUSPENDED LOAD**BAKED ANODE STORAGE**

Unloading · stacking · separation

BLOCK SEPARATION · CRUSH**RODDING MACHINE**

Anode block joined to stub / yoke assembly

BELL GRAB HOOK · PINCH**HOOKING / UNHOOKING STATION**

Load to potroom transport system

SUSPENDED LOAD · STRUCK-BY**POTROOM — ANODE IN SERVICE**

Anode installed · partially consumed · returned as spent butt

SPENT BUTT RETURN · CRANE**BATH CRUSHER**

Crust broken · stub cleaned · bath contamination removed

IMPACT · LACERATION · CHEMICAL**STUB REPAIR → BACK TO RODDING · 600–900 CYCLES/DAY****EVERY STEP INVOLVES SUSPENDED LOAD INTERACTION**

Seven transfer points. Seven suspended-load interactions. Every arrow in this diagram represents at least one moment where a worker must guide, position, hook, or release a load while it is connected to a mechanical lifting device. In a plant producing 250,000 tonnes per year, that sequence repeats 600–900 times every day.

4 CURRENT FIELD INTERFACES OBSERVED

The table below documents the manual interfaces currently observed in Rodding Shop operations across the industry, and their engineering limitations. These observations are not a criticism of current practice. They identify where purpose-designed engineered interfaces are absent.

CURRENT INTERFACE	ENGINEERING LIMITATION
Fabricated steel guide rod	No defined grip surface, load-catch head, or rated capacity. Slips under lateral load — causes sudden worker lunge toward hazard zone. Typically 1–1.5 m length provides inadequate stand-off for bell grab and stem operations.
Plain guide rope / tag rope	Provides swing control only — no lateral positioning capability. Prone to tangling around stub yokes and grab structures. No defined grip point; rope wraps around hands under load, creating entanglement risk.
Crow bar	Designed for leverage, not positioning. No ergonomic grip for sustained guiding operations. Holding hand must remain near the working end — within the impact zone during crust-breaking tasks. Not rated for load guidance forces.
Improvised scraper (welded plate on rod)	Unfinished edges create laceration risk at grip point. Short overall length keeps hands close to roller tables and crusher surfaces. No defined face geometry — bath crust fragments deflect unpredictably during clearing strokes.
Bare hands	Zero stand-off distance. Worker body enters load swing zone and load drop zone simultaneously. No protection against abrasive carbon surfaces, frozen bath crust, or chemically active fluoride residues on spent anode faces.

ENGINEERING OBJECTIVE

Replace improvised interfaces with purpose-designed interfaces that maintain a defined stand-off distance, provide a rated grip and controlled contact point, and keep the worker outside the load swing zone and crush envelope throughout every transfer operation in the anode cycle.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Baked Anode Unloading — Rail Wagon or Flatbed		
	SUSPENDED LOAD · STRUCK-BY · CRUSH		
	WHY THE HAND IS THERE Baked anode blocks are unloaded from incoming wagons using overhead cranes and spreader beams. The spreader must be aligned over each block before engagement. Workers create separation between adjacent blocks, latch and unlatch the spreader hook, and steady the block during initial lift-off from the wagon bed.	CURRENT FIELD INTERFACE Fabricated steel guide rod in contact with anode block face or spreader structure during descent. Guide rope looped around spreader for swing control. Bare hands on block edges during final positioning. Hands near spreader hook during engagement with anode lifting slot.	EXPOSURE TYPE Crush between adjacent anode blocks as spreader lifts and block shifts. Struck-by if spreader slips during hook engagement. Laceration from abrasive carbon block edges. Hand in load swing zone throughout lift sequence with no defined stand-off.
	ENGINEERING OBJECTIVE Maintain lateral control of the crane spreader during descent and guide block separation from outside the crush zone — hands never in contact with the block face or spreader structure during suspension.	REPRESENTATIVE INTERFACE Load-It S-Head (4–6 ft) for block separation and spreader guidance. Anti-Tangle Tagline (25–30 ft) for swing control during lift. No direct hand contact with load or spreader during suspension.	
	"When the spreader is being lowered onto an anode block in the wagon, who is creating the gap between adjacent blocks — and where are their hands relative to the block faces at that moment?"		

HIGH	Bell Grab Hooking — Rodded Anode Assembly Despatch		
	SUSPENDED LOAD · PINCH · CAUGHT-BETWEEN		
	WHY THE HAND IS THERE Rodded anode assemblies are loaded onto the potroom transport system via overhead crane and bell grab. The bell grab must be lowered precisely over the stub yoke and latched before the crane can lift. Workers position the descending grab using guide rods and stabilise it as it approaches the stub head.	CURRENT FIELD INTERFACE Guide rod in contact with bell grab body during descent for lateral steering. Rod also used to press latch release mechanism during unhooking. Hand on grab structure during latch confirmation. Guide rope on grab as trailing swing control.	EXPOSURE TYPE Hand caught between descending bell grab and stub yoke during final alignment. Crush if grab slips sideways under crane motion. Latch mechanism pinch during manual engagement. Worker in load drop zone throughout hooking sequence.
	ENGINEERING OBJECTIVE Guide the descending bell grab laterally onto the stub yoke, and engage and release the latch mechanism, while the worker remains outside the crush zone between the grab and the stub head throughout the full descent sequence.	REPRESENTATIVE INTERFACE Load-It S-Head (4–6 ft) for lateral grab guidance during descent. XT-Hook J-Head (2–3 ft) for latch engagement and release. Anti-Tangle Tagline for swing control. No hand contact with grab body during suspension.	
	<i>"The bell grab weighs several hundred kilograms and descends under crane control. At what point in the descent does a worker's hand make contact with it — and could that contact be eliminated with a longer, rated interface?"</i>		

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

MEDIUM			
Spent Anode Unhooking at Bath Crusher Intake			
SUSPENDED LOAD · LACERATION · CHEMICAL EXPOSURE			
WHY THE HAND IS THERE Spent anode butts arrive at the bath crusher intake suspended from the transport crane. The bell grab or hook must be released before the butt can be processed. The butt surfaces carry frozen electrolyte — abrasive, fluoride-containing, and at elevated temperature on arrival from the potroom.		CURRENT FIELD INTERFACE Guide rod used to press latch release on bell grab while butt is still partially suspended. Guide rope used to control final lowering. Hands approach butt stub surface to confirm landing before release. Bare skin contact with frozen bath crust surface during unloading.	
		EXPOSURE TYPE Laceration from sharp frozen bath crust edges on butt surface. Chemical burn from fluoride-containing bath residue on skin. Crush if butt shifts on landing surface before grab release. Hand in load zone during grab release sequence.	
ENGINEERING OBJECTIVE Confirm full load landing and energy release, then disengage the bell grab latch, without any hand entry into the zone between the spent butt, the landing surface, and the crane hook during suspension or final lowering.		REPRESENTATIVE INTERFACE XT-Hook J-Head (2–3 ft) for bell grab latch release from safe stand-off. Anti-Tangle Tagline for controlled final lowering. Full energy release confirmed before any manual approach to the load surface.	
"At the bath crusher intake, is the spent anode butt fully set down and energy released before any worker approaches — or does grab release happen while the crane is still holding tension?"			

HIGH				Spent Anode Cleaning — Bath Crust Removal at Crusher	
IMPACT · LACERATION · CHEMICAL EXPOSURE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Spent anode butts arrive with frozen electrolyte crust adhering to the residual carbon face and stub surfaces. Crust must be broken and removed before the stub can re-enter the rodding cycle. Workers use crow bars to break the crust and improvised scrapers to clear fragments from stub surfaces and the crusher floor area.		Crow bar gripped near the working end during levering strokes. Improvised flat scraper — a metal plate welded to a short rod — used to push bath crust fragments across stub and crusher surfaces. Short handle lengths keep hands within the impact and abrasion zone throughout both operations.		Laceration from sharp frozen bath fragments ejected during crow bar impact. Impact on holding hand if crow bar slips. Fluoride skin contact from bath residue. Abrasion from unfinished scraper edges. Repetitive strain from sustained gripping during high-force levering.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Remove the holding hand from the hammer strike zone during crow bar and chisel operations, and increase stand-off distance during scraper clearing strokes so hands remain outside the ejection zone of dislodged bath crust fragments.			PSC FingerSaver (850 mm) for crow bar holding during impact strokes. Scraper Head on Load-It pole (3–4 ft) for bath crust fragment clearing from stub face and crusher floor — replaces improvised welded-plate scraper.		
"During bath crust removal, which hand is holding the crow bar and which is steadying the butt or clearing fragments — and is the steadying hand always clear of the strike zone?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Stem Assembly Transfer — Crane Movement to Repair Bay	
SUSPENDED LOAD · CRUSH · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Stub and yoke assemblies are moved by overhead crane between the unhooking station, the stub repair bay, and the rodding machine. Each transfer requires crane hook engagement and the stem to be guided to its landing position. Stems are elongated, irregular in profile, and prone to rotation and swing during crane travel.		Guide rod in contact with stem body during horizontal travel to prevent rotation. Guide rod used to steady stem during final landing on repair bay supports. Guide rope attached to stem base as trailing tagline. Hand on stem surface during hook engagement at lifting point.		Crush between swinging stem and fixed structure during crane travel. Struck-by if stem rotates unexpectedly during lift. Hand in load drop zone throughout transfer. Fabricated guide rod slips under lateral load — sudden lunge toward moving stem.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Maintain directional control of the stem assembly during crane travel, and guide final landing onto repair bay supports, while the worker remains outside the load swing radius and load drop zone throughout the full transfer sequence.			Load-It S-Head (6 ft) for stem guidance during crane travel — rated grip, engineered head, controlled stand-off. Anti-Tangle Tagline (25–30 ft) as trailing control line. Worker remains outside load swing radius at all times.		
"When a stem assembly is travelling on the crane, where is the guiding worker — and what is their distance from the load if the crane stops suddenly or the stem begins to rotate?"					

MEDIUM				Stub Handling During Clad Repair & Pitted Stem Work	
PINCH · IMPACT · CAUGHT-BETWEEN					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Returned stubs with corroded nipple surfaces or damaged cladding are placed on repair stands for remediation. Workers use hammers and chisels to remove damaged material, and grinding tools for surface preparation. The stub must be held or steadied during these operations, and rejected stubs are moved individually by crane.		Guide rod used to steady the stub on the repair stand during hammer and chisel work. Chisel held by bare hand during hammer strikes. Hands on stub face during dimensional inspection. Guide rod used to stabilise rejected stub during crane pick-up.		Impact on holding hand during chisel and hammer work on stub surface. Pinch between stub and repair stand if stub shifts during grinding. Caught-between stub and crane hook during rejected stub crane pick-up. Abrasion from cast iron stub surface during handling.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Remove the holding hand from the hammer strike zone during all chisel and punch operations on stub surfaces, and provide a rated stand-off interface for stub steadying during crane pick-up of rejected stems.			PSC FingerSaver (850 mm) for chisel holding during hammer work. Chisel & Punch Holder for sustained chisel operations. Load-It S-Head (3 ft) for stub steadying during crane pick-up of rejected stems.		
"During pitted stub repair, how is the stub being held steady — and is the steadying hand in the same zone as the hammer or grinding wheel?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Non-routine work in the Rodding Shop generates a disproportionate share of hand exposure incidents. The tasks below occur less frequently than the daily anode cycle but involve direct manual interaction with heavy components under conditions where normal production controls are relaxed or absent.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Rodding machine — yoke alignment jig change	Heavy cast iron jig positioned by hand in restricted machine envelope; hands between jig and machine frame during bolting	HIGH	Crush / Pinch	PSC Position & Reach Interfaces · PSC Striking & Alignment Interfaces
Bell grab overhaul — latch mechanism replacement	Hands inside grab body during latch component removal; grab partially suspended from crane during disassembly	HIGH	Crush / Caught-Between	PSC Load Control Interfaces · PSC Position & Reach Interfaces
Anode transport beam / cradle maintenance	Beam positioned by crane; hands guide beam end into cradle support during landing; limited crane operator sight line	HIGH	Crush / Suspended Load	PSC Load Control Interfaces · PSC Position & Reach Interfaces
Bath crusher jaw or liner replacement	Heavy crusher jaw positioned by crane and hand-guided into crusher housing; hands between jaw and housing during seating	HIGH	Crush / Struck-By	PSC Magnetic Handling Interfaces · PSC Position & Reach Interfaces
Overhead crane hook block replacement	Hook block suspended during reeving; hands on block body during thread-through; work at height above active floor	MEDIUM	Suspended Load	PSC Load Control Interfaces
Stub storage rack reconfiguration or repair	Heavy steel rack sections positioned manually; stub contact with rack members during reloading immediately after work	MEDIUM	Crush / Caught-Between	PSC Manual Lifting Interfaces · PSC Position & Reach Interfaces

7 RODDING SHOP QUICK ASSESSMENT CHECKLIST

Use during a plant walkdown or pre-shutdown review. Answer based on observed practice, not the written procedure.

- ☐ Are anti-tangle taglines used on every crane lift in the Rodding Shop — including bell grab descents and stem assembly transfers?
- ☐ Is the bell grab guided onto the stub yoke using a purpose-designed push/pull tool — or with a fabricated guide rod or bare hands?
- ☐ Is the bell grab latch engaged and released using a tool that keeps hands outside the grab body and load zone throughout the sequence?
- ☐ During baked anode unloading, are workers creating block separation using a rated interface — not a fabricated rod or bare hands?
- ☐ Is bath crust removal performed with chisel holders — so that no hand occupies the hammer strike zone during crow bar and impact work?
- ☐ Are stem assemblies guided during crane travel using tools that maintain a rated, controlled stand-off from the suspended load?
- ☐ During stub repair and pitted stem work, is the stub steadied by a tool — not a hand — during all grinding and chisel operations?
- ☐ Are spent anode butts fully landed and all energy released before any worker approaches to release the crane hook or bell grab?
- ☐ Is every guide rod in use in this department a manufactured, rated tool — or fabricated on-site from available steel bar?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — RODDING SHOP

Representative PSC interfaces for the scenarios identified in this chapter, organised by engineering function. Contact PSC for the full range and for guidance specific to your application, component geometry, and operating environment.

LOAD CONTROL INTERFACES — SWING, DESCENT & TAGLINE CONTROL

INTERFACE	PRIMARY RODDING SHOP APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Suspended load swing control for all bell grab descents, stem assembly transfers, and anode unloading crane lifts. Replaces plain guide rope throughout Rodding Shop — no knots, no entanglement points.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · 2 · 3 · 5
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Retrieving and attaching taglines at height on bell grab structures without climbing. Guiding stem assembly during crane travel without entering load swing zone. Extends 6–12 ft.	6–12 ft	PSC-TRT-3P	2 · 5

POSITION & REACH INTERFACES — GUIDANCE, SPOTTING & LATERAL CONTROL

INTERFACE	PRIMARY RODDING SHOP APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Bell grab lateral guidance during descent. Stem assembly guidance during crane travel. Anode block separation during wagon unloading. Stub steadying during repair bay operations.	3 ft, 4 ft, 6 ft	PSC-LIT-S003 PSC-LIT-S006 PSC-LIT-S010	1 · 2 · 5 · 6
POSITION & REACH PSC Load-It® XT-Hook (J-Head)	Bell grab latch engagement and release. Crane hook engagement on stem lifting point. Unhooking spent anode butt from crane hook at bath crusher intake. Sling leg retrieval.	2 ft, 3 ft	PSC-XT-J002 PSC-XT-J003	2 · 3 · 5
POSITION & REACH PSC Guide-It® Push/Pull Tool	Heavy-duty push/pull positioning tool for latch removal, hook engagement, and rigid contact guidance on carbon anodes and crane hooks. Distinct from LoadGuider® tagline swing control tool. Used together with LoadGuider® on crane operations.	72", 96"	PSC-GIT-72 PSC-GIT-96	1 · 2 · 3
POSITION & REACH PSC SafeGuider® Tagline Retriever	Push and pull of anode assemblies and stem structures during short-range positioning. Hardwood and aluminium head for direct contact with carbon and cast iron surfaces. Hook and reverse hook for approach and retrieval.	24", 48"	PSC-STGT-24 PSC-STGT-48	1 · 2 · 3

8 **PSC ENGINEERING INTERFACE PORTFOLIO — RODDING SHOP — CONTINUED**

Striking & Alignment Interfaces — Impact Zone Separation				
Interface	Primary Rodding Shop Application	Rep. Sizes	Part Numbers	Scenarios
Striking & Alignment PSC FingerSaver™	Holding crow bars and chisels during bath crust removal at the crusher. Holding punches and drift pins during stub repair. Removes the holding hand from the hammer strike zone entirely during all impact operations.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	4 · 6 · Maint.
Striking & Alignment PSC Chisel & Punch Holder	Holding chisels during bath crust fracture on spent anode stubs. Holding drift pins during stub alignment and jig fitting. Ergonomic grip reduces fatigue during sustained crow bar work at the bath crusher.	Standard	PSC CPH	4 · 6
Application-Specific Interfaces — Custom-Engineered for Aluminium Operations				
Interface	Primary Rodding Shop Application	Rep. Sizes	Part Numbers	Scenarios
Application-Specific PSC Load-It® Scraper Head (Custom)	Clearing frozen bath crust fragments from stub surfaces and bath crusher floor areas following crow bar breaking. Engineered scraper face on Load-It pole — replaces improvised welded-plate scrapers with a rated, ergonomic interface at correct stand-off distance.	3 ft, 4 ft	Custom — contact PSC	4

9 **ENGINEERING PRINCIPLES FROM THIS CHAPTER**

Five observations that apply beyond the Rodding Shop

The scenarios in this chapter share a common engineering pattern. These principles apply wherever workers repeatedly interact with suspended loads in confined transfer sequences — in any department, in any plant.

PRINCIPLE 01

Most hand exposure in the Rodding Shop occurs while the load is suspended — not after it has landed.

The critical exposure window is the descent and landing sequence: the period when the bell grab is approaching the stub, the stem is travelling under crane, or the anode block is being lowered to its stacking position. Engineering controls are most effective when introduced before the worker enters the hazard envelope — not after the load is already in motion.

PRINCIPLE 02

When work repeatedly requires an improvised interface, the engineering question is not why workers improvise — it is why no engineered interface exists for that task.

The fabricated guide rod is not a failure of worker behaviour. It is evidence that the task demands a tool and none has been provided. Purpose-designed interfaces address the engineering gap, not the worker.

PRINCIPLE 03

Stand-off distance is the primary variable. Increasing it reduces exposure to crush, struck-by, and caught-between hazards simultaneously.

A worker 4 feet from a swinging load faces a fundamentally different risk profile than one 18 inches away. Tool length is not an aesthetic choice — it is the primary engineering variable in suspended load guidance. Every additional foot of rated stand-off is a measurable reduction in exposure.

PRINCIPLE 04

Hook engagement and release should be designed as hands-free operations from the outset, not adapted to be safer after incidents occur.

Bell grab latching and unlatching, crane hook engagement on stem lifting points, and sling release at the bath crusher intake are all predictable, repeatable operations. Each can be performed with a tool-mediated interface. The fact that they are routinely performed by hand reflects design convention, not engineering necessity.

PRINCIPLE 05

The holding hand in impact operations is consistently the more exposed hand — and consistently the hand that no engineered interface has been designed to protect.

In crow bar and chisel work, the striking hand is the one workers and supervisors focus on. The holding hand — which steadies the chisel, positions the butt, or holds the crow bar near its working end — is stationary, closer to the impact zone, and has no engineered protection in standard practice. Chisel holders and FingerSaver tools address the holding hand specifically.

10 **APPLICATION-SPECIFIC ENGINEERING GUIDANCE**

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
● Department and task (e.g. Rodding Shop — bell grab hooking)	● Recommended interface and size for the task
● Component handled and approximate weight	● Indicative unit price (budgetary)
● Current field method in use	● Delivery lead time from Visakhapatnam
● Required stand-off distance or tool reach	● Trial order option for field evaluation
● Operating environment — heat, fluoride, restricted access	● Custom interface development pathway if required
● Indicative quantity and plant location	● Reference to comparable applications in similar plants

1 DEPARTMENT OVERVIEW

In a typical 250,000-tonne-per-year smelter, the potline operates continuously across 150–300 reduction cells, each visited multiple times per shift for crust breaking, point feeding, bath sampling, anode change, and metal tapping. Every one of those interactions is performed at or above an open cell operating at 950°C, carrying up to 300,000 amperes of direct current, with molten electrolyte and liquid aluminium metal below the crust surface. The question this chapter addresses is not whether the work is hazardous — it clearly is — but whether every task is being performed with an interface that reflects that hazard level.

The potroom is the electrolytic core of a primary aluminium smelter. Rows of reduction cells — each a steel shell lined with carbon cathode blocks and filled with molten cryolite electrolyte — carry large direct currents that reduce dissolved alumina to liquid aluminium metal. The aluminium collects at the cell floor and is periodically tapped and transferred to the cast house. Cells operate continuously at approximately 950°C, with a frozen crust of solidified electrolyte forming across the top surface between the anode assemblies.

Routine potroom work is performed by small crews moving along the potline, visiting each cell on a defined cycle. Each visit may involve crust breaking, alumina feeding, anode rod inspection, bath sampling, and cell housekeeping. Anode change and metal tapping are performed on a defined campaign basis but still represent high-frequency suspended-load operations across the full potline. In aggregate, the potroom generates more sustained manual interaction at a live thermal and chemical hazard boundary than any other department in the primary aluminium plant.

The hand exposure pattern in the potroom is distinct from most heavy industrial environments in one critical way: the hazard is not primarily mechanical. The dominant exposures are thermal — radiant heat from the cell surface and splashing molten bath — and chemical — fluoride fumes and direct contact with electrolyte. Mechanical exposures occur during anode change and metal tapping crane operations. In the potroom, a single interface improvement — increased stand-off distance — simultaneously reduces thermal, chemical, and mechanical exposure. That compounding benefit is unique to this department and defines the engineering approach throughout this chapter.

2 MAJOR EQUIPMENT & LOCATIONS

REDUCTION CELL (POT)

The primary production vessel — a rectangular steel shell 10–15 m long containing carbon cathode lining, molten cryolite electrolyte at 950°C, and liquid aluminium at the floor. Anode assemblies suspend into the bath from above. Workers interact with the cell top for every routine potroom task.

ANODE BEAM & SUPERSTRUCTURE

The overhead steel structure from which anode assemblies are suspended and from which they are raised or lowered by the cell control system. During anode change the beam is raised for spent anode extraction and new anode insertion. Workers interact with the beam and anode rods during both positioning and routine checks.

POTROOM CRANE (POT TENDER)

A dedicated overhead crane spanning the potline used for anode change, metal tapping, and cell maintenance. Workers guide the crane hook, anode assembly, and vacuum ladle during all lifting operations above the open cell — simultaneous exposure to suspended load and thermal hazard throughout.

POINT FEEDER

Automated or semi-automated device that breaks cell crust at defined feed points and drops measured alumina into the bath. On cells without automated feeders, or when feeders are blocked, crust breaking and feeding is performed manually using long-handled breaker tools and alumina scoops directly above the open bath.

BATH SAMPLING EQUIPMENT

Thermocouples and steel sampling cups on long handles used to take bath temperature and chemistry samples. The sampling cup is inserted through the crust into the molten bath, held for the required immersion period, then withdrawn. Workers lean across the cell top with the handle at arm's length throughout immersion.

METAL TAPPING EQUIPMENT

Vacuum ladles suspended from the potroom crane extract liquid aluminium from the cell floor on a defined cycle. The tapping tube must be guided through the crust into the metal layer. Workers position the crane-suspended ladle and direct tube insertion — simultaneous proximity to suspended load and open metal surface.

3 POTROOM WORK CYCLE — TASK FLOW & EXPOSURE POINTS

The diagram below shows the sequence of tasks performed at each reduction cell during a routine potroom visit. The hazard badge below each arrow identifies the primary hand exposure type at that transfer point. Every task in the sequence — without exception — is performed at or above an open cell operating at 950°C.



Dashed border = cycle repeats across the full potline each shift

4 CURRENT FIELD INTERFACES OBSERVED

The table below documents the manual interfaces currently observed in potroom operations across the industry, and their engineering limitations. These observations are not a criticism of current practice. They identify where purpose-designed engineered interfaces are absent, and what the engineering consequence of that absence is.

CURRENT INTERFACE	ENGINEERING LIMITATION
Long-handled crust breaker	Handle length varies by plant — often shorter than needed for adequate stand-off from the cell surface. Rebound on hard crust zones brings the working end back toward the worker. No defined grip guard at the holding position. Worker's hands commonly enter the radiant heat threshold zone during the driving stroke.
Bath sampling handle	Worker leans across the cell top with handle held at arm's length. The immersion angle forces the upper body over the open bath surface. Bath splashing on cup withdrawal commonly reaches the grip position and the forearm. The 30–90 second immersion period represents sustained radiant heat exposure at close range.
Fabricated guide rod (anode change)	Used to guide new anode into position above open cell. Carries the same engineering limitations as in the Rodding Shop: no defined grip, no rated capacity, no load-catch head. Provides limited stand-off distance in a thermal environment where proximity to the cell surface is additionally hazardous beyond the mechanical crush risk.
Bare hands (object retrieval)	Small tools, thermocouples, and fallen items are retrieved from the cell top by hand — often without confirmed cooling of the item or the surrounding surface. Retrieval from the beam–cell gap is done with bare hands or improvised hook tools. No purpose-designed retrieval tool is included in standard potroom equipment inventories at most facilities.
Short alumina scoop (manual feeding)	Short handle lengths bring the grip hand into the thermal zone above the bath surface. Scoop weight and reach distance create sustained ergonomic loading on wrists and shoulders during repeated feeding across the potline at high visit frequency.

ENGINEERING OBJECTIVE — POTROOM

Increase the stand-off distance between the worker's hands and the open cell for every routine task — reducing thermal, chemical, and mechanical exposure simultaneously. Where stand-off distance cannot be increased, provide a controlled contact interface that eliminates bare-hand entry into the cell hazard environment.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Manual Crust Breaking at Feed Points LINE OF FIRE · BURNS · CHEMICAL EXPOSURE		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	When the point feeder is absent, blocked, or requires manual override, workers break the frozen electrolyte crust at defined feed points using a long-handled breaker. On cells with narrow anode spacing, the working envelope restricts reach and forces workers to lean over the cell top with hands at an angle that reduces effective stand-off from the bath surface.	Standard long-handled crust breaker, typically 1.5–2.5 m total length. Worker holds the handle at mid-point during the driving stroke, bringing the grip hand into the radiant heat zone directly above the cell surface. No defined grip zone or anti-rebound feature is present on standard tools in most potrooms.	Radiant heat burns to hands and forearms from proximity to the 950°C cell surface. Bath splash burn if crust breaks unevenly and the bath surface is disturbed. Fluoride fume and skin contact from disturbed bath material. Rebound of breaker on hard crust zones, bringing the working end toward the worker's upper body.
	ENGINEERING OBJECTIVE Position the grip hand at the maximum practical stand-off from the cell surface during the full crust-breaking stroke, reducing sustained radiant heat exposure at the grip position and keeping hands outside the bath splash radius on crust fracture.		REPRESENTATIVE INTERFACE Extended-reach push tool (6 ft) for cell surface approach and debris management adjacent to the break point. SafeGuider Tagline Retriever for steady push-control at extended reach. Grip positioned at maximum safe stand-off from cell opening throughout the stroke cycle.
	<i>"At what point in the crust-breaking stroke is the grip hand closest to the cell surface — and has that distance been measured against the radiant heat threshold for this cell type and operating amperage?"</i>		

HIGH	Bath Sampling — Temperature & Chemistry BURNS · CHEMICAL EXPOSURE · FLUORIDE CONTACT		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	Bath temperature and chemistry samples are taken by inserting a sampling cup or thermocouple through the crust into the molten bath. The sample must be held at depth for a defined immersion period. Workers lean across the cell top and hold the sampling handle at arm's length above the open bath surface throughout the full immersion.	Sampling handle with cup or thermocouple at end — typically 1–1.5 m total. The grip hand is positioned well within the radiant heat zone during the immersion period of 30–90 seconds. Bath splashing on cup withdrawal commonly reaches the grip position and forearm. Sustained posture over the cell opening causes shoulder and wrist fatigue across a full shift.	Sustained radiant heat to hands and forearms during immersion. Bath splash contact on withdrawal — molten cryolite at 950°C causes immediate deep tissue burns. Fluoride exposure from the disturbed bath surface during cup insertion and removal. Ergonomic strain from sustained reach posture over the open cell across 150–300 cells per shift.
	ENGINEERING OBJECTIVE Position the grip hand at a stand-off from the cell surface that reduces sustained radiant heat exposure below the threshold distance during the full immersion period, and keeps hands outside the bath splash zone during cup withdrawal from the molten bath surface.		REPRESENTATIVE INTERFACE Extended-reach sampling handle adapter providing 6 ft equivalent grip-to-cup distance, positioning the grip hand outside the primary radiant heat zone for the full immersion period. Where sampling tools are engineered in-house, PSC Position & Reach Interfaces provide the grip extension framework.
	<i>"During the immersion period for bath sampling, where is the grip hand relative to the cell surface — and is that position within the documented radiant heat threshold for this cell design and operating temperature?"</i>		

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Anode Change — New Anode Positioning Above Open Cell	
SUSPENDED LOAD · BURNS · CRUSH					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
During anode change, a new anode assembly suspended from the potroom crane must be guided into position above the cell and lowered through the beam structure into the bath. Workers guide the suspended anode laterally to align it with the correct slot. The anode descends above an open cell at 950°C with the bath surface exposed throughout the full descent. The worker must be close enough to the cell to reach the anode at the correct height during guidance.		Fabricated guide rod in contact with the anode assembly or crane beam during descent, providing partial lateral steering. A guide rope is used for swing control but provides no lateral positioning. The worker must be close to the cell opening to reach the anode at the correct guidance height. Hands are simultaneously near the suspended load above and the open cell surface below throughout the descent.		Crush between the descending anode assembly and the beam structure during positioning. Radiant heat burns from proximity to the open cell surface during the full anode descent. Struck-by if the anode assembly swings under crane movement. Hand in the load drop zone above the open bath throughout the positioning sequence — combining thermal and mechanical exposure simultaneously.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the suspended new anode laterally into the correct beam slot while maintaining the worker's hands outside the crush zone between the anode and beam structure, and outside the radiant heat zone above the open cell surface, throughout the full crane descent sequence above the open cell.			Load-It S-Head (4–6 ft) for lateral anode guidance during crane descent above open cell — rated grip, engineered head, defined stand-off from both suspended load and cell surface below. Anti-Tangle Tagline (25 ft) for swing control. Worker stands back from cell edge; tool provides the necessary reach without requiring proximity to the bath or load drop zone.		
"During anode lowering above an open cell, how close does the guiding worker stand to the cell edge — and is that position within the radiant heat safety boundary documented for this cell design?"					

HIGH				Metal Tapping — Vacuum Ladle Positioning & Tube Insertion	
SUSPENDED LOAD · BURNS · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Liquid aluminium is tapped from the cell on a defined cycle using a vacuum ladle suspended from the potroom crane. The ladle must be positioned over the tapping point, and the tapping tube guided through the crust into the metal layer. Workers guide the descending ladle and manage tube insertion — placing them in close proximity to the open cell and the suspended ladle simultaneously.		Workers guide the vacuum ladle with hands on the ladle body or tapping tube during crane descent. Tapping tube insertion is performed by hand — workers push or direct the tube through the crust. Ladle position is confirmed from close range above the open cell, with the liquid metal surface exposed below. The tapping sequence combines suspended load handling with direct proximity to an open metal surface.		Burns from liquid aluminium splashing during tapping tube insertion through the crust. Crush between the crane-suspended ladle and cell superstructure during positioning. Sustained radiant heat exposure during close-proximity work at the cell opening. Struck-by if the ladle swings under crane movement during final approach to the tapping position.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the vacuum ladle to its tapping position and direct tapping tube approach using an interface that keeps the worker's hands outside the ladle–structure crush zone and outside the splash radius of the tapping point — throughout the full tapping sequence from ladle descent to tube withdrawal.			Load-It S-Head (4–6 ft) for vacuum ladle lateral guidance during crane descent to tapping position. Anti-Tangle Tagline for ladle swing control during crane travel. Guide-It Push/Pull Tool for tapping tube direction at stand-off during crust penetration and tube insertion into the metal layer.		
"When the tapping tube is inserted through the crust, where is the nearest worker's body relative to the open metal surface — and is that within the documented splash radius for this cell's metal inventory at full tapping depth?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

MEDIUM	Object Retrieval from Cell Top Surface & Beam Gap BURNS · CHEMICAL CONTACT · ELECTRICAL PROXIMITY		
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE	EXPOSURE TYPE
Small tools, thermocouples, sampling equipment, and maintenance items are periodically dropped onto the cell top crust surface or into the gap between the anode beam and the cell wall. Recovery is treated as a quick task and is frequently performed with bare hands or improvised hook tools, without isolation of the cell or confirmation that the item has cooled sufficiently for safe contact.		Bare hands reaching into the beam–cell gap. Improvised bent-rod hook tools fabricated from available wire or rod at the plant. Long-handled brush used to sweep items to a more accessible position before retrieval by hand. No purpose-designed retrieval tool is included in standard potroom equipment inventories at most facilities.	Burns from contact with cell components at or near operating temperature. Electrical proximity hazard when hands enter the beam–cell gap adjacent to live conductors carrying high direct current. Fluoride skin contact from cell top debris and crust fragments during retrieval. The task appears minor and routine; the compound exposure environment is not minor.
ENGINEERING OBJECTIVE		REPRESENTATIVE INTERFACE	
Retrieve dropped items from the cell top surface and beam gap area without bare hand entry into the cell thermal and electrical hazard zone, using a purpose-designed retrieval tool with sufficient reach to access items at depth between the beam and cell wall from a safe standing position.		PSC Long-Reach Pickup Tool (6 ft) with precision jaw grip for retrieving small items from the cell top surface and beam gap without hand entry into the thermal or electrical hazard zone. Jaw grip allows controlled retrieval without pushing items further into the gap during the approach.	
"When a thermocouple or small tool is dropped onto the cell top, what procedure is actually followed — and does it consistently differ from reaching in by hand to retrieve it quickly?"			

MEDIUM	Cell Housekeeping — Bath Debris & Crust Fragment Clearing CHEMICAL CONTACT · LACERATION · THERMAL		
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE	EXPOSURE TYPE
After crust breaking, anode change, and bath sampling, loose crust fragments, bath splatter, and debris accumulate on the cell top surface and superstructure. These must be cleared to maintain cell access and prevent bath chemistry contamination from surface debris. Workers use long-handled brushes and scrapers, but shorter tools in confined inter-anode spaces bring hands into the cell top environment.		Long-handled brush and scraper — standard housekeeping tools present in most potrooms. Short scraper variants used in confined inter-anode spaces force the grip hand close to the cell surface. Loose crust fragments are moved by hand when they present a tripping hazard near the cell edge. No retrieval tool routine exists for this task in standard potroom practice.	Laceration from sharp-edged frozen bath crust fragments with irregular fracture surfaces. Fluoride skin contact from disturbed crust and bath residue on the cell top surface. Thermal contact with recently broken crust that retains elevated temperature well above ambient after fracture. Hand entry into the cell top environment during debris clearance in confined inter-anode spaces.
ENGINEERING OBJECTIVE		REPRESENTATIVE INTERFACE	
Complete all cell top housekeeping tasks using tools that keep the worker's hands outside the fluoride contact zone and the thermal boundary of the cell surface — without requiring hand entry into the confined spaces between anode rods or into the zone near the cell opening edge at any point in the housekeeping sequence.		Scraper Head on Load-It pole (3–4 ft) for debris clearing in confined inter-anode spaces — engineered face geometry, correct stand-off, ergonomic grip. Long-Reach Pickup Tool for loose crust fragment retrieval near the cell edge. Hands remain outside the fluoride surface contamination zone throughout.	
"During cell housekeeping between anode positions, do the tools in use keep hands outside the fluoride contact zone — or do gloves become the primary and only defence against chemical exposure at the cell surface?"			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Non-routine potroom work carries significantly higher exposure severity than routine tasks because the cell must often be partially opened or disrupted to allow access. The normal thermal and chemical management strategies present during routine production are not fully active during maintenance interventions. Pot relining — the major cell shutdown and refractory replacement operation — is addressed in the Mechanical Maintenance chapter.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Point feeder replacement or unblocking	Hands inside feeder chute during unblocking; fluoride-crust components handled at close range to the open crust break point; thermal exposure during refitting above the bath surface	HIGH	Chemical · Thermal	PSC Position & Reach Interfaces · PSC Striking & Alignment Interfaces
Anode rod and stub inspection during change cycle	Hands on anode rod surface at close range above open cell; stub inspection requires leaning over cell opening with rod at arm's length in radiant heat zone	HIGH	Burns · Chemical	PSC Position & Reach Interfaces
Cell superstructure maintenance — beam rail and liner	Hands on beam structure during bolting and liner replacement above open cell; restricted envelope forces awkward hand positions adjacent to live electrical conductors	HIGH	Electrical · Crush	PSC Position & Reach · PSC Striking & Alignment Interfaces
Tapping hole maintenance — crust clearing around tap	Worker breaks and clears hardened crust around the tapping point; hands within splash radius during approach; no splash barrier present in standard practice	HIGH	Burns · Chemical	PSC Position & Reach · PSC Striking & Alignment Interfaces
Thermocouple and instrumentation replacement	Hands reach into beam–cell gap for thermocouple extraction and insertion; components at elevated temperature; live high-current conductors immediately adjacent to working space	MEDIUM	Burns · Electrical	PSC Position & Reach · PSC Retrieval Interfaces
Cathode bar connection maintenance	Bolted connections at cathode bar ends require hand access near live current-carrying conductors; torque operations with hands in restricted, energised spaces at the cell perimeter	MEDIUM	Electrical · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces

7 POTROOM QUICK ASSESSMENT CHECKLIST

- ☐ During manual crust breaking, is the grip hand outside the documented radiant heat threshold distance for this cell type and operating amperage?
- ☐ During bath sampling, does the handle length position the grip hand outside the bath splash radius during cup withdrawal from the molten bath?
- ☐ During anode change, is the new anode guided into beam position using a rated push/pull tool — not a fabricated guide rod or bare hands above the open cell?
- ☐ Is an anti-tangle tagline used on every potroom crane lift — including vacuum ladle movements during metal tapping operations?
- ☐ Is a purpose-designed retrieval tool available in the potroom for recovering dropped items from the cell top surface and beam–cell gap?
- ☐ During cell housekeeping between anode positions, are tools long enough to keep the grip hand outside the fluoride contact zone at the cell surface?
- ☐ Is there a defined tool — not a procedure alone — for unblocking point feeders without requiring hand entry into the feeder chute above the open bath?
- ☐ During tapping hole maintenance, is a stand-off method in place before any worker approaches to break crust around the tapping point?
- ☐ Are thermocouple and instrumentation replacements in the beam–cell gap performed with cell isolation confirmed and a retrieval tool available at the worksite?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — POTROOM

Representative PSC interfaces for the scenarios identified in this chapter, organised by engineering function. Contact PSC for guidance specific to your cell type, superstructure geometry, anode spacing, and operating environment.

LOAD CONTROL INTERFACES — CRANE LIFT, SWING & TAGLINE CONTROL

INTERFACE	PRIMARY POTROOM APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for all potroom crane lifts — vacuum ladle during metal tapping, new anode assembly during change cycle, maintenance equipment over open cells. Replaces plain guide rope throughout the potline. No knots, no entanglement points, resistant to fluoride contamination.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	3 · 4 · Maint.
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Retrieving and attaching taglines at height on potroom crane ladle structures without climbing. Accessing crane hook points above cell superstructure from a safe floor position. Extends 6–12 ft telescopically with Jiffy-Lock secure extension.	6–12 ft	PSC-TRT-3P	3 · 4 · Maint.

POSITION & REACH INTERFACES — GUIDANCE, SPOTTING & STAND-OFF CONTROL

INTERFACE	PRIMARY POTROOM APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	New anode lateral guidance during crane descent above open cell. Vacuum ladle guidance during tapping positioning. Provides rated stand-off in the compound thermal and mechanical potroom environment. Ergonomic D-handle for sustained use across a full potline visit cycle.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	3 · 4
POSITION & REACH PSC Guide-It® Push/Pull Tool	Tapping tube direction during insertion above the cell surface. General load guidance for potroom crane lifts. Nylon head for contact with carbon anode surfaces without damage. Crane hook spotting above open cell during anode change and tapping setup.	72", 96"	PSC-GIT-72 PSC-GIT-96	4 · 6
POSITION & REACH PSC SafeGuider® Tagline Retriever	Push and pull control at extended reach during anode assembly positioning above cell. Dual-function head for approach and retrieval. Hardwood and cast aluminium for durability in the potroom environment.	24", 48"	PSC-STGT-24 PSC-STGT-48	1 · 3

8 **PSC ENGINEERING INTERFACE PORTFOLIO — POTROOM — CONTINUED**

RETRIEVAL INTERFACES — OBJECT RECOVERY FROM HAZARDOUS ZONES

INTERFACE	PRIMARY POTROOM APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving dropped thermocouples, sampling cups, and small tools from the cell top surface and beam–cell gap. Precision jaw grip provides secure hold at 6 ft reach — recovery without hand entry into the thermal and electrical hazard zone. Trigger handle for controlled gripping action.	6 ft	PSC-ST	5 · 6

APPLICATION-SPECIFIC INTERFACES — CUSTOM-ENGINEERED FOR POTROOM OPERATIONS

INTERFACE	PRIMARY POTROOM APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
APPLICATION-SPECIFIC PSC Load-It® Scraper Head (Custom)	Clearing loose crust fragments and bath debris from cell top surface and confined inter-anode spaces during housekeeping operations. Engineered scraper face on Load-It pole provides defined stand-off from fluoride-contaminated surfaces and replaces short-handled improvised tools used in inter-anode gaps.	3 ft, 4 ft	Custom — contact PSC	6 · Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Five observations specific to the potroom environment

The potroom is the only department in an aluminium plant where every routine task is performed in the simultaneous presence of thermal, chemical, electrical, and mechanical hazards. The principles below reflect that compound exposure environment and apply wherever these conditions coexist.

PRINCIPLE 01

In the potroom, stand-off distance simultaneously reduces thermal, chemical, and mechanical exposure — making it the single most valuable engineering variable available in this department.

Adding three feet of tool reach does not only reduce crush risk. In the potroom, it simultaneously reduces radiant heat flux at the hand, reduces fluoride inhalation from the disturbed bath surface, and moves the worker outside the splash radius of the bath. No other single change achieves equivalent simultaneous reduction across all three exposure pathways. This compounding benefit is unique to the potroom environment.

PRINCIPLE 02

The severity of the potroom environment makes apparently minor tasks — object retrieval, debris clearing, thermocouple replacement — disproportionately hazardous.

A task that takes 30 seconds and appears trivial elsewhere in the plant is performed above an open cell at 950°C, adjacent to live conductors carrying up to 300,000 amperes, in a fluoride-contaminated atmosphere. The task duration has not changed. The exposure environment has. Engineering analysis must assess the environment, not just the task classification.

PRINCIPLE 03

PPE alone cannot prevent the injuries that occur in the potroom. Engineering stand-off is the only control that addresses thermal, chemical, and mechanical exposure simultaneously.

Heat-resistant gloves reduce the severity of thermal contact but do not prevent it. Chemical-resistant gloves require skin contact to function. Neither addresses crush, struck-by, or splash burns from molten bath contact. Only increasing the distance between the worker's hands and the cell surface reduces all exposure pathways at once — without requiring the worker to rely on the integrity of any worn protective item.

PRINCIPLE 04

Routine high-frequency tasks carry the highest cumulative exposure even when individual task severity is classified as medium.

Bath sampling takes 60–90 seconds per cell, performed on every cell in the potline during every shift. At 200 cells per potline, that is 200 sustained thermal exposure events per shift per worker. Cumulative thermal loading — not single-event severity — drives the long-term injury and burn scar pattern in potroom crews. Engineering controls on routine tasks deliver disproportionate risk reduction precisely because of their application frequency.

PRINCIPLE 05

Every potroom crane lift above an open cell is simultaneously a suspended-load and a thermal hazard event. Tagline and guidance tool selection must address both conditions at the same time.

Tagline protocols developed for mechanical industry crane operations are necessary but not sufficient in the potroom. The crane guidance worker must maintain stand-off from both the suspended load and the open cell below. A standard tagline used with conventional proximity to the cell edge does not reduce thermal and splash exposure during the guidance sequence. Tool selection must reflect the compound nature of the hazard.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

If any hand exposure scenario in this chapter reflects tasks observed in your plant, PSC Hand Safety India can provide engineering guidance on representative interfaces. The information below is a starting point for evaluating whether an engineered interface is worth pursuing for a specific task — it is not a binding specification.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Cell type and potline configuration (prebake or Søderberg)	Recommended interface and size for the specific cell task
Specific task and current tool or field method in use	Indicative unit price (budgetary, not binding)
Required reach from the cell edge to the worker grip position	Delivery lead time from Visakhapatnam
Operating environment — cell temperature, anode spacing, access restrictions	Application notes for the specific potroom scenario
Whether the component being guided is ferrous (magnetic interface applicable)	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Custom interface development pathway where standard products require adaptation

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1 DEPARTMENT OVERVIEW

Metal tapping and crucible transfer sit at the intersection of two distinct hazard types: the thermal environment of the potroom, where liquid aluminium is extracted from the reduction cell, and the mechanical handling environment of the cast house approach, where heavy crucibles carrying up to 8 tonnes of liquid metal are moved by overhead crane. At each transfer point in this sequence — tapping, ladle filling, pour alignment, dross handling, and furnace charging — workers are required to interact manually with either the suspended load or the open metal surface.

In a primary aluminium smelter, liquid aluminium is tapped from the reduction cells at intervals of typically 24–36 hours per cell. The metal is extracted using a vacuum ladle — a refractory-lined steel vessel suspended from the potroom crane — which fills progressively across multiple cells before transfer to the crucible filling point. The crucible receives the liquid metal at 700–750°C and transports it to the cast house, where it charges the casting or holding furnace. Dross — the oxidised surface layer that forms during transfer — must be removed at several points in this sequence using long-handled rakes and skimming tools.

The defining characteristic of this chapter's hand exposure is the combination of high-temperature liquid metal, large suspended loads, and operational time pressure. Metal transfers must be completed before the temperature drops below casting specification. That pressure creates conditions where workers approach the metal surface and vessel body more closely than the hazard warrants. Engineering interfaces that maintain stand-off without adding time to the operation are the most commercially credible solution in this environment — controls that slow the process will be bypassed, not from negligence but from production logic.

2 MAJOR EQUIPMENT & LOCATIONS

VACUUM LADLE

A refractory-lined steel vessel suspended from the potroom crane. A tapping tube inserted through the cell crust draws liquid metal into the ladle under vacuum. Full weights typically 4–12 tonnes. Workers interact with the ladle body during crane positioning and with the tapping tube during insertion and withdrawal.

CRUCIBLE & TRANSPORTER

A large refractory-lined steel vessel on a wheeled transporter, receiving liquid metal from the vacuum ladle and transporting it to the cast house. Workers interact with the crucible body during crane lifting, pour alignment, and dross skimming at the rim throughout the transfer cycle.

POTROOM & CAST HOUSE CRANE

Overhead cranes handle the vacuum ladle during tapping and the filled crucible during movement to the cast house. Each crane operation above a vessel containing liquid metal represents simultaneous suspended-load and burn hazard. Workers guide both vessels during crane descent and positioning.

METAL TRANSFER STATION

The fixed point where the vacuum ladle pours into the crucible. Alignment between ladle spout and crucible opening must be confirmed during crane descent. Metal splashing at pour initiation is a predictable and recurring event at every fill cycle.

FURNACE CHARGING POINT

At the cast house, the filled crucible is positioned over the furnace charging port and tipped to charge the furnace. Workers guide the crane-suspended crucible to the charging position. The furnace interior is at operating temperature and the charging port is open during the operation.

DROSS HANDLING EQUIPMENT

Long-handled rakes and skimming paddles used to remove the oxidised surface layer from the crucible rim and furnace surface during and after charging. Dross removal is high-frequency and generates sustained proximity to the open metal surface throughout the raking sequence.

3 METAL TAPPING & TRANSFER CYCLE — TASK FLOW & EXPOSURE POINTS**METAL TAPPING & TRANSFER CYCLE****TAPPING TUBE INSERTION**

Tube guided through crust into metal layer

LINE OF FIRE · BURNS · SUSPENDED LOAD

VACUUM LADLE FILLING

Ladle fills progressively across multiple cells

SUSPENDED LOAD · THERMAL PROXIMITY

CRUCIBLE FILLING — METAL POUR

Ladle aligned over crucible · metal poured

BURNS · METAL SPLASH · SUSPENDED LOAD

DROSS SKIMMING AT CRUCIBLE RIM

Oxidised surface layer removed before transport

BURNS · LACERATION · LINE OF FIRE

CRUCIBLE TRANSPORT TO CAST HOUSE

Filled crucible moved by crane or transporter

SUSPENDED LOAD · CRUSH HAZARD

FURNACE CHARGING

Crucible tipped to charge casting or holding furnace

BURNS · SUSPENDED LOAD · LINE OF FIRE

CAST HOUSE — Casting Operations → Chapter 06

LIQUID METAL AT 700–750°C PRESENT AT EVERY STEP

4 CURRENT FIELD INTERFACES OBSERVED

The table below documents the manual interfaces commonly observed across metal tapping and crucible operations — each a worker-created response to a task requiring physical interaction with liquid metal, suspended loads, or both, in the absence of a purpose-designed engineered interface.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands on ladle body or tapping tube	Workers guide the vacuum ladle during crane descent by placing hands on the ladle body or directing the tapping tube by hand. Zero stand-off from a vessel containing liquid metal. Any crane movement while hands are in contact creates simultaneous crush and burn exposure from two directions.
Fabricated guide rod — ladle and crucible	A bent steel rod is used to push the ladle or crucible laterally during crane descent. No defined grip, no load-catch head, not rated for the forces involved. The rod can slip under lateral load, lunging the worker toward the vessel. Length is typically insufficient to keep the worker outside the splash radius at pour initiation.
Short-handled rake — dross skimming	Standard dross rakes often have handle lengths of 1.2–1.8 m. At the crucible rim this places the grip hand within the radiant heat zone above the metal surface throughout the skimming stroke. Short handles increase wrist strain from the lateral force required to move solidifying dross along the rim.
Bare hands — pour alignment confirmation	Workers confirm ladle spout alignment by leaning over the vessel rim at close range. Where alignment requires correction, the ladle body is pushed by hand while the crane holds it above the crucible. Both actions place hands above an open vessel within the splash zone at pour initiation.
Plain rope tagline — crucible swing control	A plain fibre or wire rope controls crucible swing during crane travel. Plain ropes develop knots, fray at contact with hot vessel surfaces, and do not resist tangle around the crucible body. No defined grip point — rope wraps around hands under load, creating entanglement risk at the worst possible moment.

ENGINEERING OBJECTIVE — METAL TAPPING & CRUCIBLE OPERATIONS

Maintain a defined stand-off distance between the worker's hands and the liquid metal surface, the ladle body, and the crucible rim at every transfer point — from tapping tube insertion through to furnace charging — using rated, purpose-designed interfaces that do not add time to the metal transfer operation.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH Vacuum Ladle Positioning & Tapping Tube Insertion SUSPENDED LOAD · BURNS · LINE OF FIRE			
WHY THE HAND IS THERE The vacuum ladle must be positioned precisely over the tapping point and the tapping tube directed through the crust into the metal layer. Both operations require a worker to interact with the ladle body or tube at close range above the open metal surface — placing them simultaneously in the ladle swing zone and within the thermal hazard boundary of the cell.		CURRENT FIELD INTERFACE Ladle positioned using hands on the ladle body or a fabricated guide rod for lateral steering during crane descent. Tapping tube directed by hand during crust penetration. Worker remains within reach of the ladle body throughout the full descent sequence.	
		EXPOSURE TYPE Crush between the descending ladle and the cell superstructure. Burns from molten metal contact if the tube dislodges during insertion. Struck-by if the ladle swings during crane descent. Suspended load above and open metal surface below create compound hazard from two directions simultaneously.	
ENGINEERING OBJECTIVE Guide the vacuum ladle laterally onto the tapping position and direct the tapping tube through the crust without placing hands on the ladle body or within the splash radius of the tube insertion point — from crane descent initiation to completion of tube seating.		REPRESENTATIVE INTERFACE Representative push/pull interface (4–6 ft, S-Head) for ladle lateral guidance during crane descent. Anti-Tangle Tagline for swing control during crane travel. Tapping tube direction managed from the tool rather than by hand contact with the tube body.	
"At what point in the ladle descent does a worker's hand make contact with the ladle body or tapping tube — and is there a tool available at that point that maintains the same positional control without that contact?"			

HIGH				Metal Pour Alignment — Ladle Over Crucible	
BURNS · METAL SPLASH · SUSPENDED LOAD					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Before the vacuum ladle pours into the crucible, the ladle spout must be confirmed over the crucible opening. Where the ladle requires lateral correction, workers push the ladle body while the crane holds it suspended above the crucible — hands on a suspended vessel directly above an open receptacle into which liquid metal is about to flow.		Bare hand or fabricated rod used to push the ladle body for lateral alignment correction above the crucible rim. Worker leans over the crucible to check spout alignment visually. Pour initiation may begin while the worker is still within the splash zone if crane operator communication is not confirmed before tipping starts.		Burns from metal splash at pour initiation — a predictable, recurring event at every fill. Crush between ladle body and crucible rim during alignment correction with crane in motion. Struck-by from ladle swing if crane movement begins before the worker has cleared the vessel body.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Confirm and correct ladle spout alignment over the crucible opening from a position outside the metal splash zone and outside the ladle–crucible crush zone — before pour initiation is signalled to the crane operator, not after the pour has begun.			Representative push/pull interface (4–6 ft) for ladle body lateral correction during crane hover above crucible. Stand-off keeps the worker outside the primary splash zone at pour initiation. Alignment confirmed visually from the tool handle position — no leaning over the crucible rim required.		
"When ladle spout alignment is confirmed before pouring, is the worker's body outside the metal splash radius — confirmed before the pour signal is given, not after pour has begun?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Dross Skimming at Crucible Rim	
BURNS · LACERATION · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Dross must be removed from the crucible surface before transport to the cast house. Workers use long-handled rakes and skimming paddles to push and collect dross at the crucible rim. The task requires sustained interaction close to the open metal surface throughout the skimming cycle, repeated at each fill and after furnace charging.		Standard dross rake with handle lengths typically 1.2–1.8 m. At the crucible rim, the grip hand enters the radiant heat zone during the full skimming stroke. Solidified dross catches on the rake head and requires increased lateral force — pulling the grip hand progressively closer to the rim over the course of the skimming cycle.		Sustained radiant heat to hands and forearms during the skimming stroke. Burns if liquid metal splashes over the crucible rim when the dross layer shifts during raking. Laceration from sharp-edged solidified dross fragments at the rim. Wrist and shoulder strain from repeated lateral force application across the full skimming cycle.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Position the grip hand at a stand-off from the crucible rim that keeps it outside the radiant heat zone during the full skimming cycle and outside the metal splash radius if the dross layer shifts or the metal surface is disturbed during raking.			Extended-reach dross rake or paddle designed with grip position at 2–2.5 m from the working head. Where dross tools are engineered or procured in-house, this represents the design criterion rather than a standard PSC product. Ergonomic D-grip at the handle end reduces wrist force during lateral strokes.		
"During the dross skimming stroke, where is the worker's grip hand relative to the crucible rim — and has that position been compared against the radiant heat threshold at full crucible metal load?"					

HIGH				Crucible Crane Positioning — Transfer & Furnace Charging	
SUSPENDED LOAD · CRUSH · STRUCK-BY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Filled crucibles are moved by overhead crane and positioned over the furnace charging port for tipping. At each landing point, the crucible must be guided to its final position and the tipping mechanism engaged. Workers guide the descending crucible at both the transfer station landing and the furnace charging approach without a defined stand-off tool in most operations.		Fabricated guide rod or bare hands used to push the crucible body laterally during crane descent to the landing position. Plain rope tagline for swing control during crane travel. Workers may be positioned between the crucible and fixed plant structure during final landing — a predictable crush point rarely formally assessed in operational planning.		Crush between the descending crucible and fixed plant structure during final landing. Struck-by if the crucible swings under crane movement — the inertia of a full metal load vessel is significant. Burns from metal splash if the crucible tips during crane travel due to uncontrolled swing with a full metal inventory.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the filled crucible to its landing position without placing workers between the crucible and fixed plant structure, and without hand contact on the crucible body during suspension at any point in the crane travel and descent sequence.			Anti-Tangle Tagline for full crucible swing control during crane travel — the primary control for a vessel of this mass. Representative push/pull interface (6 ft, S-Head or equivalent) for final lateral positioning correction at the landing point. Worker positioned outside the crucible swing arc throughout travel and descent.		
"When a full crucible is being lowered to the furnace charging point, where is the guidance worker positioned relative to the space between the crucible and the charging port frame — confirmed before the crane begins to lower?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Non-routine work in metal tapping and crucible operations involves maintenance and repair of equipment that has been in contact with liquid metal. These tasks are performed on equipment retaining elevated temperature after service and carrying residual metal or dross in confined internal spaces.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Vacuum ladle refractory inspection and repair	Hands inside ladle interior during inspection; residual heat after service; solidified metal broken out with crow bars and chisels in confined ladle interior	HIGH	Burns · Impact	PSC Striking & Alignment · PSC Position & Reach Interfaces
Tapping tube replacement and seating	New tapping tube positioned and seated in ladle assembly by hand; heavy components requiring precise alignment in confined ladle neck; residual heat from previous service	HIGH	Burns · Crush	PSC Position & Reach · PSC Striking & Alignment Interfaces
Crucible lining inspection and patching	Workers reach into crucible interior for refractory inspection; lining patching requires hand positioning inside the vessel above residual metal traces; confined access geometry	HIGH	Burns · Confined Space	PSC Position & Reach · PSC Striking & Alignment Interfaces
Crucible tipping mechanism maintenance	Hydraulic or mechanical tipping actuator accessed while crucible may carry residual metal; mechanism at crucible rim height — hands in line of fire if tipping activates unexpectedly	HIGH	Burns · Crush · Line of Fire	PSC Position & Reach Interfaces
Metal spill clean-up at tapping station	Solidified aluminium splash collected from floor and equipment surfaces; material has irregular sharp edges and may retain elevated temperature well after solidification	MEDIUM	Burns · Laceration	PSC Position & Reach · PSC Retrieval Interfaces
Gas cylinder handling at tapping station	Oxygen, argon, and nitrogen cylinders moved regularly at the tapping station — a location that is simultaneously an active suspended-load and thermal hazard zone during production	MEDIUM	Crush · Ergonomic	PSC Specialised Maintenance Interfaces

7 METAL TAPPING & CRUCIBLE OPERATIONS — QUICK ASSESSMENT CHECKLIST

Use during a plant walkdown or pre-shift review. Answer based on observed practice, not the written procedure.

- ☐ During vacuum ladle crane descent above the cell, is the ladle guided using a rated push/pull tool — not by hands on the ladle body or by a fabricated rod?
- ☐ Is an anti-tangle tagline used on every crane lift of a filled vacuum ladle or crucible — at full metal load, not only during empty vessel movements?
- ☐ Before pour initiation, is the worker's body confirmed to be outside the metal splash radius — and confirmed before the pour signal is given to the crane operator?
- ☐ During dross skimming, does the rake handle length position the grip hand outside the radiant heat zone above the crucible rim at full metal load?
- ☐ During crucible landing at the furnace charging point, is the guidance worker positioned outside the space between the crucible and the charging port frame?
- ☐ Is there a defined tool and defined stand-off position for each transfer point in the tapping sequence — not only a general instruction to maintain distance?
- ☐ During ladle refractory maintenance, is the crow bar or chisel held with a holding tool — not by bare hand — during all impact operations inside the ladle interior?
- ☐ Are gas cylinders moved at the tapping station using a purpose-designed cylinder lifter — not carried by the valve or by gripping the cylinder body directly?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — METAL TAPPING & CRUCIBLE OPERATIONS

Representative PSC interfaces for the scenarios in this chapter, organised by engineering function. Contact PSC for guidance on ladle geometry, crucible size, and site-specific operating constraints before final product selection.

LOAD CONTROL INTERFACES — SUSPENDED VESSEL SWING & TRAVEL CONTROL

INTERFACE	PRIMARY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for vacuum ladle during crane travel between tapping cells and transfer station. Swing control for filled crucible during crane movement to cast house. Replaces plain rope tagline — no knots, no tangle points, resists contact with hot vessel surfaces.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · 4
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching and retrieving taglines to vacuum ladle and crucible crane rigging at height — without climbing or placing hands on the vessel body during rigging setup. Extends 6–12 ft from safe floor position.	6–12 ft	PSC-TRT-3P	1 · 4

POSITION & REACH INTERFACES — VESSEL GUIDANCE & STAND-OFF CONTROL

INTERFACE	PRIMARY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Vacuum ladle lateral guidance during crane descent above cell and transfer station. Crucible lateral correction during landing at furnace charging point. Rated grip at safe stand-off from vessel body throughout positioning.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 2 · 4
POSITION & REACH PSC Guide-It® Push/Pull Tool	Ladle spout alignment confirmation and correction above crucible rim. General load guidance during crane movements above metal-containing vessels. Nylon head suitable for contact with ladle and crucible steel body surfaces.	72", 96"	PSC-GIT-72 PSC-GIT-96	2 · 4
POSITION & REACH PSC SafeGuider® Tagline Retriever	Push and pull of ladle and crucible body during short-range positioning at transfer points. Hook and reverse hook for approach and retrieval of rigging. Hardwood body with cast aluminium head for durability at the tapping station.	24", 48"	PSC-STGT-24 PSC-STGT-48	1 · 4

STRIKING & ALIGNMENT INTERFACES — LADLE & REFRACTORY MAINTENANCE

INTERFACE	PRIMARY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding crow bars and chisels during ladle refractory breakout and solidified metal removal inside the ladle interior. Removes the holding hand from the hammer strike zone during all impact operations inside the ladle or crucible body.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.

SPECIALISED MAINTENANCE INTERFACES

INTERFACE	PRIMARY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
SPECIALISED PSC GasGrab® Cylinder Lifter	Lifting and moving oxygen, argon, and nitrogen gas cylinders used for metal treatment at the tapping station. Eliminates valve-grip and body-grip cylinder handling in a zone that is simultaneously an active suspended-load and thermal hazard area during production.	215 mm, 230 mm, 254 mm	PSC-GG-215 PSC-GG-230 PSC-GG-254	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Four observations about metal transfer operations

Metal tapping and crucible operations are distinguished from most other aluminium plant departments by the coexistence of large suspended loads and open liquid metal surfaces at every transfer point. The principles below address the engineering response to that combination.

PRINCIPLE 01

Operational time pressure in metal tapping is one of the most persistent drivers of hand exposure in the aluminium plant — and one of the least often addressed by engineering controls.

The need to complete metal transfers before the temperature drops below casting specification creates a genuine production incentive to work quickly and at close range. Engineering interfaces that maintain stand-off without adding time to the operation are the only controls that will be consistently applied. Controls that slow the process will be bypassed — not from negligence, but from production logic.

PRINCIPLE 02

A filled crucible in transit is among the highest-consequence suspended loads in the aluminium plant. Tagline control at full metal load should be treated as a mandatory operational requirement.

An empty crucible swing during crane travel is a mechanical hazard. A full crucible swing is simultaneously mechanical and thermal — the mass ensures high kinetic energy, and the metal load means any structural contact risks spillage. Anti-tangle tagline control on full crucible movements should be written into the lifting procedure, not left to individual practice.

PRINCIPLE 03

Pour alignment confirmation is a predictable hand-entry point that can be eliminated with a defined stand-off procedure — yet in most plants it is performed at zero stand-off.

The moment before pour initiation is among the most critical hand-exposure events in the tapping and transfer cycle. It is entirely predictable, repeatable, and occurs at every fill. Yet most plants have no defined tool or stand-off position for alignment confirmation — the worker leans over the crucible rim. A defined procedure with a specific tool position eliminates this exposure without adding time to the operation.

PRINCIPLE 04

Metal splash at pour initiation is a predictable physical event — not an accident. Engineering controls should treat it as a designed element of the operation.

Some degree of metal splash occurs at the initiation of every pour into a crucible. Treating it as an accident rather than a designed operational event means no stand-off position or protective measure is defined before the pour begins. Defining the splash zone and requiring the worker to be outside it before pour initiation converts a recurring exposure into a controlled, managed event.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

If any hand exposure scenario in this chapter reflects tasks observed in your plant, PSC Hand Safety India can provide engineering guidance on representative interfaces. Vacuum ladle geometry, crucible size, crane configuration, and tapping tube type all affect the appropriate interface selection.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — tapping, pour alignment, dross skimming, crucible guidance	Recommended interface and size for the specific tapping or transfer task
Ladle or crucible capacity and crane type in use	Indicative unit price (budgetary, not binding)
Current field method used at each transfer point	Delivery lead time from Visakhapatnam
Required stand-off distance from vessel body or metal surface	Application notes addressing time-sensitivity of metal transfer operations
Time constraint — transfer window before temperature drop	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Reference to comparable applications at similar primary aluminium facilities

Application validation: sales@pschandsafety.com · +91 96031 66448 · pschandsfree.com

1 DEPARTMENT OVERVIEW

The cast house receives liquid aluminium from the potroom crucibles and converts it into saleable product — ingots, billets, slabs, and wire rod — through a sequence of melting, alloying, treating, and casting operations. It is the department in the primary aluminium plant where the largest volumes of liquid metal are handled at the most varied range of temperatures, vessel sizes, and process conditions. The combination of open furnace doors, crane-suspended crucibles, rotating casting tables, and high-temperature dross creates a sustained hand exposure environment across every shift throughout the year.

In most primary aluminium smelters, the cast house operates continuously alongside the potline. Liquid metal arrives from the potroom in crucibles at 700–750°C and is charged into holding or melting furnaces. Alloying additions are made, metal treatment — degassing, fluxing, grain refinement — is carried out, and the treated metal is cast into the required product form through direct chill (DC) casting, continuous casting, or open mould casting. Scrap and returns are also melted in the cast house furnaces, bringing a separate material handling exposure distinct from the primary metal flow.

The hand exposure pattern in the cast house differs from the potroom in one important respect: workers interact not only with suspended loads and open metal surfaces, but also with the physical structure of the furnace itself — doors, hearths, charging openings, and burner ports. Furnace door handling is a high-frequency, physically demanding task that receives far less engineering attention than the metal handling operations it supports. A furnace door weighing 80–200 kg that is opened and closed multiple times per shift, by hand or with minimal mechanical assistance, represents a sustained ergonomic and mechanical exposure that is structural in nature — it is built into the furnace design, not created by worker behaviour.

2 MAJOR EQUIPMENT & LOCATIONS

HOLDING & MELTING FURNACES

Refractory-lined steel shells heated by gas or oil burners, holding liquid aluminium at casting temperature. Furnace capacities typically range from 20 to 100 tonnes of liquid metal. Workers interact with the furnace at the charging opening, the metal sampling port, the tapping spout, and the burner ports during every production cycle.

FURNACE CHARGING CRANE

The overhead crane that positions the crucible over the furnace charging opening and tips it to charge the furnace. Workers guide the crane-suspended crucible during the approach to the charging opening and manage the tipping sequence. The furnace interior is at operating temperature and the charging port is open throughout the operation.

FURNACE DOOR & DOOR MECHANISM

The refractory-lined door covering the furnace charging opening. Furnace doors are opened for charging, metal sampling, dross removal, and maintenance access. Door weights range from 80 to 200 kg depending on furnace size. Most cast house furnaces rely on counterweight or hydraulic door systems, but direct manual interaction at the door frame is common during every opening cycle.

METAL TREATMENT STATION

The location, typically at the furnace tap hole or in the launder, where degassing lances, flux injection equipment, grain refiner wire, and other treatment media are introduced. Workers manage lance insertion and withdrawal, flux addition, and treatment monitoring — all close to the open metal surface at operating temperature.

CASTING TABLE & LAUNDER SYSTEM

The casting table receives treated metal from the furnace via the launder system and distributes it to the casting moulds. The launder is an open refractory channel carrying liquid metal at casting temperature. Workers interact with the launder during metal flow start-up, casting parameter adjustment, and blockage clearance.

DROSS HANDLING AREA

Dross removed from the furnace during skimming is transferred to dross pots or dross collection systems. Dross is a mixture of aluminium oxide, metallic aluminium, and flux residue at elevated temperature. It is handled using long-handled rakes, paddles, and mechanical dross presses. Manual interaction with dross is one of the highest-frequency contact exposures in the cast house.

3 CAST HOUSE PRODUCTION CYCLE — TASK FLOW & EXPOSURE POINTS**CAST HOUSE PRODUCTION CYCLE****FURNACE CHARGING**

Crucible tipped to charge holding or melting furnace

SUSPENDED LOAD · BURNS · LINE OF FIRE

FURNACE DOOR OPERATION

Door opened for charging, sampling, dross removal

CRUSH · BURNS · ERGONOMIC STRAIN

METAL SAMPLING

Temperature and chemistry samples taken at furnace

BURNS · LINE OF FIRE

METAL TREATMENT

Degassing, fluxing, grain refiner addition

BURNS · CHEMICAL · LINE OF FIRE

DROSS SKIMMING AT FURNACE

Dross removed from furnace surface before casting

BURNS · LACERATION · LINE OF FIRE

LAUNDER FLOW & CASTING START

Metal flows to casting table via open launder

BURNS · SPLASH · LINE OF FIRE

DC CASTING OPERATIONS → Chapter 07

LIQUID ALUMINIUM PRESENT AT EVERY STAGE

4 CURRENT FIELD INTERFACES OBSERVED

The table below documents the manual interfaces currently observed across cast house operations. Several of these — particularly furnace door handling and dross raking — are so embedded in standard furnace design that they are rarely identified as engineering gaps. They are nevertheless hand exposure events that occur at high frequency throughout every production cycle.

CURRENT INTERFACE	ENGINEERING LIMITATION
Direct hand contact — furnace door frame	Workers grip the furnace door frame or door handle directly during opening and closing. The door frame is at furnace operating temperature. Even where counterweight mechanisms reduce the effort required, the grip point is typically within 300 mm of a surface radiating heat from the furnace interior. Burns to knuckles, wrists, and forearms are common and often not reported as lost-time injuries.
Short-handled rake — furnace dross removal	Furnace dross rakes in many cast houses have handles of 1.5–2 m. At the furnace opening, this places the grip hand directly in the heat plume from the open furnace door throughout the skimming stroke. The posture required — leaning into the furnace opening with the rake at a low angle — forces the worker's upper body into the radiant heat zone for the full duration of each stroke.
Bare hands — crucible guidance at charging opening	Workers guide the crane-suspended crucible to the charging opening by hand or with a fabricated rod. The furnace door is open throughout this operation. The worker is simultaneously in the radiant heat zone from the furnace interior and in the suspended load zone from the crucible above. These two exposures are usually managed as if they were separate, but they occur at exactly the same moment.
Direct lance handling — metal treatment	Degassing lances, flux injection tubes, and grain refiner addition tools are inserted into the metal bath by hand at close range to the open furnace or launder surface. The lance must be held at the correct depth and angle during treatment — a sustained posture over the open metal surface lasting several minutes per treatment cycle.
Bare hands — launder blockage clearance	Frozen aluminium or dross blocking the open launder is cleared using improvised tools or by direct hand contact with a scraper or rod near the metal surface. Launder blockages are treated as urgent events — the time pressure to clear the blockage before casting is disrupted means workers approach the metal surface more closely than the hazard warrants.

ENGINEERING OBJECTIVE — CAST HOUSE

Provide a rated, purpose-designed interface for every routine hand-entry point in the cast house cycle — furnace door, charging crane guidance, dross removal, metal treatment, and launder management — that maintains defined stand-off from the furnace interior, the liquid metal surface, and the suspended crucible simultaneously.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Furnace Charging — Crucible Guidance at Charging Opening			
SUSPENDED LOAD · BURNS · LINE OF FIRE							
WHY THE HAND IS THERE The crane-suspended crucible must be positioned precisely over the furnace charging opening before tipping. The furnace door is open and the furnace interior is at operating temperature throughout the approach sequence. Workers guide the crucible to the correct position and confirm alignment before signalling for the tip — placing them at the intersection of suspended load hazard above and furnace radiant heat hazard in front.		CURRENT FIELD INTERFACE Fabricated guide rod or bare hands used to push the crucible laterally during crane descent to the charging position. Plain rope tagline for swing control during crane travel. The furnace door is open and the worker approaches the charging opening to confirm crucible alignment — placing the upper body in the furnace heat plume while simultaneously managing the suspended load.		EXPOSURE TYPE Crush between the descending crucible and the furnace charging opening frame. Burns from furnace radiant heat during the approach and alignment confirmation. Burns from metal splash at charge initiation. Struck-by if the crucible swings under crane movement during final approach to the furnace opening.			
ENGINEERING OBJECTIVE Guide the suspended crucible to the furnace charging position and confirm alignment without placing the worker's body in the furnace heat plume or within the crush zone between the crucible and the charging frame — from crane descent initiation to completion of the charge.				REPRESENTATIVE INTERFACE Representative push/pull interface (6 ft, S-Head) for crucible lateral guidance during crane descent. Anti-Tangle Tagline for swing control during crane travel. Stand-off positions the worker outside the furnace heat plume during alignment confirmation — crucible and furnace hazards addressed by the same interface simultaneously.			
<i>"During furnace charging, is the worker confirming crucible alignment from a position outside the furnace heat plume — or does alignment confirmation require them to step into the radiant heat zone with the suspended crucible directly above?"</i>							

HIGH				Furnace Door Operation — Opening, Holding & Closing	
BURNS · CRUSH · ERGONOMIC STRAIN					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
The furnace door must be opened for every charging, sampling, dross removal, and metal treatment operation. Where counterweight or hydraulic mechanisms are present, workers still interact with the door directly at the handle or door frame during initial engagement and during the final seating sequence. On older furnaces, the door is operated manually throughout the full cycle with no mechanical assistance.		Direct hand grip on door handle or door frame during opening and closing. Door weight 80–200 kg depending on furnace size. The grip point on most cast house furnace doors is within 300–400 mm of the door face, which is at furnace operating temperature. Burns to knuckle backs, wrists, and forearms from incidental contact with the door frame are the most frequent unreported injuries in the cast house.		Burns from contact with door frame at elevated temperature during grip and release. Radiant heat exposure to hands and forearms from the open furnace interior during the full door travel cycle. Crush between the door and the furnace frame during closing if the door swings unexpectedly. Cumulative ergonomic strain from repeated high-force door operation across a full shift.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Provide a grip interface for furnace door operation that positions the worker's hands at a defined stand-off from the door face and the furnace frame — eliminating incidental contact with hot surfaces during the grip, travel, and seating sequence of every door cycle.			Extended-reach door operating tool or purpose-designed door pull rod that positions the grip hand at 600–800 mm from the door face throughout the travel cycle. This is an engineering approach applicable to furnace door accessory design rather than a standard PSC catalogue product. Cast house furnace OEMs and refractory contractors are the primary implementation pathway.		
"How many times per shift is each furnace door opened and closed — and has the cumulative radiant heat and contact burn exposure from those door cycles been formally assessed as a hand injury risk?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Furnace Dross Removal — Skimming at Open Furnace Door	
BURNS · LACERATION · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Dross accumulates on the furnace metal surface during holding and must be removed before casting. Workers use long-handled rakes and paddles through the open furnace door to push dross to the charging opening where it is scooped out. The confined furnace geometry and the angle required to reach the full furnace width forces the worker's upper body partially into the furnace heat plume throughout the skimming sequence.		Long-handled dross rake, typically 1.5–2.5 m handle length. At the furnace opening, the grip hand is in the furnace heat plume during the full stroke. The raking angle — low approach through the furnace door — means wrist and forearm are consistently closer to the metal surface than the rake handle length implies. Dross pots are positioned at the furnace door and filled using a ladle or scoop that requires close approach to the open furnace interior.		Sustained radiant heat to hands and forearms from the open furnace interior during raking strokes. Burns from contact with hot dross during collection and transfer to the dross pot. Laceration from sharp solidified dross edges on the rake head and at the furnace door threshold. Wrist and shoulder strain from the sustained low-angle raking posture across a full furnace skim cycle.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Position the grip hand outside the furnace door heat plume during the full dross raking stroke — maintaining defined stand-off from the furnace interior throughout the skim cycle and during dross collection transfer to the dross pot.			Extended-reach dross rake with grip position at minimum 2.5 m from the working head, with ergonomic D-grip to reduce wrist strain during lateral strokes. PSC Scraper Head on Load-It pole (3–4 ft) for dross collection positioning and transfer at the furnace door threshold — engineered face geometry keeps hands outside the direct heat zone during dross pot filling.		
"During furnace dross removal, where is the worker's grip hand relative to the furnace door opening — and has the furnace skim cycle been timed to understand how long the upper body is in the heat plume per skim operation?"					

HIGH				Metal Treatment — Lance Insertion & Degassing Operation	
BURNS · CHEMICAL EXPOSURE · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Degassing lances, flux injection tubes, and grain refiner wire feeder guides must be inserted into the metal bath through the furnace or launder opening and held at the correct immersion depth during treatment. Treatment cycles typically last 15–45 minutes per furnace charge. Workers monitor the treatment at close range and manage lance position throughout, keeping hands near the open metal surface for the full duration.		Lance held or guided by hand during insertion and throughout the treatment cycle. Some lances are supported by a stand, but the final positioning and angle adjustment is manual at close range. Flux addition and grain refiner wire introduction are managed by hand at the launder or furnace opening, with the worker leaning over the open metal channel to confirm treatment progress.		Sustained radiant heat exposure to hands and forearms during the full treatment period — up to 45 minutes per charge. Burns from metal splash if the lance disturbs the metal surface during immersion or withdrawal. Chemical exposure to chlorine and fluoride compounds released during flux treatment. Ergonomic strain from sustained arm-extension posture over the open metal surface throughout the treatment cycle.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Support and position the degassing lance or treatment tool at the correct immersion depth without requiring the worker's hands to be within the radiant heat zone of the furnace or launder opening for the duration of the treatment cycle.			Mechanical lance holder or adjustable lance support stand that maintains correct immersion depth without sustained hand support. This is a process engineering control rather than a PSC catalogue product. For launder-side monitoring, representative push/pull interfaces provide positional adjustment at stand-off during treatment parameter checks.		
"During a 30-minute degassing cycle, are the worker's hands within the furnace radiant heat zone for the full duration — and is that sustained exposure documented as part of the cast house hand injury risk assessment?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH Launder System — Flow Monitoring & Blockage Clearance BURNS · SPLASH · LINE OF FIRE			
WHY THE HAND IS THERE The open launder carries liquid metal from the furnace tap hole to the casting table at low velocity. Frozen metal or dross can block the launder during casting start-up or during extended casting runs. When a blockage occurs, it is treated as an urgent event — the metal must continue flowing or the casting operation is lost. Workers approach the launder with improvised tools or bare hands to clear the blockage under production pressure.		CURRENT FIELD INTERFACE Improvised scraper, rod, or shovel used to clear blockages in the open launder channel while metal continues to flow. The open channel geometry means tools must be inserted from directly above or from the side at close range to the metal surface. In urgent situations, workers have been observed using gloved hands directly in or adjacent to the flowing metal channel to clear freeze blockages.	
		EXPOSURE TYPE Burns from metal splash during blockage clearance when solidified material breaks free suddenly. Burns from contact with the launder refractory, which is at metal temperature across its full length. Laceration from sharp frozen aluminium edges at the blockage point. The combination of operational urgency and confined launder geometry creates one of the highest-risk hand exposure events in the cast house.	
ENGINEERING OBJECTIVE Provide a purpose-designed launder clearance tool that maintains defined stand-off from the metal surface and the launder refractory during blockage clearance — without requiring the worker to approach the launder from directly above or to use improvised tools under production pressure.		REPRESENTATIVE INTERFACE Scraper Head on Load-It pole (3–4 ft) for launder blockage clearance — engineered face geometry for the launder channel profile, ergonomic grip, defined stand-off from metal surface. Replaces improvised tools and eliminates bare-hand proximity during clearance. PSC representative scraper-type interface applicable at the launder channel clearance point.	
"When a launder blockage occurs during casting, what tool does the worker reach for first — and is that tool rated and designed for that task, or is it whatever is closest to hand at that moment?"			

MEDIUM				Metal Sampling at Furnace — Temperature & Chemistry	
BURNS · CHEMICAL EXPOSURE · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Metal temperature and chemistry samples are taken at the furnace sampling port or through the open furnace door at intervals throughout the holding and casting cycle. The sampling tool must be inserted into the metal bath and held at immersion depth. Workers lean across the furnace opening with the sampling handle at arm's length — the same posture as bath sampling in the potroom, but at a larger furnace opening.		Standard thermocouple lance or sampling cup on a handle, typically 1–1.5 m total length. At the furnace opening, the grip hand is in the furnace heat plume during the immersion period. Metal splash on withdrawal reaches the grip position and forearm regularly. The larger furnace opening compared to the potroom cell means the worker's entire upper body is exposed to furnace radiant heat during sampling.		Radiant heat burns to hands and forearms during the immersion period. Metal splash from the furnace bath surface during sample cup withdrawal. Chemical exposure if flux or treatment media are present in the metal during sampling. The larger furnace opening creates a wider radiant heat exposure zone than the equivalent potroom cell sampling operation.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Position the grip hand outside the furnace radiant heat zone and outside the metal splash radius during the full furnace sampling immersion period and on cup withdrawal — using a handle or adapter that increases stand-off without compromising sampling accuracy.			Extended-reach sampling handle adapter increasing grip-to-sample-point distance to a minimum of 2 m. Where cast house sampling tools are specified or procured in-house, this represents the design criterion. For standard thermocouple lances, PSC Position & Reach Interfaces provide the grip extension framework where adaptable.		
"At the cast house furnace, is the sampling handle long enough to position the grip hand outside the furnace door heat plume during the full immersion period — or does the worker routinely absorb sustained radiant heat exposure during every sampling event?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Cast house maintenance involves working on equipment that has been in direct contact with liquid aluminium and is still at elevated temperature during most scheduled maintenance windows. Furnace relining and tap hole repair are the highest-severity non-routine activities and are typically performed by specialist refractory contractors working in confined, hot, and chemically contaminated spaces.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Furnace tap hole repair and replacement	Workers position refractory tap hole components by hand in the furnace wall; confined space at elevated temperature; heavy refractory blocks handled in restricted access geometry	HIGH	Burns · Crush · Confined Space	PSC Position & Reach · PSC Striking & Alignment Interfaces
Furnace lining repair — hot patching	Refractory patch material applied by hand or trowel to damaged furnace lining areas; furnace may still be at elevated temperature; workers lean into the furnace interior for access	HIGH	Burns · Chemical · Confined Space	PSC Position & Reach Interfaces · PSC Striking & Alignment Interfaces
Launder refractory replacement	Refractory launder sections positioned and seated by hand; residual metal traces in launder channel; heavy sections require manual alignment in confined launder geometry	HIGH	Burns · Crush	PSC Position & Reach · PSC Manual Lifting Interfaces
Casting table and mould maintenance	Mould components positioned and secured by hand; casting table mechanisms accessed for lubrication and adjustment; graphite and boron nitride coatings applied by hand in confined mould geometry	MEDIUM	Pinch · Chemical · Ergonomic	PSC Position & Reach · PSC Striking & Alignment Interfaces
Dross press operation and maintenance	Hot dross loaded into dross press by hand using ladle and rake; press mechanism accessed for maintenance while dross residue remains at elevated temperature in press interior	HIGH	Burns · Crush · Line of Fire	PSC Position & Reach · PSC Striking & Alignment Interfaces
Gas cylinder handling — furnace area	Nitrogen, argon, and chlorine cylinders used for metal treatment moved regularly in the cast house furnace area — in a zone with active suspended loads, open metal, and elevated floor temperatures	MEDIUM	Crush · Ergonomic	PSC Specialised Maintenance Interfaces

7 CAST HOUSE QUICK ASSESSMENT CHECKLIST

Use during a cast house walkdown or pre-cast review. Answer based on observed practice, not the written procedure.

- ☐ During furnace charging, is the crucible guided to the charging opening using a rated push/pull tool — not by hands on the crucible body or by a fabricated rod while the furnace door is open?
- ☐ Is an anti-tangle tagline used on every crane lift of a filled crucible during furnace charging operations — not only during transport from the potroom?
- ☐ Does the furnace door operating mechanism position the worker's grip hand at a defined stand-off from the door face and furnace frame throughout the door travel cycle?
- ☐ During furnace dross removal, does the rake handle length keep the grip hand outside the furnace door heat plume throughout the full skimming stroke?
- ☐ During degassing and metal treatment, is the lance supported at the correct immersion depth without requiring the worker's hands to remain in the furnace radiant heat zone for the full treatment duration?
- ☐ Is a purpose-designed launder clearance tool available at the casting station for use during blockages — not an improvised scraper or bare-hand approach under production pressure?
- ☐ During furnace metal sampling, does the sampling handle length position the grip hand outside the furnace door radiant heat zone throughout the immersion period?
- ☐ During tap hole repair and furnace lining patching, are chisel and crow bar operations performed with a holding tool — not bare hand — at all impact points inside the furnace?
- ☐ Are gas cylinders moved in the furnace area using a purpose-designed cylinder lifter — not carried by valve or body grip in a zone with active suspended loads and elevated floor temperatures?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — CAST HOUSE

Representative PSC interfaces for the scenarios in this chapter, organised by engineering function. Contact PSC for guidance on furnace size, door geometry, launder configuration, and site-specific operating conditions.

LOAD CONTROL INTERFACES — CRANE LIFT & CRUCIBLE SWING CONTROL

INTERFACE	PRIMARY CAST HOUSE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for filled crucible during crane travel to furnace charging position. Swing control for maintenance crane lifts over open furnace. Replaces plain rope tagline — no tangle points at the furnace opening where hot surfaces would damage a standard rope.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · Maint.
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching and retrieving taglines on crucible crane rigging at height without climbing or placing hands on the crucible body. Accessing crane hook points above the furnace charging opening from safe floor position. Extends 6–12 ft.	6–12 ft	PSC-TRT-3P	1 · Maint.

POSITION & REACH INTERFACES — VESSEL GUIDANCE & STAND-OFF CONTROL

INTERFACE	PRIMARY CAST HOUSE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Crucible lateral guidance during crane descent to furnace charging position. Stand-off positions worker outside the furnace heat plume during alignment confirmation. Also used for launder blockage clearance at stand-off from the metal surface.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 5
POSITION & REACH PSC Guide-It® Push/Pull Tool	General load guidance for crane lifts in the cast house. Crucible body contact during short-range positioning at the furnace charging opening. Nylon head suitable for contact with crucible steel body surfaces in the furnace approach zone.	72", 96"	PSC-GIT-72 PSC-GIT-96	1

APPLICATION-SPECIFIC INTERFACES — FURNACE & LAUNDER OPERATIONS

INTERFACE	PRIMARY CAST HOUSE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
APPLICATION-SPECIFIC PSC Load-It® Scraper Head (Custom)	Launder blockage clearance — engineered scraper face on Load-It pole for use in the confined launder channel profile. Dross collection positioning at the furnace door threshold. Replaces improvised scraper tools used under production pressure during launder blockages.	3 ft, 4 ft	Custom — contact PSC	5

STRIKING & ALIGNMENT INTERFACES — FURNACE MAINTENANCE

INTERFACE	PRIMARY CAST HOUSE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding chisels and crow bars during furnace tap hole breakout, refractory repair, and solidified metal removal inside the furnace interior. Removes the holding hand from the hammer strike zone during all impact operations inside the furnace body.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.

SPECIALISED MAINTENANCE INTERFACES

INTERFACE	PRIMARY CAST HOUSE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
SPECIALISED PSC GasGrab® Cylinder Lifter	Lifting and moving nitrogen, argon, and chlorine gas cylinders in the cast house furnace area. Eliminates valve-grip and body-grip cylinder handling in a zone with active suspended crucibles, open metal surfaces, and elevated floor temperatures throughout production.	215 mm, 230 mm, 254 mm	PSC-GG-215 PSC-GG-230 PSC-GG-254	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Four observations about cast house hand exposure

The cast house is where the widest variety of hand exposure types converge in a single production area — suspended loads, open liquid metal, furnace radiant heat, chemical treatment, and high-frequency mechanical door operation all occur within metres of each other across every shift.

PRINCIPLE 01

Furnace door operation is one of the most frequent unreported hand exposure events in the cast house — and one of the most structurally embedded.

Burns to knuckles, wrist backs, and forearms from incidental contact with the furnace door frame are so common they are treated as minor nuisances rather than recordable events. They occur on every door cycle, across every shift, at every furnace in the cast house. The exposure is structural — it is built into the door design — which means it will persist regardless of awareness campaigns or PPE mandates unless the door operating interface is redesigned.

PRINCIPLE 02

The cast house is the only department where suspended load and furnace heat exposure occur simultaneously at the same physical location — the charging opening.

Furnace charging requires the crane-suspended crucible to approach the open furnace door from above. The worker guiding the crucible is simultaneously managing a suspended load hazard and a furnace radiant heat hazard. These two hazards are typically assessed and controlled separately in most safety management systems — which means neither is controlled adequately at the moment of maximum combined exposure.

PRINCIPLE 03

Launder blockage clearance is among the highest-risk hand exposure events in the cast house because operational urgency and confined geometry eliminate the worker's ability to maintain stand-off.

When a launder blocks during casting, the production consequence of inaction — a lost casting campaign — creates immediate pressure to clear the blockage by whatever means is available. The confined launder channel and the absence of a purpose-designed clearance tool means that "whatever is available" is usually an improvised rod or a gloved hand. A defined tool with a defined procedure, available at the casting station before the blockage occurs, is the only control that will function under operational pressure.

PRINCIPLE 04

Sustained metal treatment operations generate cumulative radiant heat exposure that is rarely assessed because each individual exposure period appears short relative to the shift duration.

A 30-minute degassing cycle seems brief. But across multiple furnace charges per shift, multiple shifts per week, the cumulative radiant heat exposure at the furnace opening during lance holding represents a meaningful long-term thermal loading on hands and forearms. Engineering controls that support the lance mechanically eliminate this cumulative exposure at its source — not by reducing shift length or rotating workers, but by removing the physical requirement for sustained hand support near the metal surface.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

If any hand exposure scenario in this chapter reflects tasks observed in your plant, PSC Hand Safety India can provide engineering guidance on representative interfaces. Furnace size, door type, launder configuration, and metal treatment method all affect the appropriate interface selection.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — charging, door operation, dross removal, metal treatment, launder clearance	Recommended interface and size for the specific cast house task
Furnace capacity and door type (counterweight, hydraulic, manual)	Indicative unit price (budgetary, not binding)
Current field method used at each identified exposure point	Delivery lead time from Visakhapatnam
Required stand-off distance from furnace opening or metal surface	Application notes for furnace and launder-specific configurations
Launder channel geometry if launder clearance interface is required	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity and plant location	Custom interface development pathway where standard products require adaptation

Application validation: sales@pschandsafety.com · +91 96031 66448 · pschandsfree.com

1 DEPARTMENT OVERVIEW

Direct chill casting is the primary method for producing aluminium ingots, billets, and slabs for downstream rolling and extrusion. It is the final step in the primary aluminium production sequence before the metal becomes a saleable intermediate product. The casting pit — an open, water-cooled mould table above a hydraulic platform that descends as the cast length grows — is the most concentrated hand exposure location in the cast house. Setup before casting, start-up at metal contact, and product extraction after casting are each distinct hand exposure events that occur at or above the open metal surface, around suspended tooling, and adjacent to hydraulic mechanisms under load.

In direct chill casting, treated liquid aluminium flows from the holding furnace through the launder system into a water-cooled mould table positioned above the casting pit. The mould table contains multiple individual moulds — typically 4 to 48 moulds depending on the casting machine — each producing one ingot, billet, or slab. A dummy block at the base of each mould seals the bottom at casting start and is withdrawn downward as metal fills the mould and solidifies against the water-cooled walls. The hydraulic casting platform descends at a controlled rate matching the solidification speed, withdrawing the growing cast product downward into the pit until the desired cast length is reached.

The hand exposure pattern in DC casting is concentrated at three points in the casting cycle. Setup — positioning the mould table, seating the dummy blocks, and connecting the cooling water system — involves working directly at the pit edge above an empty casting pit with heavy components that must be manually aligned. Start-up — the first 30–60 seconds of metal contact with the mould — is the highest-severity event because breakthrough or bleed-out is most likely at this point and workers are closest to the open metal surface when confirming casting has started correctly. Extraction — after casting is complete, the cast product must be lifted from the pit, sawn to length, and transferred to the homogenisation furnace or despatch area — involves crane guidance of heavy ingot or billet bundles at close range.

2 MAJOR EQUIPMENT & LOCATIONS

CASTING PIT & HYDRAULIC PLATFORM

The pit is an open, rectangular excavation below the casting machine floor level, typically 6–12 m deep depending on cast length. The hydraulic platform carries the dummy blocks and descends as casting progresses. Workers access the pit edge during setup, start-up monitoring, and product extraction — each access point is above a progressively deeper open pit.

MOULD TABLE

The water-cooled table positioned above the casting pit containing the individual casting moulds. The mould table must be set up before each cast with correct metal distribution systems and seals. Workers position the mould table, connect launder sections, and seat the metal distribution system — all at the pit edge with the mould table at operating height.

DUMMY BLOCK ASSEMBLY

The dummy block is a platform that seals the base of each mould at casting start and is attached to the descending casting platform. Dummy blocks are positioned and seated in the mould from above before casting, requiring workers to reach into the mould or pit edge to confirm correct seating. Dummy block weights range from 5 to 80 kg depending on product size.

CASTING CRANE

The overhead crane used to lift the cast sow, ingot bundle, or billet bundle from the pit after casting is complete, and to move it to the saw, scalper, or homogenisation furnace. The crane also handles the mould table and launder sections during setup. Workers guide all of these suspended loads during crane positioning above and adjacent to the pit.

SAWING STATION

Cast billets and ingots are sawn to length at a fixed sawing station. Sawn pieces must be handled and transferred after cutting. The saw generates sharp aluminium swarf and presents nip point and blade proximity hazards. Manual handling of freshly sawn aluminium surfaces presents laceration risk from sharp cut edges throughout the sawing cycle.

COOLING WATER SYSTEM

Direct cooling water is applied to the cast product as it emerges from the mould. Water connections, spray rings, and cooling headers must be connected during setup and disconnected after casting. Water under pressure at the mould level, combined with molten metal above, creates a flash steam hazard if connections fail during start-up.

3 DC CASTING CYCLE — TASK FLOW & EXPOSURE POINTS

DC CASTING CYCLE

MOULD TABLE & LAUNDER SETUP

Mould table positioned · launder connected · seals fitted

SUSPENDED LOAD · CRUSH · PIT EDGE

DUMMY BLOCK POSITIONING

Dummy blocks seated in moulds from pit edge

CRUSH · CAUGHT-BETWEEN · PIT EDGE

CASTING START-UP

Metal contacts mould · casting confirmed · platform descends

BURNS · SPLASH · LINE OF FIRE

CASTING RUN — MONITORING

Platform descends · cast length grows · parameters monitored

BURNS · LINE OF FIRE · PIT EDGE

CAST PRODUCT EXTRACTION

Ingot / billet bundle lifted from pit by crane

SUSPENDED LOAD · CRUSH · STRUCK-BY

SAWING & PRODUCT TRANSFER

Cast product sawn to length · transferred to scalper or furnace

LACERATION · NIP POINT · SUSPENDED LOAD

SCALPER / HOT ROLLING → Chapter 08 / 09

LIQUID METAL AND OPEN PIT PRESENT AT START-UP

4 CURRENT FIELD INTERFACES OBSERVED

The table below documents the manual interfaces observed across the DC casting cycle. Several of these occur at the pit edge — a location where both the depth hazard below and the liquid metal or suspended load above are simultaneously present.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — mould table positioning and launder connection	The mould table is positioned by crane and guided to its landing position by hand. Launder sections are connected at the mould level by hand with workers leaning across the pit edge. Both operations place hands in the crush zone between the crane-suspended mould table and the casting machine frame, and at the pit edge with the open pit below.
Direct hand reach — dummy block seating confirmation	After dummy blocks are lowered into the moulds by crane, workers confirm correct seating by reaching into or across the mould from the pit edge. The dummy block weighs 5–80 kg depending on product size. If the dummy block shifts during seating confirmation, hands between the block and the mould wall are in the crush zone. The pit is open below throughout this operation.
Close observation — casting start-up at mould level	During the first 30–60 seconds of metal contact, workers lean over the mould table to observe metal filling and confirm that casting has started correctly in all moulds. Breakthrough or bleed-out at start-up releases liquid metal at the point of closest worker proximity. This is the highest-consequence exposure point in the DC casting cycle.
Bare hands — ingot and billet bundle guidance during extraction	The cast product bundle is lifted from the pit by crane and guided to the saw or transfer station by hand or fabricated rod. Billet bundles may weigh 5–15 tonnes. The lift passes above the open pit during the initial extraction phase. Workers guide the bundle during crane travel with no rated stand-off interface in standard use.
Direct hand contact — sawn product handling and transfer	Freshly sawn aluminium ends have sharp edges from the saw cut. Workers handle sawn billets and ingot sections during transfer to subsequent processing. Cut edges are not deburred at the saw — the sharpness is a predictable consequence of the sawing process, not a variable.

ENGINEERING OBJECTIVE — DC CASTING

Provide rated, purpose-designed interfaces for every hand-entry point in the DC casting cycle — mould table guidance, dummy block confirmation, start-up monitoring stand-off, cast product extraction, and sawn product handling — that keep workers outside the crush zone, the pit edge hazard zone, and the liquid metal splash radius throughout the full casting cycle.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Mould Table Setup — Crane Positioning at Pit Edge	
SUSPENDED LOAD · CRUSH · PIT EDGE PROXIMITY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
The mould table is lifted by crane and positioned above the casting pit before each casting run. Workers guide the crane-suspended mould table to its landing position on the casting machine frame, connect launder sections at the mould level, and fit seals and distribution systems. All of these tasks are performed at the pit edge with the open pit immediately below and the crane-suspended mould table above.		Bare hands or fabricated rod used to guide the mould table during crane descent to the casting machine frame. Launder connections made by hand reaching across the pit edge. Workers stand at the pit edge with the open pit below throughout the mould table setup and launder connection sequence.		Crush between the descending mould table and the casting machine frame during positioning. Struck-by if the mould table swings under crane movement. Fall hazard from proximity to the open pit edge during launder connection and mould table seating. Load drop zone directly above the open pit throughout the crane descent sequence.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the crane-suspended mould table to its landing position on the casting machine frame without placing workers between the mould table and the machine frame, and without requiring hand contact on the mould table body during suspension above the open pit.			Representative push/pull interface (4–6 ft, S-Head or MagHead) for mould table lateral guidance during crane descent. Anti-Tangle Tagline for swing control during crane travel above the pit. Stand-off keeps the worker outside the crush zone and away from the pit edge during the full mould table descent and landing sequence.		
"During mould table crane descent above the open casting pit, where is the guidance worker positioned — and is that position outside the crush zone between the mould table and the casting machine frame?"					

HIGH				Casting Start-Up — Monitoring at Open Mould Level	
BURNS — LIQUID METAL · SPLASH · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
During the first 30–60 seconds after metal contacts the mould, workers observe the metal filling pattern in each mould to confirm that casting has started correctly and that no bleed-out or breakthrough is occurring. This confirmation requires close visual observation from above the mould table — the same position from which a bleed-out would release liquid metal upward and outward.		Workers lean over the mould table at the pit edge to observe metal filling visually. Some operations have platform walkways adjacent to the mould table, but the observation position is typically within 300–500 mm of the mould openings. No defined stand-off distance from the mould level is specified in most DC casting start-up procedures.		Burns from liquid metal splash if bleed-out occurs at start-up — the highest-probability time for a casting breakthrough event. The observation position directly above the mould places the worker's face and upper body in the primary ejection zone if a bleed-out occurs. This is the highest-consequence hand and body exposure point in the DC casting cycle.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Define a minimum stand-off distance from the mould level during the start-up observation period that places workers outside the primary splash zone of a bleed-out event — enforced by procedure and physical stand-off markers rather than relying on worker judgement during the highest-pressure moment of the casting cycle.			Physical stand-off markers at the casting machine floor defining the minimum observation distance from the mould level during start-up. This is a procedural and physical layout engineering control rather than a PSC catalogue product. Long-reach observation tools for mould filling confirmation at stand-off are an applicable engineering approach for new casting machine installations.		
"During casting start-up, is the minimum observation distance from the mould level defined and enforced — or does each operator determine their own proximity based on what they believe they need to see?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Cast Product Extraction — Ingot & Billet Bundle Crane Lift	
SUSPENDED LOAD · CRUSH · STRUCK-BY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After casting is complete, the hydraulic platform is raised and the cast product bundle — ingots, billets, or slabs still assembled on the dummy block carrier — is lifted from the pit by the casting crane. The bundle must be guided during the initial lift from the pit and during crane travel to the saw or transfer station. Bundle weights typically range from 5 to 20 tonnes.		Fabricated rod or bare hands used to guide the bundle during the initial lift from the pit and during crane travel to the saw station. The bundle passes above the open pit during the initial extraction phase before clearing the pit edge. Workers stand at the pit edge during the initial lift to ensure the bundle clears the pit walls without contact.		Crush between the ascending bundle and the pit wall or casting machine structure during initial extraction from the pit. Struck-by if the bundle swings during crane lift above the open pit. Load drop into the open pit if rigging fails during initial extraction. Worker at pit edge during the highest-consequence crane lift in the cast house.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the cast product bundle during pit extraction and crane travel to the saw or transfer station without placing workers at the pit edge during the initial lift, and without hand contact on the bundle body at any point during suspension above the open pit or during crane travel.			Anti-Tangle Tagline for bundle swing control during crane travel from pit to saw station. Representative push/pull interface (6 ft, S-Head) for lateral bundle guidance during crane travel. Worker positioned outside the pit edge exclusion zone during the initial extraction lift — guidance begins after bundle has cleared the pit walls.		
"During cast product extraction from the pit, at what point does a worker approach the pit edge — and is there a defined exclusion distance from the pit edge during the initial crane lift before the bundle has cleared the pit walls?"					

MEDIUM				Sawn Product Handling — Transfer After Sawing	
LACERATION · PINCH · SUSPENDED LOAD					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After sawing to length, individual billets, ingot sections, or slab pieces must be transferred from the saw to the transfer table, conveyor, or bundling station. Freshly sawn aluminium ends have sharp edges as a predictable consequence of the saw cut. Workers handle the sawn pieces during positioning on the transfer system or during manual stacking and bundling.		Direct hand contact with sawn aluminium pieces during transfer positioning and bundling. Gloves provide some protection against lacerations from cut edges but do not eliminate the exposure. Where crane or conveyor systems transfer sawn pieces, workers guide the pieces to final position by hand during the landing sequence.		Laceration from sharp sawn aluminium edges on cut ends — a predictable and consistent hazard at every sawing cycle. Pinch between sawn pieces during stacking or bundling operations. Crush if a crane-handled bundle contacts the worker during the final positioning of sawn pieces on the transfer system.	
ENGINEERING OBJECTIVE		REPRESENTATIVE INTERFACE			
Transfer and position sawn aluminium pieces without direct bare hand contact with the sawn ends — using a tool interface that maintains stand-off from the sharp cut faces and the pinch zones between pieces during stacking and bundling operations.		Representative push/pull interface (S-Head, 3–4 ft) for positioning sawn pieces on the transfer system without bare hand contact with cut ends. MagHead interface (2–3 ft) for positioning and guiding individual billet or ingot sections that are ferrous-compatible. Long-Reach Pickup Tool for retrieving pieces that have fallen or misaligned on the transfer system.			
"After sawing, are workers handling sawn aluminium ends with bare hands or with a tool that maintains stand-off from the cut face — and has the laceration rate from sawn product handling been tracked separately from other cast house hand injuries?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Non-routine work in DC casting involves maintenance of the casting machine, mould table, hydraulic platform, cooling water system, and pit structure. Much of this work is performed in or adjacent to the casting pit — a confined, wet, and slippery environment with limited access and restricted egress.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Mould replacement and refurbishment	Individual moulds lifted from the mould table by crane or by hand; mould weight 15–80 kg; positioned on refurbishment bench and reassembled with graphite rings and distribution bags by hand in confined mould interior	HIGH	Crush · Pinch · Chemical	PSC Position & Reach · PSC Manual Lifting Interfaces
Dummy block maintenance and replacement	Dummy blocks lifted from platform by crane; connection pins and retaining hardware removed and refitted by hand in confined pit geometry; residual water and aluminium scale on surfaces	HIGH	Crush · Pinch · Pit Environment	PSC Position & Reach · PSC Striking & Alignment Interfaces
Hydraulic platform maintenance	Hydraulic cylinder seals and connections accessed from within the casting pit; platform partially raised during access; hydraulic pressure present in adjacent systems; confined and wet working environment	HIGH	Crush · Hydraulic · Confined Space	PSC Position & Reach Interfaces
Cooling water system maintenance	Spray rings, headers, and flow distribution components accessed at mould level; residual cooling water and aluminium scale create slip and chemical exposure; connection hardware tightened by hand in restricted access geometry	MEDIUM	Chemical · Pinch · Ergonomic	PSC Striking & Alignment · PSC Position & Reach Interfaces
Saw blade and guide replacement	Saw blade removal and installation requires hands within the blade guard area adjacent to the saw teeth; guide and fence adjustment performed with hands near the blade path; sharp aluminium swarf accumulated in saw housing	HIGH	Laceration · Pinch · Cut	PSC Striking & Alignment · PSC Position & Reach Interfaces
Casting breakthrough clean-up	Solidified aluminium from a casting breakthrough collected from pit floor, platform, and cooling water channels; material has sharp irregular edges; residual heat retained well after solidification; clean-up performed in confined pit environment	HIGH	Burns · Laceration · Confined Space	PSC Position & Reach · PSC Retrieval Interfaces

7 DC CASTING QUICK ASSESSMENT CHECKLIST

Use during a casting machine walkdown or pre-cast setup review. Answer based on observed practice, not the written procedure.

- ☐ During mould table crane descent above the open pit, is the mould table guided using a rated push/pull tool — not bare hands or a fabricated rod at the pit edge?
- ☐ Is an anti-tangle tagline used on every crane lift above the casting pit — mould table, dummy block carrier, and cast product bundle?
- ☐ During casting start-up, is a minimum stand-off distance from the mould level defined and enforced — not left to individual worker judgement during the highest-risk period of the cast?
- ☐ During cast product extraction from the pit, is there a defined pit edge exclusion zone that workers must not enter until the bundle has cleared the pit walls?
- ☐ During crane travel of the cast bundle from pit to saw station, is swing control maintained using a rated tagline — not by hand contact on the bundle body?
- ☐ After sawing, are workers handling sawn aluminium ends using a tool interface rather than bare hand contact with the cut face?
- ☐ During dummy block seating confirmation, are hands entering the mould from above — and if so, is the dummy block fully at rest and energy released before hands approach?
- ☐ During casting breakthrough clean-up, is a rated retrieval and clearance tool available in the pit — not improvised tools or bare hand approach to solidified material in the confined pit environment?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — DC CASTING

Representative PSC interfaces for the scenarios in this chapter, organised by engineering function. Contact PSC for guidance on casting machine geometry, pit dimensions, and bundle weight before final product selection.

LOAD CONTROL INTERFACES — CRANE LIFT, SWING & BUNDLE CONTROL

INTERFACE	PRIMARY DC CASTING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for mould table during crane descent above open pit. Swing control for cast bundle during extraction from pit and crane travel to saw. Swing control for dummy block carrier during repositioning. Replaces plain rope taglines at every casting crane lift point.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · 3
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching and retrieving taglines to mould table, bundle carrier, and crane rigging at height above the casting pit without climbing or placing hands on the suspended load during rigging setup. Extends 6–12 ft.	6–12 ft	PSC-TRT-3P	1 · 3

POSITION & REACH INTERFACES — MOULD TABLE, BUNDLE & PRODUCT GUIDANCE

INTERFACE	PRIMARY DC CASTING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Mould table lateral guidance during crane descent above open pit. Cast bundle lateral guidance during crane travel from pit to saw. Sawed product positioning on transfer system without bare hand contact with cut ends.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 3 · 4
POSITION & REACH PSC Load-It® MagHead Push/Pull (Fixed)	Magnetic attachment to ferrous components in the casting machine frame during mould table setup. Positioning of ferrous saw guides, fences, and adjustment components during saw maintenance. 550 lb holding capacity.	2 ft, 3 ft, 4 ft	PSC-LIT-MG002 PSC-LIT-MG003 PSC-LIT-MG004	1 · 4 · Maint.
POSITION & REACH PSC Long-Reach Pickup Tool	Retrieving small components dropped into the casting pit during setup or maintenance. Recovering dummy block pins, hardware, and small tools from the pit floor without requiring worker entry into the pit for retrieval. Precision jaw grip at 6 ft reach.	6 ft	PSC-ST	Maint.

STRIKING & ALIGNMENT INTERFACES — CASTING MACHINE MAINTENANCE

INTERFACE	PRIMARY DC CASTING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding pins, drifts, and chisels during dummy block hardware removal and installation in confined pit geometry. Saw blade retaining bolt driving during saw maintenance. Removes the holding hand from the hammer strike zone during all impact operations in the casting machine.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.

SPECIALISED MAINTENANCE INTERFACES

INTERFACE	PRIMARY DC CASTING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
SPECIALISED PSC GasGrab® Cylinder Lifter	Lifting and moving gas cylinders used for casting machine cleaning and maintenance in the cast house area. Eliminates valve-grip and body-grip handling in an environment with active crane operations and open pit hazards in proximity.	215 mm, 230 mm, 254 mm	PSC-GG-215 PSC-GG-230 PSC-GG-254	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Four observations about DC casting hand exposure

DC casting is distinguished from other aluminium plant departments by the coexistence of an open pit, a suspended load above it, and liquid metal approaching from the furnace — all at the same location during setup and start-up. The principles below address the engineering response to that compound hazard geometry.

PRINCIPLE 01

The casting pit creates a third hazard direction that does not exist elsewhere in the plant: the exposure is above (suspended load), in front (liquid metal), and below (open pit) simultaneously.

Most industrial hand exposure scenarios involve hazard from one or two directions. The casting pit setup and start-up sequence involves hazard from three directions simultaneously. Engineering controls that address only one — typically the suspended load — leave the worker exposed from the other two. The stand-off distance that protects against the suspended load must also provide separation from the pit edge, and must be achieved from a position that is outside the liquid metal splash zone.

PRINCIPLE 02

Casting start-up is the highest-consequence hand and body exposure point in DC casting — and the one most likely to be approached at minimum stand-off because it requires visual confirmation of what is happening inside the mould.

The instinct to lean closer to confirm that casting has started correctly is entirely rational. Something critical is happening and the worker needs to see it. The engineering response is not to tell workers to stand further back — it is to design the observation method so that adequate confirmation can be achieved at a safe distance. Defined stand-off markers and remote observation protocols address this without asking workers to accept reduced situational awareness.

PRINCIPLE 03

Sawn aluminium edges are sharp by design — sharpness is a consequence of the sawing process, not a variable. Engineering controls for sawn product handling should treat sharp edges as a permanent feature, not as a defect to be managed by PPE alone.

Gloves reduce laceration severity from sawn aluminium edges but do not prevent the contact that causes them. A tool interface that maintains stand-off from the sawn face eliminates the contact. Since every sawn piece has a sharp end and every handling event brings a worker into contact with that end, the cumulative laceration exposure from sawn product handling across a production year is substantial — and substantially preventable.

PRINCIPLE 04

Casting breakthrough clean-up generates some of the most difficult working conditions in the cast house — confined space, hot material, sharp edges, urgency — and is typically performed with the least preparation.

A casting breakthrough is an unplanned event, and the clean-up that follows is therefore also unplanned. Workers enter the pit with whatever tools are available, under pressure to restore casting capability quickly. A defined breakthrough response kit — including rated retrieval tools, clearance interfaces, and protective equipment appropriate for the confined pit environment — converts an improvised emergency response into a managed procedure.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

If any hand exposure scenario in this chapter reflects tasks observed in your plant, PSC Hand Safety India can provide engineering guidance on representative interfaces. Casting machine geometry, pit dimensions, mould table configuration, and cast product bundle weight all affect the appropriate interface selection.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — mould setup, start-up monitoring, bundle extraction, sawn product handling	Recommended interface and size for the specific DC casting task
Casting machine type and pit depth	Indicative unit price (budgetary, not binding)
Cast bundle weight and crane type in use	Delivery lead time from Visakhapatnam
Current field method used at each identified exposure point	Application notes for pit environment and confined access conditions
Whether components are ferrous (magnetic interface applicable)	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Reference to comparable applications at similar DC casting installations

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1 DEPARTMENT OVERVIEW

Scalping is the first mechanical processing step after DC casting. The cast ingot or slab surface — which contains segregation, oxides, and casting defects — is milled away on all faces to expose clean aluminium metal before hot rolling. Scalping machines are large, purpose-built milling machines that remove 3–12 mm from each face of the ingot as it passes through on a roller table. The two dominant hand exposure events in the scalper area — ingot guidance on the roller table and swarf clearance from the milling bed — were directly observed at a Hindalco flat-rolled products plant and are documented in this chapter from those field observations.

The scalper operates continuously during production. Ingots typically weigh 3–20 tonnes and are fed to the scalper on a roller table from the ingot storage bay or directly from the homogenisation furnace. As each ingot approaches the scalper, it must be aligned with the milling head centreline — a positioning task that requires workers to interact with the ingot on the moving roller table. After each pass, the milled face is covered with aluminium swarf — fine, sharp, curled metal chips at elevated temperature — that must be cleared before the ingot is flipped for the next face pass. Swarf clearance is performed at close range to the roller table surface and the milling head. The ingot is typically flipped between face passes using a turnover crane or tilting roller table. During the flip, the ingot must be guided laterally to maintain centreline position. After scalping is complete on all faces, the ingot is transferred to the hot rolling mill preheating furnace. At each of these transfer points — roller table approach, milling pass, swarf clearance, flip, and transfer — workers interact manually with the ingot or the roller table surface in the absence of purpose-designed interfaces.

2 MAJOR EQUIPMENT & LOCATIONS

SCALPER / INGOT MILLING MACHINE A large purpose-built milling machine that removes the surface layer from each face of the DC cast ingot. The milling head rotates at high speed and is fed toward the ingot face by a hydraulic clamping mechanism. The scalped face is flat, bright, and free of surface defects. Workers interact with the ingot on the infeed and outfeed roller tables on both sides of the scalper.	ROLLER TABLE Driven rollers that carry the ingot to and from the scalper. Roller tables present nip point hazards at every roller gap. Ingots on the moving roller table must be guided laterally by workers if they drift from the centreline — the combination of a 3–20-tonne moving load and powered nip points creates the primary hand exposure in the scalper area.
INGOT TURNOVER CRANE / TILTING TABLE Used to flip the ingot between scalper passes to present each face to the milling head. Turnover cranes lift and rotate the ingot; tilting tables tip it mechanically. During the flip sequence, workers guide the ingot laterally and confirm correct landing on the roller table — often using improvised tools or direct contact with the ingot body.	SWARF COLLECTION SYSTEM Aluminium swarf — fine, sharp, curled chips at milling temperature — falls from the scalper head during each pass and accumulates on the roller table and milling bed floor. Swarf must be cleared between passes to prevent ingot surface contamination and roller table blockage. Workers use rakes and shovels to clear swarf, typically at close range to the roller table nip zone.
INGOT STORAGE BAY Cast ingots waiting for scalping are stored in the ingot bay and moved to the roller table infeed by crane or transfer vehicle. Workers guide the crane-suspended ingot during landing on the roller table — a suspended load operation immediately adjacent to the powered roller table nip zone.	OUTFEED TRANSFER TO HOT MILL After scalping, the ingot is transferred to the hot rolling mill preheating furnace by crane or transfer table. Workers guide the crane-suspended ingot during this transfer. The ingot surface temperature after scalping is significantly elevated, adding a thermal exposure to the suspended load hazard during the transfer sequence.

3 SCALPER OPERATION CYCLE — TASK FLOW & EXPOSURE POINTS**SCALPER OPERATION CYCLE****INGOT CRANE LANDING ON ROLLER TABLE**

Ingot lowered from crane onto infeed roller table

SUSPENDED LOAD · CRUSH · NIP POINT PROXIMITY

INGOT ALIGNMENT ON ROLLER TABLE

Ingot guided laterally to scalper centreline

CAUGHT-BETWEEN · CRUSH · STRUCK-BY

SCALPER MILLING PASS

Ingot feeds through milling head · face material removed

LACERATION · EJECTED SWARF · ENTANGLEMENT

SWARF CLEARANCE FROM ROLLER TABLE

Aluminium milling swarf cleared between passes

LACERATION · NIP POINT · BURNS FROM HOT SWARF

INGOT FLIP — NEXT FACE PRESENTED

Ingot turned over · repositioned on roller table

SUSPENDED LOAD · CRUSH · CAUGHT-BETWEEN

TRANSFER TO HOT ROLLING MILL

Scalped ingot transferred to hot mill preheat furnace

SUSPENDED LOAD · BURNS · STRUCK-BY

HOT ROLLING MILL → Chapter 09

ROLLER TABLE NIP POINTS PRESENT AT EVERY STAGE

4 CURRENT FIELD INTERFACES OBSERVED

The interfaces below were directly observed at a Hindalco flat-rolled products plant during a site visit in March 2026. They represent the working field reality in a well-run, ISO 45001-aligned operation — not a poorly managed facility. The engineering gap is structural: no purpose-designed hand-free guiding or positioning tools were deployed in any area assessed during the visit.

CURRENT INTERFACE	ENGINEERING LIMITATION
Improvised bent steel rod — ingot guidance on roller table	A custom-fabricated bent steel rod approximately 1.5 m long was observed being used to guide and manipulate aluminium ingots on the scalper roller table. While the length provides some stand-off, the tool has no engineered grip, no load-catch head, and no guard. Worker hands remain within the pinch and crush zone of the roller table nip points throughout the guidance operation. The rod can slip under lateral load, causing the worker to lunge toward the ingot and the nip zone.
Improvised flat scraper — swarf clearance	An unguarded improvised scraper — a bare metal plate welded to a short rod — was observed being used to clear aluminium milling swarf and surface debris from the roller table and scalper bed. The short handle length places the worker's hands dangerously close to the moving roller table surface. The scraper edge is unfinished and sharp. No ergonomic grip is present, meaning sudden slip directs the hand toward the nip zone.
Bare hands and improvised rod — ingot crane landing guidance	Workers were observed guiding crane-suspended ingots during landing on the roller table infeed using bare hands or the same improvised bent rod. The crane-suspended ingot above and the powered roller table below create simultaneous hazard from two directions. The improvised rod provides no rated load-catch capability and gives no protection against ingot swing during crane descent.
Direct hand approach — ingot face inspection after scalping	After each scalping pass, workers approach the freshly milled ingot face to inspect the surface quality. The milled surface is at elevated temperature and has sharp edge transitions at the ingot corners. Close visual inspection of the face is performed with the roller table still capable of motion and the next ingot in queue on the infeed section.

ENGINEERING OBJECTIVE — SCALPER & INGOT MILLING

Provide purpose-designed interfaces for ingot guidance on the roller table and swarf clearance from the milling bed that maintain defined stand-off from the roller table nip zone and the scalper milling head throughout the full scalping cycle — replacing improvised tools observed in current practice.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Ingot Guidance on Roller Table — Lateral Alignment to Scalper Centreline	
CAUGHT-BETWEEN · CRUSH · NIP POINT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
As the ingot travels on the roller table toward the scalper, it must be aligned with the milling head centreline. If the ingot drifts laterally, it will enter the scalper off-centre, producing an uneven cut or jamming the machine. Workers correct the ingot position by applying lateral force using whatever tool is available — in most operations, an improvised bent rod or bare-hand push against the ingot face.		Improvised bent steel rod approximately 1.5 m long, used to push the ingot laterally on the moving roller table. No engineered grip, no load-catch head, no guard. At a Hindalco flat-rolled products plant, this was the only guiding interface observed in use. The rod tip contacts the ingot face while the rod end is held by the worker adjacent to the roller table nip zone.		Caught-between the ingot and the roller table side guide if the ingot shifts unexpectedly during the push. Crush between the ingot and adjacent equipment if the roller table drive moves the ingot while the worker's hands are in contact. Nip point injury if the improvised rod slips and the worker's hand contacts the roller table surface. Struck-by the ingot face if it bounces laterally.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Apply lateral force to the ingot on the roller table to correct its centreline alignment without placing the worker's hands within the nip zone of the roller table or within the crush zone between the ingot and the side guides — using a tool with a defined grip position at rated stand-off from the nip point.			purpose-designed ingot-guidance head on Load-It pole (custom — contact PSC for geometry) — engineered wide-V head designed for ingot face geometry, providing lateral contact point at 4–6 ft stand-off from the worker's grip position. Replaces the improvised bent rod observed in field practice with a rated, ergonomic, purpose-designed interface.		
"When the ingot drifts from centreline on the roller table, what does the operator reach for — and does that tool keep their grip hand outside the roller table nip zone throughout the lateral correction stroke?"					

HIGH Swarf Clearance from Roller Table and Scalper Bed LACERATION · NIP POINT · BURNS — HOT SWARF			
WHY THE HAND IS THERE Aluminium milling swarf — fine, sharp, curled metal chips at milling temperature — accumulates on the roller table surface and scalper bed after each pass. It must be cleared between passes to prevent ingot surface contamination and to maintain roller table function. Workers clear swarf using a scraper or rake, working at close range to the roller table surface with the drive system either running or capable of being restarted.		CURRENT FIELD INTERFACE Improvised flat scraper — a bare metal plate welded to a short rod — observed in use at a Hindalco flat-rolled products facility. Short handle length places the worker's hand dangerously close to the roller table surface. The scraper edge is unfinished, presenting laceration risk if the hand slides toward the working end. No ergonomic grip is present to prevent fatigue-induced tool slip during the clearance stroke.	
		EXPOSURE TYPE Laceration from contact with aluminium swarf — sharp, curled, and at milling temperature. Nip point injury if the scraper slips and the hand contacts the roller table surface during the clearance stroke. Burns from hot swarf contact with bare hands or wrists during collection and disposal. Laceration from the unfinished scraper edge if the tool is gripped incorrectly during high-force clearing strokes.	
ENGINEERING OBJECTIVE Clear aluminium milling swarf from the roller table surface and scalper bed without placing the worker's hands within the laceration zone of the swarf accumulation or within the nip zone of the roller table — using a purpose-designed scraper with defined grip position, engineered working edge, and adequate stand-off from the roller table surface.		REPRESENTATIVE INTERFACE PSC Load-It® Scraper Head (custom configuration, 1–12 ft) — purpose-built scraper face on a Load-It pole, ergonomic D-handle, stand-off length keeping grip hand clear of the roller table surface throughout the clearance stroke. Replaces the improvised scraper observed in current field practice with a rated, controlled-edge interface.	
"During swarf clearance between scalper passes, how close is the worker's grip hand to the roller table surface — and is the tool being used purpose-designed for that task or improvised from available materials?"			

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH	Ingot Crane Landing — Guidance Onto Infeed Roller Table		
	SUSPENDED LOAD · CRUSH · NIP POINT PROXIMITY		
	WHY THE HAND IS THERE Ingots arriving from the homogenisation furnace or ingot bay are crane-suspended and must be lowered onto the infeed roller table. The landing position must be correct — centred on the roller table width and at the correct infeed position for the scalper. Workers guide the ingot during crane descent to achieve correct landing position and prevent the ingot from contacting the roller table side guides during descent.	CURRENT FIELD INTERFACE Improvised bent rod or bare hands used to guide the crane-suspended ingot during descent onto the infeed roller table. The ingot weight (3–20 tonnes) means any swing during crane movement carries significant momentum. The roller table below has active nip points at every roller gap. Workers stand adjacent to the roller table during ingot landing — simultaneously in the load swing zone and adjacent to the nip zone.	EXPOSURE TYPE Crush between the descending ingot and the roller table side guides during landing. Struck-by if the ingot swings during crane descent — ingot momentum at 3–20 tonnes is substantial even at low crane speeds. Nip point injury if the worker's hand contacts the roller table during repositioning after ingot landing. Foot crush if the ingot lands off-centre and slides laterally off the roller table.
	ENGINEERING OBJECTIVE Guide the crane-suspended ingot to its correct landing position on the infeed roller table without placing workers between the ingot and the roller table side guides, and without bare-hand contact on the ingot body during suspension — from crane descent initiation to ingot seated and stationary on the roller table.	REPRESENTATIVE INTERFACE Anti-Tangle Tagline for ingot swing control during crane travel from ingot bay to roller table. Representative push/pull interface (4–6 ft, custom ingot-guidance head (contact PSC for geometry specification) or S-Head) for lateral ingot guidance during final crane descent to the roller table infeed position. Worker positioned outside the ingot swing arc during descent.	
	<i>"When the ingot is lowered onto the infeed roller table, where is the guidance worker positioned relative to the roller table nip zone — and is the stand-off maintained using a rated tool or by relying on the worker's judgement of safe distance?"</i>		

MEDIUM	Post-Scalp Surface Inspection — Freshly Milled Face Approach		
	LACERATION · BURNS — HOT SURFACE · NIP POINT		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	After each scalper pass, the milled surface must be visually inspected to confirm that the required depth of cut has been achieved and that no surface defects remain. Workers approach the freshly milled face to inspect it — either visually at close range or by hand contact with the surface to check for remaining scale or oxide inclusions. The inspection is performed on the roller table with the ingot stationary.	Close visual approach to the freshly milled face — workers lean over the ingot on the roller table to inspect the surface. In some operations, the surface is touched by hand to confirm that scale has been removed. The roller table drive may be in a state where inadvertent activation is possible. Swarf from the previous pass may still be present on the adjacent roller surfaces.	Laceration from contact with sharp edge transitions at ingot corners after scalping — these are extremely sharp on a freshly milled face. Burns from contact with the freshly milled surface which retains heat from the cutting operation. Nip point exposure if the worker reaches across the roller table toward the milled face with the roller table capable of motion.
	ENGINEERING OBJECTIVE	REPRESENTATIVE INTERFACE	
Inspect the freshly milled ingot surface without bare hand contact with the hot, sharp-edged surface and without leaning across the roller table into the nip zone — using visual inspection protocols and, where surface contact is required, a tool interface that maintains stand-off from the roller surface.	Visual inspection from a defined safe distance — no tool required for the inspection itself. Where surface contact for quality confirmation is part of current practice, a scraper or smooth-face contact tool at arm's reach provides the tactile feedback without bare hand entry onto the sharp-edged milled surface or into the roller table nip zone.		
"After a scalper pass, does the quality inspection protocol require bare hand contact with the freshly milled ingot face — and if so, has the laceration risk from sharp edge transitions on a freshly milled face been assessed?"			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Scalper maintenance involves working on a large milling machine with high-speed rotating tooling, hydraulic clamping systems, and the roller table drive mechanism. Most maintenance requires the machine to be isolated and locked out, but residual risks from sharp tooling, heavy components, and confined access remain throughout the maintenance window.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Milling cutter replacement and indexing	Individual milling inserts or cutter blocks accessed by hand in the scalper head; sharp cutting edges on all cutter components; head must be manually rotated to access each insert position; heavy cutter block weights	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Roller table roller replacement	Individual rollers lifted from table frame by crane or chain hoist; connection hardware removed and refitted by hand in confined roller table geometry; rollers at elevated temperature from production	HIGH	Crush · Burns · Pinch	PSC Position & Reach · PSC Manual Lifting Interfaces
Scalper hydraulic clamp maintenance	Hydraulic cylinder seals and connections accessed from underneath the scalper bed; confined access; hydraulic pressure present in adjacent circuits; heavy clamp components require manual support during maintenance	HIGH	Crush · Hydraulic · Confined Space	PSC Position & Reach Interfaces
Swarf collection system clearance	Accumulated swarf cleared from under the scalper bed and from conveyors by hand using shovels and rakes; swarf is hot, sharp, and compacted; working under the scalper in a restricted space	HIGH	Laceration · Burns · Confined Space	PSC Position & Reach · PSC Retrieval Interfaces
Ingot guide rail and fence adjustment	Side guide rails and fences adjusted by hand during setup for a new ingot size; adjustment hardware tightened in confined roller table geometry adjacent to nip points; guides are heavy fabricated steel components	MEDIUM	Pinch · Crush · Ergonomic	PSC Striking & Alignment · PSC Position & Reach Interfaces

7 SCALPER QUICK ASSESSMENT CHECKLIST

Use during a scalper area walkdown. Answer based on what tools are actually in use — not what is written in the procedure or available in the tool store.

- ☐ When the ingot drifts from centreline on the roller table, what does the operator reach for — a purpose-designed ingot guidance tool or an improvised rod, shovel, or bare hands?
- ☐ During ingot guidance on the roller table, is the worker's grip hand kept outside the roller table nip zone throughout the lateral correction stroke?
- ☐ Is the swarf clearance tool used between scalper passes a purpose-designed scraper with an ergonomic grip — not a fabricated plate on a short rod or a bare shovel?
- ☐ During swarf clearance, is the worker's hand kept outside the roller table nip zone throughout the clearance stroke?
- ☐ When the ingot is lowered onto the infeed roller table by crane, is an anti-tangle tagline used for swing control during crane travel?
- ☐ During ingot crane landing on the roller table, is the guidance worker's hand position outside the crush zone between the ingot and the roller table side guides?
- ☐ Does the post-scalp surface inspection protocol require bare hand contact with the freshly milled face — and if so, has the laceration risk from sharp edge transitions been assessed?
- ☐ During milling cutter replacement, are sharp insert components handled using a tool — not bare hands — during removal, rotation, and refitting of cutter blocks in the scalper head?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — SCALPER & INGOT MILLING

Representative PSC interfaces for the scenarios in this chapter, informed by direct field observations at a Hindalco flat-rolled products plant. Contact PSC for guidance on ingot size, roller table geometry, and scalper machine configuration.

POSITION & REACH INTERFACES — INGOT GUIDANCE & ROLLER TABLE STAND-OFF

INTERFACE	PRIMARY SCALPER APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® custom ingot-guidance head (contact PSC for geometry specification) (Custom)	Lateral ingot guidance on the roller table — engineered wide-V head designed for aluminium ingot face geometry. Guides billets and ingots along the roller table from 4–6 ft stand-off, keeping the grip hand outside the nip zone. Heat-treated steel head for durability at milling machine temperatures. Directly addresses the improvised bent rod observed in field practice.	4 ft, 6 ft, 8 ft	Custom — contact PSC	1 · 3
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Ingot lateral guidance during crane landing on infeed roller table. Ingot positioning between scalper passes. General push/pull interface at roller table and scalper area where ingot face geometry does not require the Wide-V head profile.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 3

APPLICATION-SPECIFIC INTERFACES — SWARF CLEARANCE & MILLING BED

INTERFACE	PRIMARY SCALPER APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
APPLICATION-SPECIFIC PSC Load-It® Scraper Head (Custom)	Aluminium milling swarf clearance from roller table surface and scalper bed between passes. Purpose-built scraper face on Load-It pole — heat-treated steel, ergonomic D-handle, stand-off keeping grip hand clear of roller table surface. Directly addresses the improvised short-rod scraper observed in field practice at Hindalco.	3 ft, 4 ft, 6 ft	Custom — contact PSC	2 · Maint.

LOAD CONTROL INTERFACES — INGOT CRANE SWING & TRAVEL CONTROL

INTERFACE	PRIMARY SCALPER APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for crane-suspended ingots during travel from ingot bay to roller table infeed. Swing control during ingot flip crane operations between scalper passes. Replaces plain rope taglines in the scalper area — no tangle points adjacent to the roller table nip zone.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	3

STRIKING & ALIGNMENT INTERFACES — SCALPER MAINTENANCE

INTERFACE	PRIMARY SCALPER APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts, pins, and chisels during milling cutter insert removal, roller table hardware driving, and ingot guide rail adjustment. Removes the holding hand from the hammer strike zone during all impact operations in the scalper maintenance area.	250 mm, 350 mm, 850 mm	PSC-FS-250 PSC-FS-350 PSC-FS-850	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Three observations about the scalper as an engineering gap

The scalper area was assessed at a Hindalco flat-rolled products plant operating under an ISO 45001 EHS system with active permit-to-work and mandatory PPE. No purpose-designed hand-free guiding or positioning tools were deployed in any area assessed during that visit. The principles below reflect what was observed.

PRINCIPLE 01

The improvised tool is not evidence of poor safety culture — it is evidence of an engineering gap. When a purpose-designed tool does not exist for a task, workers create one.

The bent rod and the welded scraper plate observed at a well-managed Hindalco facility were not acts of recklessness. They were rational responses to a genuine task requirement in the absence of a designed solution. The worker who fabricated the bent rod was trying to keep their hand away from the ingot and the roller table. The engineering response is not to prohibit the improvised tool — it is to replace it with one that actually achieves the engineering objective it was attempting to approximate.

PRINCIPLE 02

Roller table nip points are present at every stage of the scalper cycle. Stand-off from the roller surface is the single engineering variable that addresses multiple simultaneous exposure types.

During ingot guidance, swarf clearance, crane landing, and post-scalp inspection, the roller table nip zone is present throughout. A tool that positions the worker's grip hand outside the nip zone during one task also reduces exposure during all others. This compounding benefit — the same interface working across multiple scenarios — justifies investment in a single well-designed tool rather than multiple purpose-built ones.

PRINCIPLE 03

Freshly milled aluminium edges are among the sharpest surfaces in any manufacturing environment. They should be treated as a permanent feature of the scalper output, not as an incidental hazard.

Every ingot that exits the scalper has four freshly milled faces with razor-sharp edge transitions at every corner. These edges do not blunt quickly. Every subsequent handling operation — flip, transfer, inspection, loading onto the hot mill — brings workers into proximity with those edges. An engineering control strategy for the scalper must address not only the roller table nip zone during milling but also the sharp-edged product that results from it.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

PSC Hand Safety India has conducted direct field assessments at aluminium flat-rolled products facilities and can provide engineering guidance on scalper-specific interfaces based on ingot size, roller table geometry, and scalper machine configuration.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — ingot guidance, swarf clearance, crane landing, surface inspection	Recommended interface and head configuration for the specific scalper task
Ingot or slab dimensions and weight range	Custom head geometry options for specific ingot profiles
Roller table width and drive type	Indicative unit price (budgetary, not binding)
Current tool or method in use at each exposure point	Delivery lead time from Visakhapatnam
Required stand-off from roller table surface or ingot face	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Reference to comparable assessments at similar flat-rolled facilities

Application validation: sales@pschandsafety.com · +91 96031 66448 · pschandsfree.com

1 DEPARTMENT OVERVIEW

The hot rolling mill receives scalped aluminium ingots and reduces them from cast thickness — typically 400–600 mm — to intermediate gauge in a series of passes through work rolls rotating at high speed. Each pass reduces the thickness by 15–40%, generating a strip that grows progressively longer and thinner with each pass until it reaches the target hot-band gauge of 3–10 mm. Workers interact with the strip at threading, crop shear approach, coil transfer, and edge trim points. In a field observation at a Hindalco rolling facility, workers were seen with hands directly on or near the aluminium strip at an active mill nip roll — one of the highest-consequence hand exposure events in any rolling operation.

Hot rolling mills operate at strip temperatures of 350–500°C. The strip surface cools rapidly through the mill but remains at significantly elevated temperature at the exit side and during early coiling passes. The strip is under tension and travels at increasing speed with each pass — early passes may be 1–3 m/s, while finishing passes at thin gauge can reach 10–15 m/s. Workers interact with the strip during threading (the first pass through the mill before tension is established), crop shear trimming of the leading and trailing end, coil mandrel threading, and during any strip tracking adjustments required as the pass proceeds.

The nip point hazard at the hot rolling mill is categorically different from the nip hazards discussed in the scalper chapter. Rolling mill nip rolls are powered to very high forces, rotate at high speed, and pull material in with significant grip. Contact between a hand and a rolling mill nip in motion does not allow recovery time. The injury consequence of nip contact at a hot rolling mill is among the most severe in the aluminium industry. Engineering controls that maintain absolute stand-off from the nip zone during every manual interaction with the strip are the only adequate response.

2 MAJOR EQUIPMENT & LOCATIONS

ROLLING MILL STAND (WORK ROLLS)

The primary reduction unit — two or four work rolls in a housing, driven to apply compressive force to the strip as it passes through the roll gap. The nip point at the roll bite is the highest-consequence hand exposure location in the hot rolling mill. Workers must never approach the roll bite area while the mill is running. Interaction occurs at the entry table and exit table on either side of the mill stand.

ENTRY TABLE & STRIP THREADING SYSTEM

The entry table guides the ingot or thick strip into the mill stand for the first pass. Threading — inserting the leading edge of the strip into the roll gap — requires close worker approach to the entry side of the nip zone. On mills without automatic threading systems, workers guide the strip leading edge manually during the first pass through the roll gap.

CROP SHEAR

A guillotine or rotary shear cuts the leading and trailing ends of the hot strip to remove irregular crop ends before finishing. Workers approach the shear for strip positioning and crop removal. The shear blade and the strip under tension create simultaneous laceration and entanglement hazards at the crop shear approach zone.

COILER & MANDREL

After reaching target hot-band gauge, the strip is coiled on a mandrel for transfer to the cold rolling mill or annealing furnace. Threading the leading strip end onto the coiler mandrel requires worker approach to the coiler entry at strip speed. Coil transfer from the coiler involves crane handling of coils weighing 3–15 tonnes.

EDGE TRIMMER / SLITTER

Some hot rolling lines include an edge trimmer that removes irregular strip edges between passes. The edge trimmer presents nip point, laceration, and ejected trim scrap hazards. Trim scrap accumulates in the trimmer area and must be cleared manually, bringing workers into proximity with sharp aluminium strip edges.

COIL BAY & TRANSFER CRANE

Hot-rolled coils are transferred from the coiler to storage or to the cold rolling mill entry by overhead crane. Coil weights of 3–15 tonnes and elevated coil temperatures after hot rolling create a combined suspended load and thermal exposure during all coil bay crane operations. Workers guide coils during crane transfer and during coil car positioning.

3 HOT ROLLING CYCLE — TASK FLOW & EXPOSURE POINTS**HOT ROLLING MILL CYCLE****INGOT LOAD & ENTRY TABLE APPROACH**

Preheated ingot loaded onto entry table roller system

SUSPENDED LOAD · BURNS · NIP POINT PROXIMITY

STRIP THREADING — FIRST PASS

Strip leading edge guided into roll gap for first reduction pass

NIP POINT · ENTANGLEMENT · BURNS

REVERSING MILL PASSES

Strip reduced pass by pass · strip grows longer and thinner

NIP POINT · STRIP TRACKING · LACERATION

CROP SHEAR — LEADING & TRAILING END TRIM

Irregular crop ends cut before finishing passes

LACERATION · EJECTED CROP · LINE OF FIRE

COILER THREADING & COIL BUILDUP

Strip leading end threaded onto coiler mandrel

ENTANGLEMENT · NIP POINT · LACERATION

HOT COIL TRANSFER TO COIL BAY

Coil removed from mandrel · transferred by crane to coil bay

SUSPENDED LOAD · BURNS · STRUCK-BY

COLD ROLLING MILL → Chapter 11

NIP CONTACT AT HOT MILL SPEED HAS NO RECOVERY TIME

4 CURRENT FIELD INTERFACES OBSERVED

The most critical observation from the Hindalco flat-rolled products facility was at the hot rolling mill: a worker was seen leaning forward with hands directly on or near the aluminium strip as it fed through active nip rolls, apparently guiding or checking strip alignment with the mill running and the strip under tension. This is one of the highest-severity hand exposure events in any rolling operation.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands on strip near active nip rolls	A worker was directly observed with hands on or adjacent to an aluminium strip feeding through active rolling mill nip rolls, apparently checking or guiding strip alignment while the mill was running and the strip was under tension. Nip roll contact at operating speed is catastrophic — degloving or amputation occurs faster than any reflexive withdrawal. This is the single highest-severity hand exposure event documented in this guide.
Improvised long rod — strip threading guidance	Workers use long rods or paddles to guide the strip leading edge into the roll gap during threading. On mills without automated threading systems, this brings the worker into close proximity with the entry nip zone during the period of highest threading uncertainty — the first contact between the strip and the rolls, when cobbles are most likely to occur.
Bare hands — crop trim piece handling at shear	After the crop shear cuts the leading or trailing end, the severed crop piece must be removed from the shear table. Workers handle the freshly sheared crop with bare hands or heavy gloves. Sheared aluminium edges are extremely sharp. The strip under tension and the shear blade proximity create simultaneous laceration hazards from two directions during crop removal.
Bare hands on coils — coil bay guidance during crane transfer	Hot-rolled coils transferred by crane in the coil bay are guided to their storage or transfer position by workers using bare hands or improvised rods. Coil temperatures after hot rolling remain elevated. Sharp strip edges on the coil outer wrap present laceration risk. Coil weights of 3–15 tonnes mean any swing during crane travel carries significant momentum.

ENGINEERING OBJECTIVE — HOT ROLLING MILL

Eliminate all direct hand contact with the strip at or near the mill nip zone during threading, strip tracking, and coiler approach.
Provide purpose-designed interfaces for crop shear trim handling and coil bay crane guidance that maintain defined stand-off from the nip zone, the shear blade, and the moving coil body throughout the hot rolling cycle.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Strip Alignment Check Near Active Mill Nip Rolls		
	NIP POINT · ENTANGLEMENT · CATASTROPHIC INJURY		
	WHY THE HAND IS THERE When the strip tracks off-centre during a rolling pass, the worker's instinct is to reach for the strip to guide it back to the correct position. The strip is moving, the rolls are turning, and the misalignment is visible. The apparent solution — push the strip laterally — is the same action that would be taken safely in a non-hazardous handling context. The nip roll makes it catastrophic. This exact behaviour was observed at a Hindalco rolling facility with the mill running.	CURRENT FIELD INTERFACE Bare hands placed on or adjacent to the aluminium strip to guide alignment while the mill is running and the nip rolls are in motion. Observed directly at a Hindalco flat-rolled products facility. The strip was under tension, the rolls were turning at operating speed, and the worker's hands were within the nip entry zone. No stand-off tool was in use at the moment of observation.	EXPOSURE TYPE Nip roll contact at operating speed — degloving or traumatic amputation with no recovery time. The rolling mill nip is the highest-consequence hand exposure in aluminium processing. There is no partial injury from nip contact at mill speed. The entire hand, wrist, or forearm is drawn through the roll gap before any reflexive response is possible.
	ENGINEERING OBJECTIVE Strip alignment corrections during a rolling pass must be performed using a tool that maintains absolute stand-off from the nip entry zone — or the pass must be stopped and the mill reversed before any manual intervention at the strip surface is permitted. No direct hand contact with the strip while nip rolls are in motion is acceptable under any operational circumstances.	REPRESENTATIVE INTERFACE PSC Load-It with M-Head (12-inch reach) for strip lateral guidance at stand-off during low-speed threading and alignment. For any alignment correction during a running pass, the defined procedure must require mill stop before manual strip contact — no tool provides sufficient protection for hand-to-strip contact while the nip rolls are in motion at operating speed.	
	"During a rolling pass, if the strip tracks off-centre, what is the operator's trained response — and does that response require the mill to stop before any manual contact with the strip is permitted?"		

HIGH	Strip Threading — Leading Edge Guidance Into Roll Gap		
	NIP POINT · BURNS — HOT STRIP · ENTANGLEMENT		
	WHY THE HAND IS THERE Threading the strip leading edge into the roll gap for the first pass requires guiding the strip nose into the entry zone of the mill at low speed. On mills without automated threading systems, workers use long paddles or rods to guide the strip leading edge from the entry table into the roll gap — working within the nip entry zone at the moment the rolls first contact the strip.	CURRENT FIELD INTERFACE Long rod or paddle used to guide the strip leading edge toward the roll gap during threading at low mill speed. Worker is positioned at the entry side of the mill, adjacent to the nip entry zone, during the threading sequence. The first contact between the strip and the rolls — the threading moment — is when cobbles and strip jump are most likely and when the worker is closest to the nip.	EXPOSURE TYPE Nip point injury if the strip jumps or cobbles during threading and the rod or the worker's hand is pulled into the roll gap. Burns from contact with the strip surface at hot rolling temperature. Entanglement of the guiding tool in the roll gap if the strip catches the tool during the threading sequence and draws it — and the worker's hands — toward the nip.
	ENGINEERING OBJECTIVE Guide the strip leading edge into the roll gap during threading while maintaining the worker's hands outside the nip entry zone and outside the strip temperature contact zone — using a tool that cannot be drawn into the roll gap if the strip catches it during the threading sequence.	REPRESENTATIVE INTERFACE PSC Load-It with M-Head (12-inch) for strip leading edge guidance during low-speed threading — engineered head geometry provides lateral guidance without entering the nip zone. Tool length positions the grip hand outside the nip entry zone during the full threading sequence. Non-entanglement head design prevents the tool from being drawn into the roll gap if the strip catches it.	
<i>"During strip threading at low mill speed, where is the threading tool's working end relative to the roll gap entry — and can the tool be drawn into the roll gap if the strip catches it during the threading sequence?"</i>			

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Crop Shear — Trim Piece Removal After Shearing	
LACERATION · EJECTED MATERIAL · LINE OF FIRE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After the crop shear cuts the leading or trailing end of the hot strip, the severed crop piece must be cleared from the shear table before the next pass. Crop pieces range from a short irregular wedge to a full-width strip section. Workers approach the shear table to remove the crop piece while the strip remains live on the entry side and the shear mechanism is in a reset state.		Workers handle crop pieces with bare hands or heavy gloves. Freshly sheared aluminium strip ends have razor-sharp edges from the shear cut. At hot rolling temperature, the cut edge is additionally at risk of brief contact burns. The strip on the entry side of the shear remains under tension and at temperature. Crop pieces may be heavy — a full-width crop section at 6 mm gauge can weigh 20–50 kg.		Severe laceration from sheared aluminium edge — shear cuts produce extremely sharp edges with no burr. Burns from contact with the hot strip surface during crop removal. Struck-by if the crop piece springs or slides unexpectedly during removal. Ejected material if the shear cuts at a point where the strip is under tension and the crop is thrown forward.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Remove crop pieces from the shear table without bare hand contact with the sheared edges of the strip — using a tool that grips or controls the crop piece while maintaining the worker's hands outside the laceration zone of the sheared edge and outside the ejection zone of the shear.			PSC Load-It with S-Head or XT-Hook for controlled movement of crop pieces on the shear table — engineered grip or hook contact avoids direct hand contact with sheared edges. For heavy full-width crops, crane sling or magnetic lifter provides the primary removal interface. PSC Long-Reach Pickup Tool for retrieving small crop pieces that have moved off the shear table.		
"After the crop shear cuts, how is the crop piece removed from the shear table — and does the removal method require bare hand contact with the freshly sheared strip edge?"					

HIGH				Hot Coil Handling in Coil Bay — Crane Transfer Guidance	
SUSPENDED LOAD · BURNS — HOT COIL · LACERATION					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Hot-rolled coils removed from the coiler mandrel are transferred by overhead crane to coil bay storage or to the cold mill entry coil car. Workers guide the coil during crane travel and during the final landing sequence. At a Hindalco facility, workers were observed directly touching suspended coils during crane operations — including at least one instance where the worker's body was between the coil and the landing surface during the approach.		Bare hands or improvised rods used to guide hot coils during crane travel and landing. The outer wrap of a hot-rolled coil has a sharp leading edge from the coiler cut. Coil temperature after hot rolling remains elevated for several hours. Coil weights of 3–15 tonnes mean lateral momentum during crane travel is significant even at low travel speeds.		Laceration from contact with the sharp outer wrap leading edge during coil guidance. Burns from contact with the hot coil surface. Crush between the coil and fixed structure during crane landing. Struck-by if the coil swings during crane travel — direct observation at Hindalco showed a worker in contact with the suspended coil while the crane was in motion.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide hot coils during crane travel and landing in the coil bay without direct hand contact with the coil surface, the sharp outer wrap edge, or the crane rigging — using stand-off tools that keep workers outside the coil swing arc throughout the crane travel and landing sequence.			Anti-Tangle Tagline for coil swing control during crane travel. PSC Load-It MagHead Extendable (2–3 ft) where coil material is ferrous-compatible. Representative push/pull interface (S-Head, 4–6 ft) for lateral coil guidance during landing. No body contact with suspended coil at any point during crane travel or descent.		
"In the coil bay, at what point during a hot coil crane transfer does the guidance worker first make physical contact with the coil — and is that point before or after the coil has reached its final suspended position above the landing target?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Hot rolling mill maintenance involves working on large, high-force machinery with heavy rolls, high-pressure hydraulic systems, and strip threading paths that retain sharp aluminium residue from production. Roll changes — the most frequent planned maintenance activity — require crane handling of rolls weighing 5–30 tonnes each.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Work roll change	Work rolls (5–15 tonnes each) pulled from housing by crane or roll change car; rolls guided during extraction and insertion by hand or rod in confined mill housing geometry; adjacent roll surfaces at production temperature	HIGH	Crush · Burns · Pinch	PSC Load Control · PSC Position & Reach Interfaces
Backup roll change	Backup rolls (15–30 tonnes each) require crane extraction from mill housing; confined geometry; workers guide rolls during crane descent and insertion — simultaneous suspended load and pinch hazard in the mill window	HIGH	Crush · Suspended Load · Pinch	PSC Load Control · PSC Position & Reach Interfaces
Cobble clearance — strip jam in mill	Cobbled strip removed from mill housing by hand tools and crane; strip is buckled, sharp-edged, and at temperature; confined mill window access; high-force strip under residual tension	HIGH	Laceration · Burns · Crush	PSC Position & Reach · PSC Striking & Alignment Interfaces
Crop shear blade replacement	Shear blade removed and replaced by hand in the shear housing; blade edges are at cutting sharpness; heavy blade weight requires manual support during alignment; residual strip material in shear throat	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Edge trimmer knife and guide maintenance	Rotary trim knives accessed for replacement or sharpening; knife edges at cutting sharpness; guide adjustment performed with hands adjacent to knife path; trim scrap in knife housing	HIGH	Laceration · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces

7 HOT ROLLING MILL QUICK ASSESSMENT CHECKLIST

Use during a hot rolling mill walkdown. The first item addresses the most critical observation from field practice and should be assessed before any other question.

- ☐ Is there a written and trained procedure that requires the mill to stop before any manual contact with the strip is permitted during a rolling pass — including strip alignment corrections?
- ☐ During strip threading at low mill speed, is the threading tool's working end kept outside the nip entry zone — and can the tool be drawn into the roll gap if the strip catches it?
- ☐ After the crop shear cuts, is the crop piece removed using a tool — not bare hands — that maintains stand-off from the freshly sheared strip edge?
- ☐ During hot coil crane transfer in the coil bay, is an anti-tangle tagline used for swing control — and are workers outside the coil swing arc throughout crane travel?
- ☐ During coil landing in the coil bay, are workers guiding the coil using a stand-off tool — not bare hand contact with the hot coil outer wrap?
- ☐ During cobble clearance, are workers using purpose-designed tools for buckled strip removal — not bare hands or improvised rods in the confined mill window?
- ☐ During work roll change, is the roll guided during crane extraction and insertion using a rated push/pull tool — not bare hands or a fabricated rod in the confined mill housing?
- ☐ During crop shear blade replacement, are the blade edges handled using a tool — not bare hands — throughout the removal, positioning, and alignment sequence?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — HOT ROLLING MILL

Representative PSC interfaces for the scenarios in this chapter. Contact PSC for guidance on mill type, roll gap geometry, coil weight, and specific threading system configuration before product selection.

POSITION & REACH INTERFACES — STRIP GUIDANCE & NIP STAND-OFF

INTERFACE	PRIMARY HOT MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (M-Head)	Strip leading edge guidance during low-speed threading — M-Head provides lateral strip contact at stand-off from the nip entry zone. Strip alignment correction during stopped mill conditions. Non-entanglement head design prevents the tool from being drawn into the roll gap. 12-inch head reach.	1 ft, 2 ft	PSC-LIT-M002 PSC-LIT-M008	1 · 2
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Crop piece lateral movement on shear table after shearing. Coil lateral guidance during crane landing in coil bay. Roll guidance during extraction and insertion in mill housing during roll change operations.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	3 · 4 · Maint.
POSITION & REACH PSC Load-It® MagHead Extendable	Magnetic attachment to ferrous mill components during roll change and mill maintenance. Positioning of roll change car components. Crane hook spotting above mill housing during roll extraction. 550 lb magnetic holding capacity, 2–8 ft extendable reach.	2–8 ft	PSC-LIT-MAG-FG-008	Maint.

LOAD CONTROL INTERFACES — COIL & ROLL CRANE SWING CONTROL

INTERFACE	PRIMARY HOT MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for hot coils during crane transfer from coiler to coil bay storage. Swing control for work rolls and backup rolls during crane-assisted roll change operations. Replaces plain rope taglines in the hot mill coil bay where sharp strip edges would damage standard ropes.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	4 · Maint.

RETRIEVAL INTERFACES — CROP & TRIM SCRAP RECOVERY

INTERFACE	PRIMARY HOT MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving small crop pieces that have moved off the shear table onto the mill floor. Recovering trim scrap and small strip pieces from the edge trimmer area without bare hand contact with sharp aluminium edges. Precision jaw grip at 6 ft reach.	6 ft	PSC-ST	3 · Maint.

STRIKING & ALIGNMENT INTERFACES — MILL MAINTENANCE

INTERFACE	PRIMARY HOT MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts and pins during roll change hardware driving, shear blade retaining bolt installation, and edge trimmer knife alignment. Removes the holding hand from the hammer strike zone during all impact operations in the hot mill maintenance area.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Three observations about nip point exposure in the hot rolling mill

The hot rolling mill is the one location in this guide where the severity of the hand exposure event is categorically different from all others. Contact with a nip roll at operating speed is not a severe injury — it is a permanent one. The principles below reflect that distinction.

PRINCIPLE 01

At the hot rolling mill nip, the distinction between "working near the hazard" and "in contact with the hazard" collapses in less than one second. Engineering controls must prevent proximity, not just contact.

In most industrial environments, there is a measurable interval between hazard proximity and injury — time for reflexive withdrawal, time for the safety system to respond, time for the injury to progress. At a rolling mill nip at operating speed, this interval does not exist. The hand is pulled through the roll gap before the nervous system transmits the signal to withdraw. The only engineering control adequate to this hazard is one that prevents proximity to the nip entry zone, not one that responds after proximity has been achieved.

PRINCIPLE 02

The instinct to reach for a drifting strip during a rolling pass is rational. The procedure that overrides it must be equally rational — and trained until it is the instinctive response.

A worker who reaches for a drifting strip to correct its alignment is applying exactly the same logic they use successfully in a hundred non-hazardous handling tasks every day. The rolling mill nip converts that rational action into a catastrophic one. The engineered response is not to criticise the instinct — it is to provide a trained, procedural, and physical alternative that satisfies the same operational need without the proximity. Mill stop before manual contact must become the instinctive response to strip misalignment.

PRINCIPLE 03

Hot rolling generates sharp-edged product at every stage — strip edges, crop ends, trim scrap, and coil outer wraps. A single interface strategy for sharp-edge handling reduces the total laceration exposure across the full hot rolling cycle.

Sheared crop ends, trimmed strip edges, cobbled strip, and freshly coiled outer wraps all present laceration risk from the same mechanism — sharp aluminium cut edges in motion or under tension. A push/pull interface that maintains stand-off from strip edges during crop handling also works for coil guidance and trim scrap clearance. A single well-designed tool, used consistently across all sharp-edge interactions in the hot mill, provides more cumulative protection than multiple task-specific solutions that workers must learn to select and switch between.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

PSC Hand Safety India has conducted direct field assessments at aluminium flat-rolled products facilities and can provide engineering guidance on hot mill specific interfaces. Mill configuration, roll gap geometry, threading system type, and coil weight range all affect the appropriate interface selection.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — threading, alignment, crop handling, coil guidance, roll change	Recommended interface and head type for the specific hot mill task
Mill type — reversing rougher, tandem, single-stand finishing	Indicative unit price (budgetary, not binding)
Current tool or method in use at each exposure point	Delivery lead time from Visakhapatnam
Strip threading system — automated or manual	Application notes specific to nip zone stand-off requirements
Coil weight range and crane type in coil bay	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Reference to comparable assessments at similar rolling facilities

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1 DEPARTMENT OVERVIEW

Cold rolling reduces the hot-rolled aluminium strip to final gauge at room temperature, achieving the surface finish, flatness, and mechanical properties required for the end product. Strip gauges range from 3 mm at the cold mill entry to 0.006 mm at the thinnest foil gauges — a reduction ratio that demands extremely precise roll gap control and high strip tension throughout the mill. The hand exposure pattern in cold rolling shares many features with hot rolling but differs in three critical respects: strip speeds are higher, the strip surface is coated with rolling oil making it simultaneously slippery and flammable, and strip breaks — where the strip fractures under tension — release significant stored elastic energy.

Cold rolling mills operate as tandem mills (multiple stands in sequence) or as reversing single-stand mills, depending on the product mix and production volume. Strip enters the mill as a hot-rolled coil and exits as a cold-rolled coil for annealing, further cold reduction, or finishing. Workers interact with the strip at coil loading on the pay-off reel, strip threading through the mill stands, tension reel approach at the exit, trim scrap clearance, and during strip break recovery when the strip fractures under tension during a rolling pass.

Strip break recovery is the highest-severity non-routine event in the cold rolling mill. When the strip breaks, the trailing end springs back under tension release, and the leading end may wrap around rolls or jam in the mill gap. Recovery requires manual strip handling in a confined mill environment with sharp edges, residual rolling oil on all surfaces, and limited access. The improvised nature of strip break recovery — performed urgently, without a standard tool, in a space not designed for manual access — creates a clustered exposure that combines laceration, entanglement, and slip hazards simultaneously.

2 MAJOR EQUIPMENT & LOCATIONS

PAY-OFF REEL (UNCOILER)

The pay-off reel holds the entry coil and unwinds it at the speed required by the mill. Coil loading onto the pay-off reel requires crane positioning of the coil onto the mandrel — a suspended load operation. Strip leading end threading from the pay-off reel through the entry guides requires worker approach to the pay-off reel nip zone at low speed during threading.

MILL STANDS (WORK ROLLS & BACK-UP ROLLS)

One to six mill stands in sequence, each reducing strip thickness by 10–30% per pass. The roll bite in each stand is the primary nip hazard. Strip at cold rolling gauges and speeds means that nip contact consequences are equivalent to the hot rolling mill — catastrophic and without recovery time. Stand-off from the nip zone during all manual interactions near the mill is the fundamental requirement.

TENSION REEL (COILER)

The exit tension reel coils the reduced strip at the correct speed and tension. Strip threading onto the tension reel mandrel requires worker approach to the reel entry at strip speed. The tension reel nip — between the coiling strip and the building coil surface — is a powered nip hazard equivalent to the mill stand roll bite.

EDGE TRIMMER & TRIM SCRAP SYSTEM

Many cold rolling lines include an edge trimmer that removes irregular strip edges. Trim scrap — thin, sharp, curled strips of aluminium — must be cleared from the trimmer and scrap collection system. Trim scrap accumulation is a recurring laceration hazard at the cold rolling mill that is often managed with bare hands despite the extreme sharpness of cold-rolled aluminium strip edges.

ENTRY AND EXIT BRIDLE ROLLS

Bridle rolls at the mill entry and exit establish and maintain strip tension. The bridle roll nip zones are powered and represent the same hazard class as the mill stand roll bite. Workers interact with the bridle roll area during threading and during strip break recovery when strip must be re-threaded through the bridle system.

ROLLING OIL SYSTEM

Rolling oil is applied to the strip and rolls throughout the cold rolling process to lubricate the roll bite and cool the strip surface. The oil creates a uniformly slippery surface on the mill floor, on the strip itself, and on all equipment in the mill. This significantly increases slip risk during all manual interventions, particularly during strip break recovery where urgency and confined access compound the slip hazard.

3 COLD ROLLING CYCLE — TASK FLOW & EXPOSURE POINTS

COLD ROLLING MILL CYCLE

ENTRY COIL LOADING — PAY-OFF REEL

Hot-band coil loaded onto pay-off reel mandrel by crane

SUSPENDED LOAD · CRUSH · NIP PROXIMITY

STRIP THREADING THROUGH MILL STANDS

Strip leading end threaded through bridles and mill stands

NIP POINT · ENTANGLEMENT · LACERATION

ROLLING RUN — FULL SPEED PRODUCTION

Strip reduced through stands at production speed

NIP POINT · STRIP BREAK RISK · LACERATION

EDGE TRIMMING & TRIM SCRAP CLEARANCE

Strip edges trimmed · scrap cleared from trim system

LACERATION · NIP POINT · ENTANGLEMENT

TENSION REEL COILING & COIL REMOVAL

Reduced strip coiled · coil removed by crane

SUSPENDED LOAD · LACERATION · CRUSH

STRIP BREAK RECOVERY (NON-ROUTINE)

Strip fracture · manual recovery in confined mill environment

LACERATION · NIP · SLIP · ENERGY RELEASE

FINISHING LINES → Chapters 13 / 14

RED BOX = UNPLANNED EVENT — highest-severity in cold rolling

4 CURRENT FIELD INTERFACES OBSERVED

Cold rolling mill hand exposure patterns are consistent across the industry. The interfaces below reflect the standard working practice observed at aluminium flat-rolled products facilities across multiple site assessments.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — trim scrap clearance at edge trimmer	Cold-rolled aluminium trim scrap is among the sharpest material in any aluminium plant — thin strip cut to a narrow width with two sheared edges on each piece. Trim scrap accumulates in coiled loops in the scrap collection tray. Workers clear it by hand or with improvised hooks. Gloves are the only control in most operations, and they are routinely cut through by cold-rolled aluminium trim edges.
Improvised rod or tool holder — strip threading through mill	Threading the strip leading end through the mill stands requires guiding the strip nose past bridge rolls, deflector rolls, and into the roll gap of each stand in sequence. Workers use long rods, modified pliers, or improvised strip-grabbing tools to guide the threading process. No standard rated threading tool exists in most cold rolling operations — the threading interface is improvised to fit the available space in the mill window.
Bare hands — strip break recovery	During strip break recovery, the broken strip end is sharp, oil-coated, under residual tension, and located in a confined mill environment with limited access. Workers reach into the mill gap area to retrieve the broken end, cut it square, and re-thread through the mill. The combination of sharp edges, oil on all surfaces, urgency, and confined access creates the highest-concentration hand exposure event in the cold rolling mill.
Bare hands or gloves — coil outer wrap edge contact	Cold-rolled coil outer wrap edges are sharp from the edge trimmer cut and from the natural edge condition of cold-rolled strip. Workers contact the outer wrap edge during coil transfer, coil strapping, and wrapping operations. The extreme sharpness of cold-rolled aluminium strip edges makes glove penetration common — lacerations through glove material are a predictable and recurring event in the cold rolling coil bay.

ENGINEERING OBJECTIVE — COLD ROLLING MILL

Provide purpose-designed interfaces for trim scrap clearance, strip threading, strip break recovery, and coil outer wrap handling that eliminate bare hand and unrated-glove contact with cold-rolled aluminium edges throughout the cold rolling cycle — including the unplanned strip break recovery sequence.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Trim Scrap Clearance at Edge Trimmer		
	LACERATION · ENTANGLEMENT · NIP POINT		
	WHY THE HAND IS THERE The edge trimmer removes 5–25 mm from each strip edge, generating a continuous narrow strip of cold-rolled aluminium that must be collected and removed. Trim scrap accumulates as a coiled, tangled bundle in the scrap collection tray adjacent to the trim knives. Workers clear the tray periodically using hooks, rakes, or bare hands — the tray location adjacent to the trim knife and the coiler nip zone means clearance is always performed in close proximity to live hazards.	CURRENT FIELD INTERFACE Bare hands or improvised hooks used to pull trim scrap from the collection tray. Cold-rolled trim scrap is the sharpest material encountered in routine handling in any aluminium plant — thin, narrow, sheared on both edges, and with no surface finish that would reduce the edge severity. Gloves are routinely cut through. The tangled coil nature of trim scrap means it catches on itself and on the tool, increasing the force required and the risk of sudden release.	EXPOSURE TYPE Severe laceration from contact with cold-rolled aluminium trim scrap edges — capable of cutting through standard safety gloves. Entanglement if the scrap catches on the tool or the worker's clothing during clearance. Nip point if the worker's hand enters the trim knife housing or the scrap coiler nip zone during the clearance operation. Cut depth on cold-rolled trim edges penetrates to bone without resistance.
	ENGINEERING OBJECTIVE Clear cold-rolled aluminium trim scrap from the collection tray without bare hand or bare-arm contact with the trim scrap edges — using a tool with sufficient reach to access the tray from outside the trim knife and scrap coiler nip zone, and with a grip or hook design that prevents the tangled scrap from catching and pulling the tool and the worker's hands toward the nip.	REPRESENTATIVE INTERFACE PSC Long-Reach Pickup Tool (6 ft) for controlled extraction of trim scrap bundles from the collection tray — precision jaw grip avoids tangling, reach keeps hands outside the trim knife nip zone. PSC Load-It® Scraper Head (custom — contact PSC) for pushing compacted scrap toward the tray exit. No bare hand contact with cold-rolled trim scrap edges at any point during clearance.	
<i>"During trim scrap clearance, has the laceration rate specifically from trim scrap contact been tracked — and does the current clearance method reliably prevent bare hand or forearm contact with the trim scrap edges throughout the full clearance cycle?"</i>			

HIGH				Strip Break Recovery — Re-Threading in Confined Mill Environment	
LACERATION · NIP POINT · SLIP · ENERGY RELEASE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
When the strip breaks during a rolling pass, the trailing end springs back under tension release and the leading end may wrap around rolls or jam in the mill gap. Recovery requires workers to enter the mill area to retrieve the broken ends, cut them square with a portable shear, and re-thread through the full mill sequence. The recovery is performed under production pressure in a confined, oil-covered environment with sharp strip ends at multiple locations simultaneously.		Bare hands and improvised tools used to retrieve and manage broken strip ends in the mill window area. Rolling oil on all surfaces creates a slip hazard throughout the recovery sequence. The strip ends are sharp from the fracture point. Urgency to restore mill production compresses the time taken for hazard assessment before manual entry into the mill area. No standard strip break recovery kit exists in most cold rolling operations.		Severe laceration from contact with fractured strip ends — fracture edges are irregular and extremely sharp. Nip point exposure if hands or tools enter the roll gap during strip retrieval. Slip and fall on oil-covered mill floor during recovery sequence. Energy release from residual strip tension if the strip springs when released during recovery. The combination of all four exposure types simultaneously under production pressure is the defining characteristic of this scenario.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Define a standard strip break recovery sequence — with a specific recovery kit, specific tool selection for each step, and defined clearance confirmation before mill re-start — that eliminates improvised bare-hand recovery under production pressure in an oil-covered mill environment.			Strip break recovery kit approach: PSC Load-It with S-Head for strip end retrieval and positioning in the mill window. PSC Long-Reach Pickup Tool for retrieving strip ends from confined roll area. Purpose-designed strip break recovery is a procedural and kit engineering control rather than a single PSC product — contact PSC for mill-specific kit specification.		
"When a strip break occurs, is there a defined recovery kit and procedure that workers follow — or does each recovery depend on whatever tools and methods are available to the operator at that moment?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Entry Coil Loading — Pay-Off Reel Mandrel Approach	
SUSPENDED LOAD · CRUSH · LACERATION					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Hot-band coils are loaded onto the pay-off reel mandrel by crane. After landing, the coil outer wrap must be cut and the strip leading end threaded through the entry guide to the first bridle roll. The strip leading end cut — made with a portable shear or cutter — must be guided through the entry system at threading speed. Workers are adjacent to the pay-off reel nip zone during both the coil landing and the entry threading sequence.		Crane-suspended coil guided onto the mandrel by hand or fabricated rod. After landing, the outer wrap strap is cut by hand and the wrap peeled back to expose the strip leading end. The leading end is grabbed and fed through the entry guide — direct hand contact with the strip leading edge, which has a sharp cut end from either the coiler shear or the previous mill's exit shear.		Crush between the crane-suspended coil and the pay-off reel mandrel housing during landing. Laceration from the sharp outer wrap strip edge when peeling back the coil wrap. Nip point exposure during entry threading if the hand approaches the pay-off reel nip zone. Struck-by if the coil swings during crane descent above the pay-off reel.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Land the entry coil on the pay-off reel mandrel and thread the strip leading end through the entry system without bare hand contact with the coil outer wrap edge or the strip leading cut end, and without placing workers in the crush zone between the coil and the mandrel housing during crane descent.			Anti-Tangle Tagline for coil swing control during crane descent to pay-off reel. Representative push/pull interface (S-Head, 4 ft) for coil lateral guidance during mandrel approach. For strip leading end threading, an entry threading tool or strip guide paddle maintains stand-off from the pay-off reel nip zone during the threading sequence.		
"During entry coil loading, does the outer wrap removal require bare hand contact with the sharp strip wrap edge — and has that contact been assessed as a laceration risk separate from the general coil handling assessment?"					

MEDIUM				Cold-Rolled Coil Outer Wrap Handling — Strapping & Transfer	
LACERATION · SUSPENDED LOAD · CAUGHT-BETWEEN					
WHY THE HAND IS THERE After the cold-rolled coil is removed from the tension reel mandrel, it must be strapped, wrapped, and transferred to the inspection or despatch area. Coil strapping requires workers to handle the coil outer wrap edge while feeding the strap around the coil circumference. The outer wrap of a cold-rolled coil has a sheared edge from the exit shear cut — extremely sharp, consistent along the full coil width.		CURRENT FIELD INTERFACE Direct hand contact with the coil outer wrap edge during strapping — workers guide the strap around the coil and must reach past or over the outer wrap edge to complete the strap loop. Heavy gloves provide some protection but cold-rolled aluminium strip edges cut through standard industrial gloves at gauge thicknesses below 1 mm. The injury rate from coil strapping edge contact is consistent and predictable across the industry.		EXPOSURE TYPE Laceration from contact with cold-rolled aluminium outer wrap edge during coil strapping — capable of penetrating standard industrial gloves. Caught-between the coil and the strapping equipment or coil car during the strapping sequence. Crush if the coil rolls or shifts during strapping before it is fully secured on the coil car.	
ENGINEERING OBJECTIVE Complete coil strapping and transfer without bare hand or unprotected forearm contact with the cold-rolled aluminium outer wrap edge — using a tool or strap-feeding system that maintains stand-off from the coil edge throughout the strapping sequence.			REPRESENTATIVE INTERFACE Representative push/pull interface for coil positioning during strapping. Strap-feeding tool or paddle to guide strapping material around coil without requiring hands to contact the outer wrap edge directly. This is an engineering approach applicable to coil strapping accessory design rather than a standard PSC catalogue product.		
"During coil strapping after cold rolling, how close do workers' hands come to the outer wrap edge — and has the laceration rate from outer wrap edge contact during strapping been tracked as a separate injury category?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Cold rolling mill maintenance combines the nip and crush hazards of the hot mill with the additional laceration severity of cold-rolled aluminium edges and the slip hazard created by rolling oil on all mill surfaces. Roll changes and strip break recovery are the most frequent non-routine activities.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Work roll change	Work rolls pulled from housing by roll change car; guided by hand or rod during extraction and insertion; oil-covered roll surfaces in confined mill window; rolls at production temperature	HIGH	Crush · Pinch · Slip	PSC Load Control · PSC Position & Reach Interfaces
Strip break recovery	Broken strip ends retrieved from mill window and roll gap by hand; strip is sharp, oil-covered, under residual tension; confined access; multiple sharp ends at different locations simultaneously	HIGH	Laceration · Nip · Slip · Energy Release	PSC Position & Reach · PSC Retrieval Interfaces
Edge trimmer knife change	Rotary trim knives removed and replaced; knife edges at cutting sharpness; oil on all surfaces creates additional slip risk; confined access to knife housing with residual trim scrap	HIGH	Laceration · Slip · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Roll gap adjustment and screwdown maintenance	Screwdown mechanism and wedge block accessed by hand in mill housing for adjustment; confined geometry; heavy components; residual rolling oil on mechanism surfaces	MEDIUM	Crush · Pinch · Ergonomic	PSC Striking & Alignment · PSC Position & Reach Interfaces
Rolling oil system maintenance — spray bar and nozzle	Spray bars and nozzles accessed for cleaning and replacement while mill floor is oil-covered; spray connections under pressure in adjacent circuits; oil mist on all surfaces during and after production	MEDIUM	Slip · Chemical · Pinch	PSC Position & Reach Interfaces

7 COLD ROLLING MILL QUICK ASSESSMENT CHECKLIST

Use during a cold rolling mill walkdown. The trim scrap and strip break questions should be assessed first — they represent the highest laceration frequency events in the cold rolling area.

- ☐ During trim scrap clearance, is a purpose-designed tool used to extract scrap from the collection tray — not bare hands or improvised hooks adjacent to the trim knife nip zone?
- ☐ Is there a defined strip break recovery kit available at the mill — with specific tools for strip retrieval, and a defined sequence that does not rely on improvised bare-hand recovery?
- ☐ During entry coil loading, is the coil outer wrap removal performed using a tool — not bare hands — that avoids contact with the sharp strip wrap edge?
- ☐ During strip threading through the mill stands, is a rated threading tool used — not an improvised rod or modified plier — to guide the strip nose past nip rolls and bridle rolls?
- ☐ During coil strapping after rolling, does the strapping method prevent bare hand or forearm contact with the cold-rolled aluminium outer wrap edge?
- ☐ During work roll change, is the roll guided during extraction and insertion using a rated tool — not bare hands or a fabricated rod in the oil-covered, confined mill window?
- ☐ Is the mill floor and mill window area free of pooled rolling oil that creates a slip hazard during any manual intervention — particularly during strip break recovery?
- ☐ During edge trimmer knife change, are the knife edges handled using a tool — not bare hands — during removal, transport, and installation in the trimmer housing?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — COLD ROLLING MILL

Representative PSC interfaces for the scenarios in this chapter. Contact PSC for guidance on mill configuration, coil weight range, trim scrap volume, and strip break recovery requirements before product selection.

POSITION & REACH INTERFACES — STRIP, COIL & ROLL GUIDANCE

INTERFACE	PRIMARY COLD MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Entry coil guidance during crane landing on pay-off reel. Exit coil lateral positioning during coil car transfer. Strip end retrieval and positioning during strip break recovery. Roll guidance during extraction and insertion in mill housing during roll change.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	3 · Maint.
POSITION & REACH PSC Load-It® Push/Pull Tool (M-Head)	Strip leading edge guidance during threading through mill stands and bridge rolls at low mill speed. Non-entanglement head design critical for cold mill threading — prevents the tool from being drawn through the nip rolls if the strip catches during threading.	1 ft, 2 ft	PSC-LIT-M002 PSC-LIT-M008	Thread. · Maint.

RETRIEVAL INTERFACES — TRIM SCRAP & STRIP BREAK RECOVERY

INTERFACE	PRIMARY COLD MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Controlled extraction of trim scrap bundles from collection tray — jaw grip avoids tangling, reach keeps hands outside trim knife nip zone. Strip end retrieval from confined roll gap area during strip break recovery without bare hand entry into the mill window.	6 ft	PSC-ST	1 · 2 · Maint.
RETRIEVAL / CLEARANCE PSC Load-It® Scraper Head (Custom)	Pushing compacted trim scrap toward collection tray exit. Clearing strip remnants and swarf from the cold mill floor and threading path during strip break recovery. Purpose-built scraper face with ergonomic grip for use in confined mill areas with oil-covered surfaces.	3 ft, 4 ft	Custom — contact PSC	1 · 2

LOAD CONTROL INTERFACES — COIL CRANE SWING CONTROL

INTERFACE	PRIMARY COLD MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for entry coils during crane descent to pay-off reel. Swing control for exit coils during transfer to coil bay or inspection area. Replaces plain rope taglines — no entanglement at sharp coil outer wrap edges that would damage a standard rope during crane travel.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	3 · 4

STRIKING & ALIGNMENT INTERFACES — COLD MILL MAINTENANCE

INTERFACE	PRIMARY COLD MILL APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts and pins during roll change hardware driving and edge trimmer knife alignment. Oil-covered surfaces increase slip risk during all impact operations in the cold mill — the FingerSaver isolates the holding hand from the strike zone regardless of surface condition.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Three observations about hand exposure in the cold rolling mill

Cold rolling adds two hazard conditions not present in hot rolling: cold-rolled aluminium edges are significantly sharper than hot-rolled edges, and rolling oil creates a uniformly slippery environment that makes all manual interventions more hazardous than the same task in a dry environment.

PRINCIPLE 01

Cold-rolled aluminium trim scrap is one of the sharpest materials encountered in routine industrial handling. It should be managed with the same engineering controls applied to blade edges, not with the controls applied to general metal scrap.

Cold-rolled aluminium strip at 0.3–1 mm gauge has an edge condition after shearing that is comparable in severity to a razor blade. It cuts through standard safety gloves reliably. Treating trim scrap as a general scrap handling task — with gloves as the primary control — results in a predictable and consistent laceration rate. The engineering response is to eliminate hand contact with the trim scrap edges through a retrieval and clearance tool, not to specify a thicker glove.

PRINCIPLE 02

Strip break recovery concentrates more simultaneous hand exposure types than any other single event in the cold rolling mill — and is performed without preparation, under production pressure, in an oil-covered environment.

A strip break is an unplanned event. The recovery that follows is therefore also unplanned, which means it is performed with whatever tools are at hand, with whatever procedure the operator remembers or improvises, in a time-compressed environment. A pre-defined recovery kit and a trained recovery sequence convert this from an improvised emergency into a managed procedure — and that conversion is only possible before the break occurs, not after.

PRINCIPLE 03

Rolling oil on the mill floor does not just create a slip hazard — it converts every manual intervention in the mill area into a higher-risk event than the same task in a dry environment.

Tool grip is reduced. Footing is uncertain. Reflexive movements to regain balance can direct hands toward nip zones. The effect of rolling oil is cumulative and ambient — it affects every manual task in the mill area simultaneously, not just the tasks where oil is directly applied. Engineering controls in the cold rolling mill must account for the oil environment as a baseline condition, not as an additional risk layer to be managed separately.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

If any hand exposure scenario in this chapter reflects tasks observed in your plant, PSC Hand Safety India can provide engineering guidance on representative interfaces. Cold mill configuration, strip gauge range, trim scrap volume, and strip break frequency all affect the appropriate interface selection and kit specification.

INFORMATION TO PROVIDE	WHAT PSC PROVIDES
Specific task — trim scrap, strip break recovery, threading, coil handling	Recommended interface for specific cold mill task
Mill type — tandem, reversing single-stand, foil mill	Strip break recovery kit specification for your mill type
Strip gauge range at entry and exit	Indicative unit price (budgetary, not binding)
Current tool or method in use at each exposure point	Delivery lead time from Visakhapatnam
Trim scrap volume and current clearance method	Trial order option for in-plant evaluation before bulk commitment
Indicative quantity required and plant location	Reference to comparable assessments at similar cold rolling facilities

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1 DEPARTMENT OVERVIEW

Finishing lines convert cold-rolled coil into the forms required by the end customer — slit coils, cut-to-length sheets, levelled sheet, tension-levelled strip, and inspected coil. These are the highest-frequency manual interaction points in a flat-rolled aluminium plant. Unlike rolling mills, finishing lines involve workers handling the finished aluminium product directly — touching, positioning, inspecting, stacking, and packing pieces that are sharp, thin, and at the final surface quality standard. The laceration rate across finishing lines is higher than in any other area of the aluminium plant precisely because the product is handled most at this stage.

Finishing lines in a flat-rolled plant typically include slitters (which cut the wide cold-rolled coil into narrower widths), cut-to-length lines (which shear the strip into sheet of defined length), levellers and tension levellers (which flatten the strip to flatness specification), and inspection lines (where the strip surface is examined before despatch). Each line has its own pattern of manual interaction — coil loading at the entry, strip threading through the line, and product handling and packing at the exit. Across all of them, the common exposure is direct hand contact with cold-rolled aluminium strip and sheet edges.

Field observations at a Hindalco flat-rolled products plant identified coil handling during crane operations as a primary exposure on finishing lines — workers directly touching suspended coils, inserting slings with hands between the coil and the crane hook, and guiding coils to packing stations without stand-off tools. These observations are directly referenced in the scenarios below. The finishing line environment also involves the highest worker density of any area in the plant — multiple operators working simultaneously on a single line with shared interaction points.

2 MAJOR EQUIPMENT & LOCATIONS

SLITTING LINE

The slitter cuts the full-width cold-rolled coil into multiple narrower coils using a set of circular knives. Slit coils are narrower, lighter, and have two additional sheared edges per coil compared to the entry coil. Workers handle slit coils at the exit for recoiling, strapping, and transfer — each slit coil has razor-sharp edges on both sides of its width.

CUT-TO-LENGTH LINE

The cut-to-length line shears the strip into individual sheets of defined length. Sheets exit the line onto a stacking table where they are accumulated and transferred to the packing station. Sheet edges from the cross shear are sharp. Workers interact with sheets during stacking, counting, and transfer — often handling thin sheet directly with the hand-to-edge contact that generates the highest laceration frequency in finishing.

LEVELLER & TENSION LEVELLER

Roller levellers and tension levellers flatten cold-rolled strip to the flatness specification required for the end product. Strip must be threaded through the leveller rolls, and the leveller roll gap must be adjusted for each product. The leveller roll nip zones are present at each roll pair — threading workers must interact with the strip near multiple simultaneous nip points.

INSPECTION LINE

Coil surface inspection requires the strip to pass over an inspection table under defined lighting conditions while inspectors observe both faces. Inspectors work adjacent to the moving strip during inspection — touching the strip to confirm surface conditions, marking defects, and managing the strip speed to allow adequate inspection time. Edge contact during inspection is common.

PACKING & DESPATCH AREA

Finished coils and sheets are wrapped, strapped, labelled, and loaded for despatch. Wrapping and strapping operations require direct interaction with the product outer wrap edge. Loading onto trucks or rail wagons by crane requires coil and sheet bundle guidance during crane descent — the same suspended load and sharp edge combination present throughout the finishing area.

COIL TRANSFER CRANE & COIL CAR

Overhead cranes and coil cars transfer coils between finishing line entry, exit, and storage. At a Hindalco facility, workers were observed directly handling suspended coils during crane operations — touching the coil body, inserting slings, and guiding coils to packing stations without stand-off tools. These observations are the primary field evidence for this chapter.

3 FINISHING LINE CYCLE — TASK FLOW & EXPOSURE POINTS**FINISHING LINE CYCLE****ENTRY COIL LOADING & THREADING**

Cold-rolled coil loaded · strip threaded through line

SUSPENDED LOAD · LACERATION · NIP POINT

SLITTING / SHEARING / LEVELLING

Strip processed through slitter, shear, or leveller

NIP POINT · LACERATION · EJECTED MATERIAL

STRIP / SHEET INSPECTION

Surface inspected · defects marked · quality confirmed

LACERATION · EDGE CONTACT · NIP PROXIMITY

SHEET STACKING & COIL RECOILING

Sheets stacked at exit · slit coils recoiled on mandrel

LACERATION · CAUGHT-BETWEEN · PINCH

STRAPPING, WRAPPING & LABELLING

Product wrapped · strapped · labelled for despatch

LACERATION · EDGE CONTACT · PINCH

CRANE TRANSFER TO DESPATCH / WAREHOUSE

Finished product loaded for despatch by crane

SUSPENDED LOAD · LACERATION · CRUSH

DESPATCH TO CUSTOMER

LACERATION FROM ALUMINIUM EDGES IS THE DOMINANT EXPOSURE

4 CURRENT FIELD INTERFACES OBSERVED

The field observations below are drawn from the Hindalco Taloja flat-rolled products facility assessment (March 2026) supplemented by industry-wide finishing line practice. Finishing line coil and sheet handling represents the highest-volume manual interaction with sharp aluminium edges in the plant.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — coil guidance during crane operations	At a Hindalco finishing line, workers were directly observed touching suspended coils during crane operations — hands on the coil body while the load was suspended. Coil outer wrap edges are sharp. The crane load swing zone, the coil outer wrap edge, and the proximity to coil bay fixed structures create simultaneous laceration, suspended load, and crush exposure at the moment of hand contact.
Bare hands — sling insertion between coil and hook	Workers were observed inserting lifting belt slings into crane hooks with hands between the coil eye and the hook — hands between the load and the rigging during the attachment sequence. If the coil shifts during sling insertion, the hand in the gap between the coil eye and the hook is in the crush zone with no withdrawal time.
Direct hand contact — sheet stacking at cut-to-length exit	Sheets exiting the cut-to-length shear are stacked by workers who handle each sheet at the edges to position it on the stack. Cut-to-length sheared sheet edges have the same sharpness characteristics as cold-rolled slit edges. At high production rates, stacking involves repeated rapid edge contact across hundreds of sheets per hour. Cumulative laceration from sheet stacking is one of the highest-frequency injury sources in finishing.
Direct hand contact — strip inspection near moving strip edge	During inspection, workers touch the strip surface to confirm surface condition and mark defects. The strip is moving slowly, but the edge of the strip at the inspector's hand position represents a sustained laceration exposure. Inspectors working along the inspection table routinely have hands or forearms adjacent to the moving strip edge throughout the full inspection run.

ENGINEERING OBJECTIVE — FINISHING LINES

Provide stand-off interfaces for coil crane guidance and eliminate bare hand contact with cold-rolled aluminium sheet and strip edges during stacking, strapping, inspection, and transfer operations throughout the finishing line area.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Coil Crane Guidance — Finishing Line Entry & Exit	
SUSPENDED LOAD · LACERATION · CRUSH					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Coils are loaded onto finishing line mandrels and removed from exit recoilers by overhead crane. Workers guide the crane-suspended coil to its landing position and insert slings for coil transfer. At a Hindalco facility, workers were directly observed with hands on suspended coils during crane movements — touching the coil body to guide it laterally while the load was still in motion, and inserting slings with hands between the coil eye and the crane hook.		Bare hands used to guide suspended coils during crane operations on finishing lines. Slings inserted by hand with the worker's hand in the gap between the coil eye and the crane hook during attachment. Coils guided to packing stations by hand contact with the coil outer wrap. No stand-off tool observed in use for coil guidance at the Hindalco finishing lines during the March 2026 site visit.		Crush between the coil eye and the crane hook during sling insertion. Laceration from the sharp coil outer wrap edge during guidance. Struck-by if the coil swings during crane travel while hands are in contact with the coil body. The finishing area has higher worker density than any other area in the plant — multiple workers in the crane swing zone simultaneously is common.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide crane-suspended coils to their landing position on finishing line mandrels and in the packing area without direct hand contact with the coil body or the coil outer wrap edge, and without placing hands between the coil eye and the crane hook during sling attachment.			Anti-Tangle Tagline for coil swing control during crane travel. PSC TRT-3P Extendable Tagline Retriever for attaching slings and taglines at height without placing hands between the coil and the crane hook. Representative push/pull interface (S-Head, 4 ft) for coil lateral guidance during crane descent to mandrel or packing position.		
"When a coil is being loaded onto a finishing line mandrel by crane, at what point does the guidance worker first touch the coil — and are their hands clear of the coil eye and crane hook during sling attachment?"					

HIGH				Sheet Stacking at Cut-to-Length Exit — Repeated Edge Contact	
LACERATION · PINCH · CAUGHT-BETWEEN					
WHY THE HAND IS THERE Sheets exiting the cut-to-length shear travel onto a stacking table where they are accumulated into piles for transfer. Workers stack each sheet by handling it at the edges to position it correctly on the pile. At typical production rates of 10–30 sheets per minute, stacking involves repeated rapid edge contact — a worker stacking for a full shift may contact sheet edges several thousand times in one production run.		CURRENT FIELD INTERFACE Direct hand contact with sheet edges during stacking — workers grip or guide each sheet at the sheared edges to position it on the stack. Gloves are the primary control. At the production rates required on modern cut-to-length lines, the stacking action must be rapid and repetitive, making careful edge avoidance impractical even when workers intend to apply it.		EXPOSURE TYPE Cumulative laceration from repeated contact with sheared aluminium sheet edges across a full stacking shift. Pinch between sheets during stacking when a sheet slides on the pile before the worker's hands clear the edge. Caught-between sheets and the stacking table if a sheet rides up or misaligns during the stacking sequence at speed.	
ENGINEERING OBJECTIVE Position and stack cut-to-length sheets at the exit table without sustained direct hand contact with sheared sheet edges — using a sheet handling interface that positions sheets correctly on the stack while maintaining stand-off from the sheared edge across the full production run.			REPRESENTATIVE INTERFACE Suction-cup or mechanical sheet lifter for large gauge sheet handling at the stacking table — eliminates edge contact entirely. For thin sheet where suction lifters are not practical, purpose-designed sheet handling guides that allow stack positioning without hand contact with the sheared edge. This is a process engineering control area — PSC can advise on sheet-specific interface options.		
"On the cut-to-length exit stacking table, has the cumulative laceration exposure from sheet edge contact across a full stacking shift been quantified — and is the current control (gloves) reducing the injury rate or only the severity?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Coil Strapping & Wrapping — Outer Wrap Edge Contact	
LACERATION · PINCH · CAUGHT-BETWEEN					
WHY THE HAND IS THERE After recoiling at the finishing line exit, slit coils and full-width coils must be strapped, wrapped in paper or film, and labelled for despatch. Strapping requires workers to feed the strap around the coil circumference — which brings hands close to or in contact with the sharp outer wrap edge. Wrapping in paper or film requires handling the outer wrap while positioning the wrapping material around the coil perimeter.		CURRENT FIELD INTERFACE Direct hand approach to the coil outer wrap edge during strapping and wrapping. On slit coils, the outer wrap edge is on both sides of the coil width — both edges are sheared and sharp. Workers feeding straps must reach past or around these edges. Strap tensioning brings the strap tight against the outer wrap edge while hands are still managing the strap path — a predictable edge contact event on every coil strapped.		EXPOSURE TYPE Laceration from contact with cold-rolled aluminium outer wrap edge during strapping — capable of penetrating standard industrial gloves on thin gauge slit coil. Pinch between the strap and the coil outer wrap during strap tensioning. Caught-between the coil and the strapping buckle or seal tool during the strap tightening sequence.	
ENGINEERING OBJECTIVE Complete coil strapping and wrapping without bare hand or forearm contact with the cold-rolled aluminium outer wrap edge — using a strap-feeding approach or tool that guides the strap around the coil perimeter without requiring hands to contact the sharp edge during the full strapping sequence.			REPRESENTATIVE INTERFACE Strap-feeding tool or paddle to guide strapping material around the coil without requiring hand contact with the outer wrap edge. Semi-automatic strapping machines eliminate manual strap feeding entirely for high-volume operations. This is an engineering approach to strapping process design rather than a standard PSC catalogue product — contact PSC for application-specific guidance.		
"During coil strapping on the finishing line, does the strap-feeding method require the worker's hands to pass adjacent to or in contact with the sharp outer wrap edge — on every coil strapped, across every shift?"					

MEDIUM				Strip Inspection — Edge Proximity During Moving Strip Inspection	
LACERATION · NIP POINT PROXIMITY · CAUGHT-BETWEEN					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
During strip inspection, inspectors walk alongside or stand adjacent to the moving strip on the inspection table, touching the surface to confirm quality conditions and marking defects. The strip is moving at inspection speed — slow enough for observation but fast enough to generate laceration from edge contact. Inspectors' hands and forearms are adjacent to the strip edge for the full duration of each coil inspection run.		Direct hand and forearm approach to the moving strip edge during inspection. Marking of defects requires close approach to the strip surface. The inspection table does not typically have a physical guard between the inspector's hands and the strip edge. The sustained duration of inspection — one coil may take 15–30 minutes to inspect — means the cumulative proximity to the moving strip edge is significant per shift.		Laceration from contact with the moving strip edge during inspection if the inspector's hand drifts laterally. Caught-between the strip and the inspection table if the strip tracks laterally during inspection and the inspector's hand is between the strip and the table edge. Nip point proximity at the inspection table drive rolls at either end of the inspection pass.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Define a physical boundary between the inspector's working position and the moving strip edge that prevents inadvertent hand contact with the strip edge during the full inspection run — without obstructing the visual inspection of the strip surface that is the purpose of the operation.			Physical edge guard on the inspection table that defines the lateral boundary between the inspector's hand position and the strip edge. This is a fixed engineering control at the inspection table rather than a PSC tool. Where edge guards are not in place, a defined hand-position protocol supported by inspection table markings provides a procedural stand-off boundary.		
"On the inspection table, is there a physical boundary between the inspector's hand position and the moving strip edge — or is the inspector's lateral proximity to the strip edge defined only by their own judgement during each inspection run?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Finishing line maintenance involves knife changes, roll replacements, and threading path clearance — all performed on equipment whose primary function is cutting or gripping aluminium strip. Residual strip pieces and trim scrap in the maintenance area add laceration risk to all maintenance activities.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Slitter knife and spacer change	Circular slitting knives removed and replaced by hand; knife edges are at sharpened cutting condition; knife sets are heavy (20–80 kg per set); spacers fitted by hand in confined arbor geometry adjacent to knife edges	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Cut-to-length shear blade replacement	Shear blade removed and replaced in the shear housing; blade at cutting sharpness; heavy blade requires manual support during positioning; residual aluminium strip and trim in shear throat	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Leveller roll replacement and gap setting	Leveller rolls removed and replaced by crane or chain hoist; rolls guided by hand in confined leveller housing; gap setting hardware adjusted by hand adjacent to roll nip zones	HIGH	Crush · Pinch · Ergonomic	PSC Position & Reach · PSC Striking & Alignment Interfaces
Threading path clearance — strip jam or cobble	Jammed strip cleared from slitter, leveller, or shear threading path by hand; strip is sharp, under residual tension; confined access between rolls; multiple sharp strip ends at different locations simultaneously	HIGH	Laceration · Pinch · Energy Release	PSC Position & Reach · PSC Retrieval Interfaces
Coil car and mandrel maintenance	Coil car mechanisms and mandrel hydraulics accessed for maintenance with coil residue present; mandrel expansion hardware adjusted by hand in confined geometry with sharp strip ends in the mandrel bore	MEDIUM	Laceration · Pinch · Crush	PSC Striking & Alignment · PSC Position & Reach Interfaces

7 FINISHING LINES QUICK ASSESSMENT CHECKLIST

Use during a finishing line area walkdown. The first three items address the highest-frequency laceration exposure points identified in field assessments.

- ☐ During coil crane operations on finishing lines, are workers using a stand-off tool — not bare hands — to guide suspended coils, and are hands clear of the coil eye and crane hook during sling attachment?
- ☐ On the cut-to-length exit stacking table, does the stacking method allow workers to position sheets without sustained direct hand contact with sheared sheet edges across the full production run?
- ☐ During coil strapping, does the strap-feeding method prevent hand contact with the cold-rolled aluminium outer wrap edge throughout the full strapping sequence on every coil?
- ☐ On the inspection table, is there a physical boundary or defined hand position protocol that prevents the inspector's hand from contacting the moving strip edge during the full inspection run?
- ☐ During slitter knife change, are knife sets handled using a tool — not bare hands — during removal from the arbor and transport to the knife store?
- ☐ During threading path clearance after a strip jam, are workers using purpose-designed retrieval tools — not bare hands or improvised hooks — to clear jammed strip from the leveller or slitter threading path?
- ☐ Is an anti-tangle tagline used on every overhead crane coil lift in the finishing area — not only on heavy coils, but on all coil sizes handled in this area?
- ☐ Are the laceration injuries from finishing line sheet and coil edge contact tracked separately by operation (slitting, CTL stacking, strapping, inspection) rather than as a single finishing area total?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — FINISHING LINES

Representative PSC interfaces for the scenarios in this chapter. Contact PSC for guidance on coil weight range, sheet gauge, slitter configuration, and strapping method before product selection.

LOAD CONTROL INTERFACES — COIL CRANE SWING & SLING MANAGEMENT

INTERFACE	PRIMARY FINISHING LINE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for coils during crane transfer between finishing line entry and exit positions, coil bay storage, and packing stations. Directly addresses the field observation of workers touching suspended coils during crane operations at finishing lines.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching slings and taglines to coils at height without placing hands between the coil eye and the crane hook during attachment. Extends 6–12 ft from safe floor position. Directly addresses the observation of hands in the coil eye–hook crush zone during sling insertion.	6–12 ft	PSC-TRT-3P	1

POSITION & REACH INTERFACES — COIL & STRIP GUIDANCE

INTERFACE	PRIMARY FINISHING LINE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Coil lateral guidance during crane descent to finishing line mandrel and packing station. Strip leading edge guidance during threading through slitter, leveller, and inspection table. General push/pull interface across the finishing line area for load guidance without bare hand contact.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · Maint.
POSITION & REACH PSC Load-It® XT-Hook Push/Pull	Coil handling and guidance using the hook head for engagement with coil sling loops, C-hook saddles, and rigging without bare hand contact with the coil body or outer wrap edge. J-Hook variant for drag operations during coil positioning in the coil bay.	2 ft, 3 ft	PSC-XT-J002 PSC-XT-J003	1 · 3

RETRIEVAL INTERFACES — STRIP JAM CLEARANCE & SCRAP RECOVERY

INTERFACE	PRIMARY FINISHING LINE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving strip pieces and trim scrap from confined threading paths during jam clearance on slitters, levellers, and shears. Controlled extraction without bare hand contact with sharp strip edges in confined finishing line access geometry.	6 ft	PSC-ST	Maint.

STRIKING & ALIGNMENT INTERFACES — FINISHING LINE MAINTENANCE

INTERFACE	PRIMARY FINISHING LINE APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts and pins during slitter knife arbor hardware driving, leveller roll pin installation, and shear blade retaining bolt work. Removes the holding hand from the hammer strike zone during all impact operations in the finishing line maintenance area.	250 mm, 350 mm, 850 mm	PSC-FS-250 PSC-FS-350 PSC-FS-850	Maint.

9 ENGINEERING PRINCIPLES FROM THIS CHAPTER

Three observations about finishing line hand exposure

Finishing lines have the highest laceration frequency of any area in the aluminium plant — not because the hazard severity is higher than in the potroom or rolling mill, but because the contact frequency is higher. Workers handle the finished product directly, repeatedly, at production rate.

PRINCIPLE 01

Finishing line lacerations are driven by contact frequency, not contact severity. The control strategy must address how often workers touch aluminium edges, not just how sharp those edges are.

A worker stacking cut-to-length sheets may contact sheet edges several thousand times in a single shift. Each individual contact carries a modest laceration probability. Across several thousand contacts, the cumulative probability of injury is high and predictable. Reducing the sharpness of the edge does not change this calculation meaningfully. Reducing the number of edge contacts — by changing the handling method — does.

PRINCIPLE 02

Field observations at well-managed finishing lines show that crane guidance tools are absent, not that workers are reckless. The tool must exist at the point of use before it can be applied.

At a Hindalco finishing line — ISO 45001 aligned, active permit-to-work system, mandatory PPE in force — workers were observed touching suspended coils during crane operations because no stand-off tool was available at that point in the finishing line. The absence of the tool was the engineering gap. A tool that exists in the tool store but is not at the crane working position provides no protection during the lift.

PRINCIPLE 03

Strapping and wrapping generate predictable edge contact on every coil processed. The cumulative annual exposure from strapping alone — across all finishing line production — typically exceeds the exposure from all crane guidance events combined.

Coil strapping is performed on every coil that leaves the finishing line. If the strapping method requires the worker's hand to pass adjacent to the outer wrap edge — which it does in most manual strapping operations — then the number of edge contact events per year from strapping alone is equal to the total number of coils produced. Engineering the strapping method to eliminate this contact addresses the highest-volume edge exposure in the finishing area.

10 APPLICATION-SPECIFIC ENGINEERING GUIDANCE

1 DEPARTMENT OVERVIEW

Annealing and heat treatment restore the ductility of work-hardened aluminium strip and sheet, and develop the mechanical properties required for specific alloy tempers. Coils and stacked sheets are loaded into batch or continuous annealing furnaces at temperatures typically ranging from 150°C to 550°C, held for defined time-temperature cycles, and then removed and cooled before returning to the production line. The hand exposure in this department is concentrated at two points: loading and unloading the furnace — where heavy coils or sheet stacks at elevated temperature are handled by crane — and the post-anneal cooling and handling period, where product temperature is high but falling and workers may underestimate residual heat.

Annealing furnaces in a flat-rolled aluminium plant are typically batch bell furnaces (where the furnace hood is lowered over a stack of coils on a base) or continuous furnaces (where the strip passes through on a conveyor). Batch bell furnaces require crane handling of coil stacks and furnace hoods — both involving suspended loads of substantial mass. Continuous furnaces require strip threading and strip break recovery within the furnace entry and exit zones. Both types generate post-anneal hot product that must be handled before it has fully cooled to ambient temperature.

A distinct secondary exposure in the annealing area is from process atmospheres. Some aluminium annealing furnaces use nitrogen or nitrogen-hydrogen protective atmospheres to prevent surface oxidation during annealing at higher temperatures. Gas cylinders supplying these atmospheres are handled in the annealing area alongside active crane operations and hot product — combining gas cylinder handling risk with suspended load and thermal exposure in the same physical space.

2 MAJOR EQUIPMENT & LOCATIONS

BATCH BELL ANNEALING FURNACE

A furnace hood lowered by crane over a stack of coils on a refractory base. After the annealing cycle is complete, the hood is lifted by crane and the hot coil stack is exposed. Workers approach the coil stack to confirm it has cooled sufficiently, attach lifting slings, and guide the crane during coil removal. Coil stack temperatures after annealing cycle completion can still be 150–300°C depending on the cooling hold time.

CONTINUOUS ANNEALING FURNACE

A furnace through which the strip passes on a conveyor or driven roll system. Entry and exit zones require strip threading and management. Strip exits the furnace at elevated temperature and passes through cooling sections before recoiling. Workers interact with the strip at the entry and exit, and manage the cooling zone between furnace exit and the exit coiler.

FURNACE HOOD & HOOD CRANE

The furnace hood for batch annealing is lifted and lowered by a dedicated crane. Hood weights range from 5 to 30 tonnes depending on furnace size. Workers guide the hood during crane descent onto the coil base and during hood lifting after the annealing cycle — a large suspended load operation directly above the product being annealed.

COIL BASE & CONVECTOR PLATE

Coils are stacked on a refractory base with convector plates between coil turns to allow furnace atmosphere circulation. Workers fit convector plates and position coils on the base before annealing — handling components that may still be hot from the previous cycle. Post-anneal, coil base components must be cleared before the base is used for the next batch.

SOLUTION TREATMENT FURNACE (AGE-HARDENING ALLOYS)

High-strength aluminium alloys (2xxx and 7xxx series) require solution treatment at higher temperatures followed by rapid quench in water or air. Solution treatment furnaces operate at 450–550°C. The quench sequence involves moving the product rapidly from the furnace to the quench tank — a time-critical operation where the urgency to complete the quench within the specified time creates production pressure that drives workers to approach hot product closely.

PROTECTIVE ATMOSPHERE GAS SYSTEM

Nitrogen, nitrogen-hydrogen, and hydrogen gas systems supply protective atmospheres to annealing furnaces. Gas cylinders and bulk supply connections are managed in the annealing area. Cylinder handling in an environment with active crane operations, hot product, and confined furnace access requires specific attention to cylinder stability and movement interface.

3 BATCH ANNEALING CYCLE — TASK FLOW & EXPOSURE POINTS**BATCH ANNEALING CYCLE****BASE PREPARATION & CONVECTOR FITTING**

Coil base cleared · convector plates fitted between coil turns

BURNS — HOT BASE COMPONENTS · LACERATION

COIL STACKING ON BASE

Coils loaded onto base by crane · stack built to height

SUSPENDED LOAD · CRUSH · LACERATION

HOOD LOWERING — FURNACE SEAL

Furnace hood lowered by crane over coil stack

SUSPENDED LOAD · CRUSH · CAUGHT-BETWEEN

ANNEALING CYCLE — HOLD & SOAK

Product held at temperature · atmosphere maintained

GAS CYLINDER HANDLING · ATMOSPHERE MONITORING

HOOD LIFTING — POST-ANNEAL EXPOSURE

Hood lifted by crane · hot coil stack exposed

BURNS — HOT COIL STACK · SUSPENDED LOAD

COIL REMOVAL & TRANSFER

Annealed coils removed by crane · transferred to cooling bay

BURNS · SUSPENDED LOAD · LACERATION

RETURN TO COLD ROLLING OR FINISHING LINE

RESIDUAL HEAT IN COIL STACK PERSISTS FOR HOURS

4 CURRENT FIELD INTERFACES OBSERVED

Annealing area hand exposure is shaped by two factors that do not appear in other processing departments: the product is invisible as a thermal hazard after the hood is removed — coils look the same at 200°C as at ambient — and the crane operations involve some of the heaviest suspended loads in the plant.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — contact with post-anneal coil to check temperature	Workers frequently confirm whether an annealed coil has cooled sufficiently by touching the coil surface or the outer wrap edge. This bare-hand temperature check is the most common hand burn source in batch annealing operations. The coil outer wrap edge is at the same temperature as the coil surface but presents the additional laceration risk of the sharp aluminium edge alongside the thermal exposure.
Bare hands — furnace hood crane guidance	The furnace hood is guided during crane descent over the coil stack using bare hands or a fabricated rod. Hood weights of 5–30 tonnes mean any swing during crane descent carries significant momentum. Workers are adjacent to the coil stack during hood lowering — in the crush zone between the descending hood and the coil stack below. No rated stand-off tool is in standard use for hood guidance in most annealing operations.
Bare hands — convector plate fitting and base preparation	Convector plates are fitted between coil turns on the annealing base before the hood is lowered. These components may still be at elevated temperature from the previous annealing cycle. Workers fit them by hand in the confined space between coil turns — a confined and thermally hazardous working geometry that is repeated on every base preparation cycle.
Improvised rod or bare hands — gas cylinder movement in annealing area	Nitrogen and protective gas cylinders are moved in the annealing area by hand grip on the valve or cylinder body — in a zone with active overhead crane operations handling furnace hoods and coil stacks, and with elevated floor temperatures adjacent to the furnace bases. Cylinder handling during active crane operations creates a combined crushing and fall hazard for the cylinder and the worker.

ENGINEERING OBJECTIVE — ANNEALING & HEAT TREATMENT

Provide rated stand-off interfaces for furnace hood crane guidance and post-anneal coil handling that keep workers outside the crush zone and thermal hazard zone throughout the loading, cycling, and unloading sequence. Eliminate bare-hand temperature checks on post-anneal product.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Furnace Hood Crane Guidance — Lowering & Lifting	
SUSPENDED LOAD · CRUSH · BURNS					
WHY THE HAND IS THERE The batch annealing furnace hood must be lowered precisely over the coil stack on the base, and the hood skirt must seat correctly on the base seal. If the hood lands off-centre, the seal is compromised and the atmosphere may leak. Workers guide the hood during crane descent to achieve correct alignment over the coil stack — placing them adjacent to the coil stack in the crush zone between the descending hood and the coils below.		CURRENT FIELD INTERFACE Bare hands or fabricated rod used to guide the hood during crane descent. After the annealing cycle, the hood is lifted by crane with the coil stack still hot underneath. Workers approach the hot coil stack to attach the next batch's coil slings while the hood is being moved on the overhead crane above. Simultaneous hood crane movement above and hot coil stack below at the same working position.		EXPOSURE TYPE Crush between the descending furnace hood and the coil stack or base during hood lowering. Burns from the hot coil stack surface if hands contact the coils while guiding the hood above. Struck-by if the heavy hood swings during crane travel or descent. The combination of large suspended load above and hot product immediately below is the defining hazard geometry of batch annealing operations.	
ENGINEERING OBJECTIVE Guide the furnace hood to its correct seating position over the coil stack without placing workers between the descending hood and the coil stack below, and without workers approaching the hot coil stack to confirm hood alignment during the crane descent sequence.			REPRESENTATIVE INTERFACE Anti-Tangle Tagline for hood swing control during crane travel. Representative push/pull interface (6 ft, S-Head or equivalent) for hood lateral guidance during descent — worker positioned outside the hood-to-base crush zone throughout the descent. Hood alignment confirmed by visual reference marks on the base rather than by worker proximity to the coil stack.		
"During furnace hood lowering, where is the guidance worker positioned relative to the coil stack and the descending hood — and is that position outside the crush zone between hood and stack throughout the full crane descent?"					

HIGH				Post-Anneal Coil Handling — Hot Coil Stack Approach	
BURNS — HOT PRODUCT · LACERATION · SUSPENDED LOAD					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After the annealing hood is lifted and removed, workers approach the coil stack to confirm it has cooled sufficiently, attach lifting slings for coil removal by crane, and begin removing coils from the stack. Post-anneal coil temperatures depend on cooling hold time — coils may still be at 150–300°C when the hood is first removed. The visual appearance of the coil provides no indication of its temperature.		Bare hand contact with the coil outer wrap or coil surface to confirm temperature before sling attachment. Slings attached by hand with the worker adjacent to a coil stack that may still be at 150–300°C. Coil removal by crane guided by hand as each coil is lifted from the stack — hands near a coil that was at annealing temperature within the last few hours.		Burns from contact with the post-anneal coil surface or outer wrap edge while confirming temperature. Burns from the coil outer wrap edge — which combines thermal exposure with the laceration risk of the sharp aluminium edge. Suspended load exposure during crane coil removal from the stack. Burns compounded by the invisible nature of the thermal hazard on a cooled-appearance coil.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Confirm post-anneal coil temperature using an instrument rather than bare-hand contact, and attach slings and guide crane coil removal without direct hand contact with the coil surface or outer wrap edge until temperature has been confirmed below the safe handling threshold.			Contact or non-contact thermometer for coil temperature confirmation — replaces bare-hand temperature check. Anti-Tangle Tagline for coil swing control during crane removal from stack. Representative push/pull interface for coil lateral guidance during crane lift — no hand contact with coil surface until temperature confirmed at safe handling level.		
"After the annealing hood is removed, how is the coil stack temperature confirmed before workers attach slings — and is that confirmation method an instrument reading or a bare-hand check?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH			Solution Treatment Quench — Time-Critical Hot Product Handling		
BURNS — HOT PRODUCT · SUSPENDED LOAD · LINE OF FIRE					
WHY THE HAND IS THERE High-strength alloy solution treatment requires the product to be transferred from the furnace to the quench tank within a defined time window — typically 15–30 seconds — to achieve the required microstructure. This time pressure is absolute: if the quench is delayed beyond the specified window, the batch must be re-treated. Workers are therefore under the highest operational pressure in the heat treatment area to complete the furnace-to-quench transfer at maximum speed, regardless of proximity to the hot product.		CURRENT FIELD INTERFACE Crane-suspended product transferred from furnace to quench tank at maximum crane speed. Workers guide the load during crane travel and confirm correct positioning over the quench tank before descent. The time pressure on the quench sequence creates exactly the same operational dynamic as metal tapping in the cast house — the production consequence of delay drives workers to work at closer range than the hazard warrants.		EXPOSURE TYPE Burns from contact with product at solution treatment temperature (450–550°C) during crane guidance. Struck-by from load swing if the crane must travel quickly to meet the quench time window. Burns from quench water splash when the hot product enters the quench tank — quench splashing is particularly severe with hot aluminium entering water. Suspended load crush during rapid crane operations under time pressure.	
ENGINEERING OBJECTIVE Guide the product from the solution treatment furnace to the quench tank within the required time window without placing workers in contact with the hot product surface or in the load swing zone during the rapid crane travel and quench descent sequence.			REPRESENTATIVE INTERFACE Anti-Tangle Tagline pre-attached before the furnace door opens — enabling immediate swing control as the load exits the furnace without requiring workers to attach taglines to a hot load under time pressure. Representative push/pull interface for quench tank positioning at stand-off from both the hot product and the quench splash zone.		
"During the solution treatment quench sequence, is the tagline attached to the load before it exits the furnace — or does the urgency of the quench time window mean taglines are sometimes omitted to save time?"					

MEDIUM			Convector Plate Fitting & Base Preparation	
BURNS — HOT COMPONENTS · LACERATION · ERGONOMIC				
WHY THE HAND IS THERE Before each annealing batch, convector plates are fitted between coil turns on the furnace base to allow atmosphere circulation. The base and convector plates from the previous annealing cycle may still be at elevated temperature. Workers fit convector plates by hand in the confined space between coil turns — a task that requires reaching into the narrow gap between large-diameter coils at close range to both the hot base and the sharp coil outer wrap edges.		CURRENT FIELD INTERFACE Direct hand contact with convector plates during fitting between coil turns. Where previous cycle heat is still present, workers rely on gloves or informal cooling time rather than temperature confirmation before handling. The confined geometry between coil turns requires hands to enter a space bounded on all sides by either hot refractory, hot coil surface, or sharp aluminium outer wrap edge.		EXPOSURE TYPE Burns from contact with convector plates or the furnace base that retain heat from the previous annealing cycle. Laceration from contact with coil outer wrap edges during convector fitting in the confined inter-coil space. Ergonomic strain from sustained awkward reach posture required to fit convectors in the space between coil turns at the height of the coil stack.
ENGINEERING OBJECTIVE Fit convector plates between coil turns without direct hand contact with base components that may still be at elevated temperature from the previous annealing cycle, and without sustained hand entry into the confined space bounded by hot refractory and sharp coil outer wrap edges.			REPRESENTATIVE INTERFACE Temperature confirmation of base and convector components before handling — contact thermometer reading before hands approach the inter-coil space. Purpose-designed convector fitting tool that allows plates to be positioned without sustained hand entry between coil turns. This is a process engineering approach rather than a standard PSC catalogue product — PSC can advise on applicable reach and positioning interfaces.	

"Before workers fit convector plates between coil turns, is the temperature of the base and convector components confirmed using an instrument — or is the decision to handle them based on elapsed time since the last cycle?"

6 NON-ROUTINE & MAINTENANCE EXPOSURE

Annealing furnace maintenance involves working inside or adjacent to equipment that retains heat from production cycles. Refractory repair and base maintenance are the most common maintenance activities and both involve working in or adjacent to the furnace interior at elevated ambient temperature.

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Furnace hood inner refractory repair	Workers enter the hood interior for refractory inspection and patching; hood interior at elevated temperature after production; refractory material applied by trowel in confined overhead geometry; working at height inside the hood	HIGH	Burns · Confined Space · Chemical	PSC Position & Reach · PSC Striking & Alignment Interfaces
Coil base refractory maintenance	Base refractory cracking and spalling repaired between annealing cycles; base still at elevated temperature; heavy refractory components positioned by hand; confined access around base edges	HIGH	Burns · Crush · Chemical	PSC Position & Reach · PSC Striking & Alignment Interfaces
Continuous furnace strip break and re-threading	Strip break in continuous annealing furnace requires manual strip retrieval in the furnace entry or exit zone; high ambient temperature; confined furnace throat geometry; strip at elevated temperature	HIGH	Burns · Laceration · Confined Space	PSC Position & Reach · PSC Retrieval Interfaces
Protective atmosphere gas cylinder replacement	Gas cylinders moved in the annealing area during active crane operations handling hoods and coil stacks; elevated floor temperature adjacent to furnace bases; cylinder movement on uneven hot floor surfaces	MEDIUM	Crush · Ergonomic · Thermal	PSC Specialised Maintenance Interfaces
Quench tank maintenance and cleaning	Quench tank interior accessed for cleaning and maintenance; tank contains residual quench water with dissolved aluminium salts; confined tank geometry; hot product residue on tank walls and base	MEDIUM	Chemical · Confined Space · Burns	PSC Position & Reach Interfaces

7 ANNEALING & HEAT TREATMENT QUICK ASSESSMENT CHECKLIST

Use during an annealing area walkdown. The first two items address the most common causes of burns in batch annealing operations.

- ☐ After the annealing hood is removed, is coil stack temperature confirmed using an instrument before workers approach to attach slings — not by bare-hand contact with the coil surface or outer wrap?
- ☐ Before convector plates are fitted between coil turns, are the plate and base temperatures confirmed by instrument — not by elapsed time since the previous annealing cycle?
- ☐ During furnace hood lowering by crane, is the guidance worker positioned outside the crush zone between the descending hood and the coil stack — using a stand-off tool for hood lateral guidance?
- ☐ During coil removal from the annealing base by crane, is an anti-tangle tagline used for swing control — and are workers outside the hot coil swing zone during crane travel?
- ☐ During solution treatment quench, is the tagline attached to the load before it exits the furnace — so tagline control is available during the rapid crane travel sequence without requiring attachment to a hot load under time pressure?
- ☐ During protective atmosphere gas cylinder replacement, are cylinders moved using a purpose-designed cylinder lifter — not by hand grip on valve or cylinder body in an active crane working area?
- ☐ During furnace hood refractory maintenance, are impact tools held with a holding tool — not bare hand — during all chisel and crow bar operations inside the hood interior?
- ☐ During continuous furnace strip break recovery, is a purpose-designed strip retrieval tool available at the furnace entry and exit — not relying on improvised bare-hand strip management at elevated temperature?

If any observation above reflects current practice in your plant, PSC Hand Safety India can review those tasks and recommend representative engineered interfaces. Contact details are on the final page of this chapter.

8 PSC ENGINEERING INTERFACE PORTFOLIO — ANNEALING & HEAT TREATMENT

LOAD CONTROL INTERFACES — HOOD & COIL CRANE GUIDANCE

INTERFACE	PRIMARY ANNEALING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for furnace hood during crane lowering and lifting. Swing control for coils during removal from the hot annealing base. Pre-attached to solution treatment loads before furnace door opens — provides immediate swing control under quench time pressure.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · 2 · 3
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Furnace hood lateral guidance during crane descent over coil stack. Post-anneal coil lateral guidance during crane removal from stack. Solution treatment load positioning over quench tank at stand-off from both hot product and quench splash zone.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 2 · 3

STRIKING & ALIGNMENT · SPECIALISED INTERFACES

INTERFACE	PRIMARY ANNEALING APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding chisels and crow bars during furnace hood and base refractory repair. Removes the holding hand from the hammer strike zone during all impact operations inside the furnace hood or at the coil base.	350 mm, 850 mm	PSC-FS-350 PSC-FS-850	Maint.
SPECIALISED PSC GasGrab® Cylinder Lifter	Moving nitrogen and protective atmosphere gas cylinders in the annealing area during active crane operations. Eliminates valve-grip and body-grip cylinder handling in a zone with elevated floor temperature and active overhead crane operations.	215 mm, 230 mm, 254 mm	PSC-GG-215 PSC-GG-230 PSC-GG-254	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — THE INVISIBLE THERMAL HAZARD

Post-anneal aluminium looks identical at 250°C and at ambient temperature. The burn hazard from hot annealed product is invisible in a way that liquid metal hazards are not.

In the potroom and cast house, the thermal hazard is visible — glowing metal, visible heat shimmer, obvious radiant heat. In the annealing bay, a coil stack at 200°C looks exactly like one at 30°C. This invisibility means that the risk of bare-hand temperature checking is higher in annealing than in any other thermal hazard area in the plant. The engineering control — instrument confirmation before hand approach — removes the need for the worker to estimate temperature from visual cues that provide no reliable information.

1 DEPARTMENT OVERVIEW

Extrusion converts heated aluminium billets into profiles — structural sections, tubes, rods, and complex architectural shapes — by forcing the billet through a precision die under high hydraulic pressure. The press ram applies forces of 1,000–14,000 tonnes, and the billet exits the die at 450–550°C. Hand exposure in the extrusion area is concentrated at four points: billet loading into the press, the die entry and exit zones at the press platen, the profile puller and run-out table where the hot extruded profile is guided away from the press, and the die shop where dies are corrected, preheated, and maintained between runs.

Billets arrive at the press either directly from a billet heating furnace (induction or gas) or from a billet storage rack. Billet temperatures at press entry are typically 420–500°C. The billet loader — a mechanical arm or manual tong system — picks the billet from the furnace exit and seats it in the press container. Workers interact with this sequence to confirm billet seating, clear billet loading errors, and remove billet discard (butt) after each extrusion cycle. The die shop services all dies between extrusion runs — cleaning, polishing, correcting profile dimensions, and preheating to 450°C before press installation.

2 MAJOR EQUIPMENT & LOCATIONS

EXTRUSION PRESS

Hydraulic press applying 1,000–14,000 tonnes of force to push the heated billet through the die. The press container, ram, and die assembly are the primary hazard locations. The ram advances at controlled speed during extrusion and retracts rapidly after the cycle. Workers must not approach the ram travel zone during the press cycle.

BILLET HEATING FURNACE

Induction or gas furnace heats billets to 420–500°C before press entry. The furnace exit presents the primary burn exposure in billet handling — billets are visually indistinguishable from cold billets once they exit the bright orange heating zone and begin to cool on the transfer table.

BILLET LOADER & CONTAINER

Mechanical or manual system transfers the heated billet from the furnace exit to the press container. Manual billet loading requires tong or manipulator approach to the hot billet. Container upset — where the billet does not seat correctly — requires manual correction close to the press die face.

RUN-OUT TABLE & PROFILE PULLER

The extruded profile exits the die at 450–550°C and is guided along the run-out table by a puller mechanism and workers. The profile is still at extrusion temperature for the first metre or more from the die. Workers guide the profile leading end onto the puller, cut profiles to length with a travelling saw, and stretch the profiles on a stretcher for straightening.

DIE SHOP

The die shop cleans, polishes, corrects, and preheats dies between extrusion runs. Die correction involves hand-grinding and polishing tools on precision die faces — work requiring close approach to the die cavity with rotating abrasive tools. Die preheating involves handling dies at up to 450°C. Die storage and transport between shop and press requires crane handling of dies weighing up to 500 kg.

LOG SAW & BILLET STORAGE

Extrusion logs (cast rods) are cut to billet length using a circular or band log saw. Log saw operations involve manual positioning of large-diameter cast rods against the saw feed system. Billet storage racks hold billets awaiting the heating furnace — loading and unloading racks by crane or manipulator requires hand interaction at the rack end positions.

3 EXTRUSION CYCLE — TASK FLOW & EXPOSURE POINTS

EXTRUSION PRESS CYCLE**BILLET HEATING — FURNACE EXIT**

Billet heated to 420–500°C · exits furnace onto transfer table

BURNS — HOT BILLET · INVISIBLE THERMAL HAZARD**BILLET LOADING INTO PRESS CONTAINER**

Hot billet transferred to press container by loader or tongs

BURNS · CRUSH — PRESS RAM · STRUCK-BY**EXTRUSION PRESS CYCLE**

Ram advances · billet extruded through die · profile exits

BURNS — HOT PROFILE · NIP POINT — PULLER**PROFILE GUIDANCE ON RUN-OUT TABLE**

Hot profile guided on run-out table · cut to length · stretched

BURNS · LACERATION — PROFILE EDGES · STRUCK-BY**BUTT DISCARD REMOVAL**

Billet butt removed from container after each press cycle

BURNS — HOT BUTT · CRUSH — PRESS RAM**DIE CHANGE — REMOVAL & INSTALLATION**

Used die removed · corrected die installed at press platen

BURNS — HOT DIE · CRUSH · PINCH**PROFILE TO AGEING / FINISHING → Chapter 17****HOT BILLET AND DIE ARE VISUALLY INDISTINGUISHABLE FROM COLD**

4 CURRENT FIELD INTERFACES OBSERVED

Field interfaces below reflect standard working practice across aluminium extrusion operations at small, medium, and large extrusion plants.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands or light gloves — profile guidance on run-out table	Workers guide the hot extruded profile along the run-out table using bare hands or light gloves — sometimes touching the profile within the first metre from the die exit where surface temperature may still be 350–450°C. The run-out table also presents a nip hazard at each driven roll pair. Profile shapes with sharp re-entrant features or thin wall sections present laceration risk alongside the thermal hazard.
Bare tongs or bare hands — butt discard handling	The billet butt — the small disc of aluminium remaining in the container after the press cycle — is ejected at full container temperature. Workers collect the butt from the ejection point using bare tongs or improvised tools. The butt is at container temperature — typically 400–450°C — at the moment of ejection, and the confined geometry of the butt ejection zone brings workers close to both the butt and the press ram return path.
Bare hands — die handling between die shop and press	Dies are transported between the die preheating oven and the press platen at 400–450°C. Workers handle pre-heated dies with heat-resistant gloves that may be inadequate for sustained contact with a 450 kg die at 450°C. The die must be oriented correctly and seated precisely in the die holder at the press platen — a positioning task that requires hands near the die face.
Bare hands — die correction grinding in die shop	Die correction involves hand-grinding and polishing tools on precision die land areas. The grinding operation generates sharp aluminium particles from previous extrusion residue on the die and fine steel abrasive particles. Hand-grinding on a die face requires close-approach work with rotating tools in the die cavity geometry.

ENGINEERING OBJECTIVE — EXTRUSION & DIE SHOP

Provide stand-off interfaces for hot billet, hot profile, and hot die handling throughout the extrusion cycle. Eliminate bare-hand contact with extruded profiles on the run-out table and with billet butts at the container exit.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Hot Profile Guidance on Run-Out Table	
BURNS — HOT PROFILE · LACERATION · NIP POINT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
The extruded profile exits the die at 450–550°C and must be guided along the run-out table to the profile puller without bending, buckling, or contacting the table guards in a way that would mark the profile surface. Workers guide the profile leading end onto the puller and manage profile alignment along the run-out table as the extrusion speed builds. For complex profiles, the worker must also confirm the profile cross-section is correct before the run is committed.		Bare hands or light gloves used to guide the hot profile on the run-out table. At the leading end closest to the die, the profile temperature may be 350–450°C. Profile shapes with thin wall sections, sharp re-entrant corners, or projecting features present simultaneous burn and laceration exposure. The run-out table driven rolls create nip points along the entire run-out table length.		Burns from contact with the hot extruded profile surface — temperature varies from 350–550°C within the first 2–3 metres from the die. Laceration from contact with sharp profile features on complex cross-sections. Nip point at each run-out table driven roll if the worker's hand contacts the table surface alongside the profile. Struck-by the profile leading end if it deflects from the puller during threading.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide the hot extruded profile onto the run-out table puller and along the run-out table without direct hand contact with the profile surface within the first 3 metres from the die exit, maintaining stand-off from both the profile temperature zone and the run-out table driven roll nip points.			PSC Load-It with S-Head (4 ft) for profile lateral guidance on the run-out table — stand-off tool keeps grip hand outside the profile temperature zone and the table nip zone. PSC FingerSaver™ for holding profile cross-section gauges and inspection tools near the hot profile. No bare hand contact with profile within 3 m of die exit.		
"At what distance from the die exit does the first hand contact with the extruded profile occur on your run-out table — and has the profile temperature at that point been measured?"					

HIGH				Die Handling — Preheated Die Transfer from Oven to Press							
BURNS — HOT DIE · CRUSH · PINCH											
WHY THE HAND IS THERE				CURRENT FIELD INTERFACE				EXPOSURE TYPE			
Dies must be preheated to 400–450°C before press installation to prevent thermal shock on first billet contact. Transfer from the preheating oven to the press requires handling a die at 400–450°C that may weigh up to 500 kg. For small dies, hand manipulation with heavy-duty heat-resistant gloves is common. For large dies, crane transfer is used but the die must be guided into the die holder with hands near the hot die face.				Heat-resistant gloves for direct die handling during die installation at the press platen. The die holder geometry requires precise die orientation and seating — workers reach into the press platen area to confirm correct die position. The platen area is at elevated temperature from the previous press cycle, and the die is at preheating temperature. Both the die face and the platen housing retain heat.				Burns from contact with the preheated die body at 400–450°C during handling and installation. Pinch between the die and the die holder if the die is displaced during installation. Crush if the die is crane-suspended and swings during transfer to the press platen. Burns from the heated press platen and container if hands contact these components during die installation.			
ENGINEERING OBJECTIVE				REPRESENTATIVE INTERFACE							
Transfer preheated dies from the oven to the press platen and seat them correctly in the die holder without sustained bare-hand contact with the die body at preheating temperature, and without placing hands between the die and the die holder during the seating operation.				PSC LoadGuider Anti-Tangle Tagline for swing control during crane die transfer. Representative push/pull interface (S-Head, 4 ft) for die lateral guidance during crane descent to press platen. Die installation tool for final seating confirmation — avoids hands between die and holder. Rated heat-resistant long-arm gloves for residual hand contact during installation alignment.							
<i>"During die installation at the press platen, are workers' hands between the die body and the die holder at any point during the seating sequence — and is the die temperature at that point confirmed?"</i>											

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Butt Discard Removal from Container after Press Cycle	
BURNS — HOT BUTT · CRUSH — RAM RETURN · STRUCK-BY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After each press cycle, a disc of aluminium — the billet butt — remains in the container. It must be sheared off and removed before the next billet is loaded. The butt is ejected from the container at container temperature (400–450°C) and must be collected from the ejection point and cleared from the press working area. Workers are required to be adjacent to the press at this point in the cycle while the ram is in its return stroke.		Bare tongs or long-handled hooks used to collect the hot butt from the ejection point. The tong grip may bring hands within 200–300 mm of the butt surface at container temperature. The butt is irregularly shaped and may roll or shift when contacted, creating unpredictable movement in the press working area. Workers are positioned adjacent to the ram return path during butt collection.		Burns from contact with the butt at container temperature if tong grip fails or butt rolls toward the worker. Crush or struck-by from the press ram return if the worker remains in the container area beyond the butt collection moment. Struck-by the butt if it bounces or shifts unexpectedly from the tong contact during collection. Burns from the ejection chute and container surround which retain heat from the press cycle.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Collect and clear the hot butt from the press working area at the completion of each press cycle without bringing the worker's hands within the thermal zone of the butt or within the ram return path — using a tool with sufficient reach to engage the butt from outside the press working zone.			PSC Load-It with S-Head or custom butt-grab head for butt collection from the ejection point at 4–6 ft stand-off — reaches the butt from outside the press ram return zone. PSC Long-Reach Pickup Tool for retrieving small butt fragments that roll away from the collection point. Defined collection position outside the ram return path marked on the press floor.		
"During butt discard collection, how close is the worker's grip hand to the hot butt at container temperature — and is the collection position inside or outside the ram return travel path?"					

MEDIUM				Die Correction Grinding in Die Shop	
LACERATION · ABRASIVE PARTICLE · ERGONOMIC					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Die correction involves manual grinding and polishing of the die land areas to adjust profile dimensions or repair die surface damage. Workers use hand-held rotary tools — die grinders, pneumatic polishers — to work on die faces that may have sharp aluminium extrusion residue in the die cavities and die bearing surfaces. The precision of die correction requires close visual approach with the grinding tool running adjacent to the die cavity opening.		Hand-held rotary die grinders used on die land areas, with the non-tool hand used to hold and position the die during grinding. Aluminium extrusion residue in die cavities is sharp and may be dislodged by the grinding action. Grinding wheel failure on a hand-held die grinder projects fragments at high velocity. Workers lean over the die to achieve the visual access required for precision grinding work.		Laceration from contact with sharp aluminium extrusion residue in die cavities during grinding preparation. Abrasive particle impact to face or eyes from the grinding operation. Rotary tool contact if the tool slips or kicks during die correction grinding. Ergonomic strain from sustained awkward posture over the die during precision grinding work.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Hold and position dies during correction grinding without placing the non-tool hand adjacent to the die cavity or grinding zone — using a die-holding device that maintains the die in the correct orientation without sustained bare-hand contact with the die face during the grinding operation.			Die-holding fixture or vice arrangement that secures the die in the correct orientation for grinding without requiring the non-tool hand to contact the die face. PSC FingerSaver™ for holding die-positioning guides and feeler gauges near the grinding zone. Full face shield as standard for all die shop grinding operations — not safety glasses alone.		
"During die correction grinding, what is holding the die in position — the worker's non-tool hand on the die face, or a fixture that secures the die independently of the grinding hand?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Press container liner replacement	Container liner removed and replaced with container at elevated temperature; heavy liner components lifted by crane; confined press access; container bore at production temperature	HIGH	Burns · Crush · Pinch	PSC Load Control · PSC Position & Reach Interfaces
Press ram seal and bearing maintenance	Ram seal and bearing accessed with ram retracted; press hydraulic circuits under pressure in adjacent systems; heavy ram components; confined press centre geometry	HIGH	Crush · Hydraulic · Pinch	PSC Position & Reach · PSC Striking & Alignment Interfaces
Log saw blade change	Circular or band saw blade removed and replaced; blade at cutting sharpness; heavy circular blade weight; residual aluminium swarf in saw housing	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Billet furnace element or burner maintenance	Heating elements or gas burners accessed in the billet furnace; furnace at elevated temperature after production; confined furnace interior; refractory surfaces at production temperature	HIGH	Burns · Chemical · Confined Space	PSC Position & Reach Interfaces
Profile saw blade change on run-out table	Travelling saw blade changed at saw housing on run-out table; blade at cutting sharpness; residual hot profile material in saw area	MEDIUM	Laceration · Burns · Pinch	PSC Striking & Alignment Interfaces

7 EXTRUSION QUICK ASSESSMENT CHECKLIST

- ☐ At what distance from the die exit does the first hand contact with the extruded profile occur — and has the profile temperature at that point been confirmed below a defined safe handling threshold?
- ☐ During butt discard collection, is the worker's grip hand outside the thermal zone of the hot butt and outside the press ram return path throughout the collection sequence?
- ☐ During preheated die transfer from the oven to the press platen, is swing control in place for crane die transfer — and are workers' hands outside the die-to-holder crush zone during seating?
- ☐ In the die shop, are dies held in a fixture during correction grinding — or does the non-tool hand contact the die face during the grinding operation?
- ☐ During billet loading, is a rated billet loader or long-handled tong used — not improvised contact with the hot billet using short tools that bring hands within the billet thermal zone?
- ☐ During log saw blade change, are blade edges handled using a tool — not bare hands — during removal from and installation in the saw housing?
- ☐ During press container maintenance, is an anti-tangle tagline used for crane swing control on heavy container liner components during extraction and replacement?

Contact PSC Hand Safety India for guidance on extrusion-specific interface selection based on press size, billet diameter, and die weight range.

8 PSC ENGINEERING INTERFACE PORTFOLIO — EXTRUSION

POSITION & REACH INTERFACES — PROFILE, BILLET & DIE GUIDANCE				
INTERFACE	PRIMARY EXTRUSION APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Hot profile guidance on run-out table. Die lateral guidance during crane descent to press platen. Butt discard collection and clearance from press working area at rated stand-off from ram return zone.	4 ft, 6 ft	PSC-LIT-S006 PSC-LIT-S010	1 · 2 · 3
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving butt fragments that roll from the ejection point. Recovering profile trim pieces from the run-out table area. Die shop scrap and abrasive particle clearance without bare-hand contact.	6 ft	PSC-ST	3 · Die Shop

LOAD CONTROL & STRIKING INTERFACES				
INTERFACE	PRIMARY EXTRUSION APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for preheated dies during crane transfer from oven to press platen. Swing control for container liner components during crane-assisted replacement.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	2 · Maint.
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts during press and die hardware installation. Die-positioning gauges near the grinding zone in die shop correction work. Log saw blade retaining bolt installation.	250 mm, 350 mm, 850 mm	PSC-FS-250 PSC-FS-350 PSC-FS-850	4 · Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — THE DIE SHOP IS NOT A LOW-HAZARD ENVIRONMENT

The die shop combines rotating abrasive tools, sharp aluminium residue, and hot dies in a workshop environment that can create a false sense of lower hazard compared to the press floor.

Die shops are quiet, well-lit, and the work is skilled and deliberate — conditions that are associated in most manufacturing settings with lower risk. But the hazards are categorical: a die grinder slip on a die cavity with sharp aluminium extrusion residue generates lacerations that are not mitigated by the calm environment. Die correction requires a physical holding fixture for the die and a defined hand exclusion zone around the grinding area — not a reliance on the die shop environment feeling less hazardous than the press floor.

1 DEPARTMENT OVERVIEW

Scrap handling and coil bay operations are the highest-volume crane interaction areas in a flat-rolled aluminium plant. Scrap arises from crop ends, trim scrap, off-specification material, and process rejects across all production departments and must be collected, consolidated, and transferred to the remelt furnace. Coil bay operations transfer production coils between processing steps. Both areas involve overhead crane operations with heavy loads, sharp aluminium edges, and workers in close proximity to suspended loads during routine operations. Field observations at a Hindalco facility documented multiple instances of workers with bare hands on suspended scrap coils during crane lifts — some while the load was still in motion.

The defining characteristic of scrap handling compared to production coil handling is that scrap material is irregular — tangled, jagged, loose-edged, and unpredictable in shape. A production coil has defined geometry; a scrap bundle does not. Workers must interact physically with the scrap to attach slings, confirm bundle stability, and position it for crane pickup — all tasks that require contact with the irregular, sharp edges of the scrap material itself. Chain crane and overhead EOT crane operations in the scrap bay are typically less choreographed than in the production coil bay, with higher worker density and less defined work zones.

2 MAJOR EQUIPMENT & LOCATIONS

SCRAP BAY OVERHEAD CRANE

EOT or monorail crane used for lifting and transferring scrap bundles, coil offcuts, and trim scrap containers between scrap bay collection points and the remelt furnace charging area. Workers guide scrap loads during crane travel and landing without the defined lifting points that characterise production coil handling.

SCRAP COIL & BUNDLE STORAGE

Area where reject coils, coil offcuts, and trim scrap bundles accumulate before transfer to remelt. Storage is typically unsystematic — scrap is placed where space is available. Workers navigate between stacked and loose scrap to access crane landing zones, creating both a trip hazard and a laceration exposure from unsecured scrap edges at ground level.

COIL BAY & COIL CAR SYSTEM

Production coils in transit between processing steps are stored in the coil bay and transferred on coil cars. Coil car loading and unloading requires crane assistance and worker guidance. The coil bay has higher crane traffic than any other area in the plant — multiple crane cycles per hour across multiple cranes sharing the bay overhead.

CHAIN CRANE & JIB CRANE (SCRAP BAY)

Lighter chain cranes and jib cranes are common in the scrap preparation area for moving individual scrap coils and cut scrap pieces. Chain crane hooks and chains create additional laceration hazards when they contact sharp scrap edges. Workers interact with chain cranes at closer range than EOT cranes, with less defined exclusion zones around the lift point.

SCRAP BALER & SHEAR

Scrap is compressed in a baler or cut in a scrap shear before charging to the remelt furnace. Loading scrap into the baler or shear requires workers to handle irregular scrap pieces — placing them into the baler throat or scrap shear feed table by hand or with long-handled tools. The baler and shear present nip and crush hazards at their feed entry zones.

REMELT FURNACE CHARGING AREA

Scrap is charged into the remelt furnace by crane or by charging machine. Workers guide scrap bundles during crane transfer to the furnace charge door. The furnace charge door area combines the suspended load hazard from the crane with thermal exposure from the open furnace.

3 SCRAP BAY & COIL BAY — EXPOSURE MAP**SCRAP HANDLING & COIL BAY CYCLE****SCRAP COLLECTION — SLING ATTACHMENT**

Slings attached to irregular scrap bundles for crane pickup

LACERATION — SCRAP EDGES · CRUSH — HOOK/CHAIN

CRANE LIFT — SCRAP BUNDLE GUIDANCE

Scrap bundle lifted · guided during crane travel

SUSPENDED LOAD · STRUCK-BY · LACERATION

SCRAP BALER / SHEAR LOADING

Scrap pieces loaded into baler throat or shear feed

CRUSH — BALER NIP · LACERATION · CAUGHT-BETWEEN

COIL BAY — PRODUCTION COIL TRANSFER

Production coils moved between processing steps by crane/car

SUSPENDED LOAD · LACERATION · CRUSH

REMELT FURNACE CHARGING

Scrap charged to remelt furnace by crane or charging machine

SUSPENDED LOAD · BURNS — FURNACE · STRUCK-BY

SLING AND RIGGING REMOVAL POST-LANDING

Slings and chains removed from landed load after deposit

LACERATION · CRUSH — LOAD SETTLE · CAUGHT-BETWEEN

SCRAP TO REMELT → Chapter 05 / Cast House

IRREGULAR SCRAP MAKES EVERY LIFT A NON-STANDARD LIFT

4 CURRENT FIELD INTERFACES OBSERVED

The field observations below are drawn from the Hindalco Taloja site assessment (March 2026). Multiple critical observations relate directly to scrap coil and overhead crane operations in the scrap and coil bay area.

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — suspended scrap coil guidance during crane lift	A worker in a green high-visibility vest was directly observed standing below and in contact with a suspended tangled scrap coil being lifted by an overhead chain crane — hands and body in the load swing zone with no tagline or push/pull tool in use. Scrap coil outer edges are irregular and sharp. This is the highest-severity observation documented in the Hindalco assessment.
Bare hands — guiding suspended scrap coil during crane travel	A second worker was observed manually guiding a suspended scrap coil during an overhead crane lift — hands physically on the load chains and coil while the load was in suspension and the crane was in motion. Adjacent scrap coils on the floor created secondary struck-by and trip hazards. No stand-off distance was maintained at any point during the observed lift.
Bare hands — sling insertion with hand in coil eye gap	Workers observed inserting slings and lifting belts into crane hooks with hands positioned between the coil eye and the hook during attachment. If the coil shifts during sling insertion, the hand in the coil eye-to-hook gap is crushed. This was observed both on production coils and on scrap coil bundles in the coil bay area.
Bare hands — scrap baler and shear feed loading	Scrap pieces loaded into the baler throat or shear feed table by hand or with short improvised tools. The baler press ram and shear blade create crush and cut hazards at the feed entry zone. Workers leaning over the feed table to position scrap pieces bring hands into the baler entry zone.

ENGINEERING OBJECTIVE — SCRAP HANDLING & COIL BAY

Eliminate bare hand contact with suspended loads in the scrap bay and coil bay through consistent use of anti-tangle taglines for swing control, stand-off tools for load guidance, and tagline retrieval tools for sling attachment at height. No worker body contact with any suspended load at any point during any crane cycle.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Suspended Scrap Coil Guidance — Bare Hand Contact During Crane Lift		
	SUSPENDED LOAD · LACERATION · STRUCK-BY		
	WHY THE HAND IS THERE Tangled or bundled scrap coils have no defined geometry and no defined crane attachment points. Workers must guide the load during crane lift to prevent it from snagging on adjacent scrap, contacting fixed structure, or swinging unpredictably. The instinct to stabilise the load by direct contact is rational — and is exactly the behaviour observed at Hindalco with a worker physically beneath and in contact with a moving suspended scrap coil.	CURRENT FIELD INTERFACE Direct hand and body contact with the suspended scrap coil during crane lift. At Hindalco, the worker was in full contact with the suspended load — hands and body — while the chain crane was in motion lifting the load. Scrap coil edges are irregular and sharp. The load swing zone extended well beyond the worker's standing position.	EXPOSURE TYPE Crush if the suspended load swings against the worker's body or the adjacent stacked scrap. Laceration from contact with irregular sharp scrap coil edges during guidance. Struck-by if the crane chain or the scrap bundle shifts suddenly during the lift. Drop injury if the load is improperly slung and drops during the lift with the worker directly beneath.
	ENGINEERING OBJECTIVE Guide suspended scrap coil loads during crane lift and travel in the scrap bay without any body or hand contact with the suspended load — using a tagline for swing control and a stand-off tool for lateral guidance, with the guidance worker positioned outside the load swing arc throughout the full crane cycle.	REPRESENTATIVE INTERFACE PSC LoadGuider Anti-Tangle Tagline for scrap coil swing control during crane lift and travel. PSC Load-It (S-Head, 4–6 ft) for lateral load guidance during crane travel and landing — worker positioned outside the swing arc. No body contact with suspended load at any point. PSC TRT-3P Tagline Retriever for attaching taglines to loads at height without hand entry into the crush zone.	
	<i>"In the scrap bay, at what point during a crane lift does any worker first make physical contact with the scrap coil — before the lift, during travel, or only after the load has landed and all load energy has been released?"</i>		

HIGH			
Sling Insertion — Hand Between Coil Eye and Crane Hook			
CRUSH · CAUGHT-BETWEEN · LACERATION			
WHY THE HAND IS THERE Slings and lifting belts must be attached to the crane hook before or during the coil lift. Workers insert the sling loop through the coil eye and onto the crane hook — a task that requires hands to enter the space between the coil inner bore and the crane hook at the moment of attachment. This is the most consistent crush exposure in coil bay operations, observed on both production coils and scrap coil bundles at the Hindalco site.		CURRENT FIELD INTERFACE Direct hand insertion of sling loops into the gap between the coil eye and the crane hook during lift rigging. Workers observed with hands positioned in the coil eye gap at the moment the crane begins to take up slack — if the coil shifts during this phase, the hand in the gap between the coil bore and the hook has no withdrawal path.	
		EXPOSURE TYPE Crush between the coil inner bore and the crane hook as the crane takes up slack and the sling tightens. Caught-between the coil and the crane hook if the coil shifts during sling attachment. Laceration from the coil inner bore edge if the hand is withdrawn rapidly at the moment the crane tightens the sling.	
ENGINEERING OBJECTIVE Attach slings and lifting belts to crane hooks for coil lifts without placing workers' hands between the coil inner bore and the crane hook at any point during the rigging sequence — using a retrieval or attachment tool that manages the sling loop from outside the coil eye crush zone.		REPRESENTATIVE INTERFACE PSC TRT-3P Extendable Tagline Retriever for feeding sling loops through coil eyes and onto crane hooks from safe floor position — eliminates hand entry into the coil bore crush zone during rigging. PSC Load-It XT-Hook for engaging and positioning sling loops without hands entering the gap.	
<i>"During coil rigging for a crane lift, at what point do workers' hands enter the gap between the coil inner bore and the crane hook — and is there a tool available that performs the sling attachment without hand entry into that gap?"</i>			

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Scrap Baler and Shear Feed Loading	
CRUSH — BALER RAM · LACERATION · CAUGHT-BETWEEN					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Scrap pieces must be positioned in the baler throat or shear feed table in a way that achieves efficient compaction or cutting. Scrap that is not correctly positioned produces a poor bale or an off-cut that requires re-processing. Workers lean over the feed table or reach into the baler throat to position scrap pieces, bringing hands into the feed entry zone of the baler or shear — the zone where the press ram or shear blade will next travel.		Direct hand reach into the baler throat or shear feed table to position scrap pieces — using bare hands or short improvised push tools. Scrap pieces are irregular and sharp-edged. The baler ram advance confirmation is often visual rather than position-monitored, meaning the gap between the operator's hand clear signal and ram advance may be shorter than the time required for hand withdrawal.		Crush from the baler press ram if the hand is in the baler throat when ram advance is initiated. Laceration from sharp scrap edges during hand positioning of irregular scrap pieces. Caught-between the scrap piece and the baler feed guide walls if the scrap shifts during positioning. Laceration from the shear blade if the worker's hand is in the shear feed zone when the shear cycles.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Load scrap pieces into the baler throat and shear feed table without placing workers' hands in the baler press ram travel zone or the shear blade travel zone — using a long-handled positioning tool that reaches into the feed zone from outside the crush and cut hazard area.			PSC Load-It with S-Head (4–6 ft) for scrap positioning in baler throat and shear feed table — reach positions scrap correctly without hands entering the baler ram or shear blade travel zone. PSC Long-Reach Pickup Tool for retrieving small scrap pieces that need precise placement.		
"During scrap baler loading, is there a defined hand exclusion zone around the baler throat — and does the loading procedure require a rated tool for scrap positioning rather than direct hand reach into the baler feed zone?"					

MEDIUM				Ground-Level Scrap Handling — Sharp Edge Contact During Bundle Assembly	
LACERATION · ERGONOMIC · STRUCK-BY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Before scrap bundles can be crane-lifted, individual scrap pieces must be assembled into a bundle that is stable and correctly slung. Workers manually drag, position, and consolidate loose scrap pieces using hooks, rakes, or bare hands. Ground-level scrap — trim scrap, crop ends, small coil offcuts — has the sharpest edges in the scrap bay and must be handled at close range during assembly.		Bare hands or bare-shaft hooks used to drag and position loose scrap pieces during bundle assembly. Cold-rolled trim scrap and crop ends in the scrap bay are at the same sharpness as when they were produced — no blunting occurs during storage. Workers navigate between unsecured scrap pieces that can shift or fall during assembly.		Laceration from contact with sharp scrap edges during ground-level scrap bundle assembly. Struck-by if an unsecured scrap piece falls from a loosely stacked bundle during assembly. Ergonomic strain from sustained stooped posture during ground-level scrap dragging and positioning with short-handled hooks.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Assemble scrap bundles at ground level without direct hand contact with sharp scrap edges — using long-handled hooks, rakes, and push tools that maintain stand-off from the scrap edge during dragging and positioning operations.			PSC Load-It with S-Head (4–6 ft) for dragging and positioning loose scrap pieces during bundle assembly. PSC Long-Reach Pickup Tool for individual sharp-edged scrap pieces that need precise placement. Purpose-designed long-handled scrap rakes for loose trim scrap consolidation — adequate length to maintain upright working posture during scrap dragging.		
"During ground-level scrap bundle assembly, what is the handle length of the tool used to drag and position sharp scrap pieces — and does that length allow the worker to maintain an upright posture with hands outside the scrap edge contact zone?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC ENGINEERING INTERFACE CATEGORY
Crane hook and rigging inspection and replacement	Crane hooks and slings inspected and replaced; hooks at height on crane saddle; replacement hardware installed with hands in hook travel zone; old slings removed with sharp edge residue from scrap contact	HIGH	Laceration · Crush · Working at Height	PSC Position & Reach · PSC Load Control Interfaces
Baler ram and shear blade maintenance	Baler press ram seal and guide maintenance in the baler throat; shear blade replacement in shear housing; both require hands in the ram/blade travel zone during maintenance work	HIGH	Crush · Laceration · Pinch	PSC Striking & Alignment · PSC Position & Reach Interfaces
Coil car wheel and drive maintenance	Coil car wheel and drive mechanism accessed for maintenance; car on rails with live crane above; coil car travel zone unmarked during maintenance; heavy car components moved by hand in confined rail geometry	HIGH	Crush · Pinch · Struck-By	PSC Position & Reach · PSC Striking & Alignment Interfaces
Scrap bay floor and drain clearance	Scrap bay floor cleared of loose scrap, aluminium swarf, and coolant drain by hand tools; sharp scrap pieces at ground level throughout; drain covers removed by hand in the scrap bay floor	MEDIUM	Laceration · Slip · Ergonomic	PSC Retrieval · PSC Position & Reach Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ In the scrap bay, is there any point during a crane lift where a worker's hands or body are in contact with the suspended scrap load — including before lift-off, during travel, and during landing?
- ☐ During coil sling attachment, are workers using a tool to feed the sling through the coil eye and onto the hook — so that no hands enter the coil bore-to-hook gap during rigging?
- ☐ Is an anti-tangle tagline used on every scrap bay crane lift — including on chain crane lifts for small scrap coils, not only on EOT crane lifts for large bundles?
- ☐ During baler loading, is a rated long-handled tool used to position scrap in the baler throat — with a defined hand exclusion zone around the baler feed entry?
- ☐ During ground-level scrap bundle assembly, are long-handled tools used for dragging and positioning sharp scrap — with adequate handle length to maintain upright working posture?
- ☐ During scrap rigging removal after landing, are slings and chains removed from the load only after the load has fully settled and all residual load energy is confirmed released?

8 PSC ENGINEERING INTERFACE PORTFOLIO — SCRAP HANDLING & COIL BAY

LOAD CONTROL INTERFACES — SCRAP & COIL CRANE SWING CONTROL

INTERFACE	PRIMARY SCRAP BAY & COIL BAY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for scrap coil bundles during crane lift and travel in the scrap bay. Swing control for production coils in the coil bay. Directly addresses the field observation of bare hand contact with suspended scrap coils during crane operations at a Hindalco facility.	25 ft, 30 ft	PSC-LGTC-25 PSC-LGTC-30	1 · 2
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching slings and taglines to coil eyes and scrap bundle rigging points from safe floor position. Eliminates hand entry into the coil bore-to-hook crush zone during sling attachment. Extends 6–12 ft from floor position.	6–12 ft	PSC-TRT-3P	2

POSITION & REACH · RETRIEVAL INTERFACES

INTERFACE	PRIMARY SCRAP BAY APPLICATION	REP. SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull (S-Head & XT-Hook)	Scrap coil lateral guidance during crane landing. Baler throat and shear feed scrap positioning. Coil lateral guidance during coil car loading and unloading. Sling loop management using XT-Hook head for engaging rigging without hand entry into the crush zone.	2–6 ft	PSC-LIT-S006/S010 PSC-XT-J002/J003	1 · 3 · 4
RETRIEVAL PSC Long-Reach Pickup Tool	Retrieving individual sharp scrap pieces during bundle assembly. Ground-level scrap piece positioning near baler and shear feeds. Scrap bay floor clearance without bare hand contact with sharp aluminium offcuts.	6 ft	PSC-ST	3 · 4 · Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — IRREGULAR SCRAP MAKES EVERY LIFT A NON-STANDARD LIFT

Standard crane lift procedures are designed for loads with defined geometry and defined lifting points. Scrap coil bundles have neither. Every scrap bay crane lift is therefore a non-standard lift — and should be managed as one.

In the coil bay, the crane operator and the ground worker can predict how the load will behave during lift because production coils have consistent shape, weight, and centre of gravity. In the scrap bay, none of these factors are predictable. A tangled scrap coil bundle may shift, tip, or spin when the crane takes up the slack. The tagline and the stand-off tool are not optional accessories in the scrap bay — they are the only controls between the worker and an unpredictable moving load.

1 DEPARTMENT OVERVIEW

Foil rolling reduces aluminium strip to gauges as thin as 0.006 mm — thinner than human hair. At these extreme gauges, the strip edge is sharper than a surgical blade. Hand exposure in foil rolling is dominated by laceration from ultra-thin foil edges, strip break recovery in a confined oil-covered mill, and the cumulative edge contact frequency during slitting, web separation, and rewinding threading. No other area of an aluminium plant produces material with this inherent edge sharpness in routine handling.

Foil processing includes slitting wide foil coils to customer widths, annealing in dedicated foil furnaces, laminating with polymer or paper substrates, and rewinding into consumer and industrial rolls. Each step requires threading, coil handling, and trim scrap clearance at foil gauge. Strip break recovery at foil gauge — where broken ends are razor-sharp and the floor is oil-covered — is the highest-severity manual event in the foil department.

2 MAJOR EQUIPMENT & LOCATIONS

FOIL ROLLING MILL

Multi-stand or reversing foil mill reducing strip to final foil gauge at high speed. Strip at exit gauge has edges sharper than surgical blades. Strip breaks are more frequent than in conventional cold rolling. Recovery at foil gauge in a confined, oil-covered mill is the highest-severity manual event in the foil department.

DOUBLING STATION

For thinnest gauges, two foil webs are rolled together. After rolling, they must be separated by hand — peeling them apart requires contact with the foil edges of both webs simultaneously throughout the separation motion.

FOIL SLITTER

Cuts wide foil coils into narrower customer widths. Foil slitter trim scrap is the sharpest material in the plant — ultra-thin strip with sheared edges on both sides. Standard cut-resistant gloves rated for cold-rolled strip may not adequately protect against foil trim scrap.

FOIL ANNEALING FURNACE

Dedicated furnaces for foil coils. Foil coil outer wrap is at foil gauge sharpness — any contact during crane transfer generates severe laceration. Foil coil structure is fragile and easily deformed by mishandling.

LAMINATING LINE

Foil laminated with polymer film or paper for packaging applications. Multiple web threading, adhesive nozzles, and nip roll pairs throughout. Chemical exposure from adhesive system during maintenance.

REWINDING LINE

Foil coils rewound into consumer or industrial rolls. Threading the foil leading edge onto the rewinding core requires repeated direct contact with the foil cut edge — potentially several hundred edge contact events per operator per shift.

3 FOIL ROLLING & PROCESSING — TASK FLOW & EXPOSURE POINTS**FOIL ROLLING & PROCESSING CYCLE****ENTRY COIL LOAD — PAY-OFF REEL**

Cold-rolled coil loaded · foil web threaded through mill

LACERATION — FOIL EDGE · SUSPENDED LOAD · NIP

FOIL ROLLING — HIGH SPEED PRODUCTION

Strip reduced to foil gauge · high speed · rolling oil

NIP POINT · STRIP BREAK RISK · CHEMICAL OIL

STRIP BREAK RECOVERY (HIGHEST SEVERITY)

Foil fractures · razor-sharp broken ends in confined oil mill

LACERATION · NIP · OIL FLOOR · ENERGY RELEASE

FOIL SLITTING

Wide foil slit to customer widths · trim scrap cleared

LACERATION — ULTRA-THIN TRIM SCRAP

DOUBLING PASS & WEB SEPARATION

Two webs rolled together · separated by hand after rolling

LACERATION — FOIL EDGE CONTACT BOTH HANDS

LAMINATING & REWINDING

Foil laminated · rewound to consumer and industrial rolls

LACERATION · CHEMICAL · NIP POINT

FOIL TO CUSTOMER / CONVERTING

FOIL EDGE SHARPNESS EXCEEDS A SURGICAL BLADE

4 CURRENT FIELD INTERFACES & ENGINEERING OBJECTIVES

CURRENT INTERFACE	ENGINEERING LIMITATION
Bare hands — foil slitter trim scrap clearance	Foil slitter trim scrap at 0.006–0.1 mm gauge is the sharpest trim scrap produced in any aluminium process. Standard cut-resistant gloves rated for cold-rolled strip may not adequately protect against ultra-thin foil edges under the extraction force required to clear tangled trim scrap from the collection tray.
Bare hands — foil strip break recovery	Foil strip break generates broken ends with razor-sharp fracture edges in a confined, oil-covered mill. Recovery at foil gauge requires handling material that cuts through standard glove materials. The combination of ultra-sharp foil, oil-covered surfaces, production urgency, and confined mill access makes foil strip break recovery one of the highest-severity manual events in any aluminium plant.
Bare hands — web separation after doubling	After rolling in the doubled configuration, the two foil webs must be peeled apart by hand. Workers hold one web and peel the other — direct contact with the foil edges of both webs simultaneously. Where webs stick and release abruptly, the foil edge contacts the hand at speed.
Bare hands — rewinding core threading	Threading the foil leading end onto the rewinding core requires direct contact with the foil cut edge. At consumer foil rewinding rates, this threading operation is performed hundreds of times per shift — a cumulative laceration exposure source that is rarely tracked separately from individual incident records.

ENGINEERING OBJECTIVE — FOIL ROLLING & PROCESSING

Provide purpose-designed interfaces for foil trim scrap clearance, foil strip break recovery, web separation, and rewinding threading that eliminate bare hand contact with ultra-thin foil edges throughout the foil processing cycle.

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Foil Strip Break Recovery — Ultra-Sharp Broken Ends in Confined Oil Mill	
LACERATION · NIP POINT · OIL FLOOR · ENERGY RELEASE					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Foil strip breaks are more frequent than in conventional cold rolling. Recovery requires retrieving broken foil ends from the confined mill window in an oil-covered environment. Foil at 0.006–0.1 mm cannot be gripped safely with standard gloves — the foil edge cuts through them. The combination of ultra-sharp foil edges, oil-covered surfaces, production urgency, and confined access makes this the highest-severity manual intervention in the foil department.		Bare hands used to retrieve and manage broken foil ends in the mill window. Standard heavy gloves inadequate at foil gauge. Rolling oil at foil mill concentrations creates a highly slippery floor and equipment surface. Workers reach into the mill gap to retrieve broken ends, cut them square, and re-thread — all with improvised tools or bare hands under production pressure.		Severe laceration from contact with fractured ultra-thin foil edges — capable of penetrating standard industrial cut-resistant gloves. Nip point exposure if tools or hands enter the roll gap during foil retrieval. Slip on oil-covered mill floor during recovery. Energy release from residual tension in the broken foil web when released.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Define a standard foil strip break recovery procedure with a specific recovery kit — tools for foil end retrieval and cut-to-square preparation — that does not require bare hand contact with ultra-thin foil edges at any step of the recovery sequence.			PSC Long-Reach Pickup Tool for controlled foil end retrieval from mill window without bare hand contact. Folded heavy card or bakelite sheet as handling interface for foil positioning without skin or glove contact. Standard foil break recovery kit specification available from PSC.		
"Is there a defined foil strip break recovery kit at your foil mill — or does each operator improvise their recovery method when a break occurs?"					

HIGH				Foil Slitter Trim Scrap Clearance	
LACERATION · ENTANGLEMENT · NIP POINT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Foil slitter trim scrap at 0.006–0.1 mm accumulates in the collection tray as tangled, razor-sharp strips. The tray must be cleared periodically. Workers reach into the tray to extract the tangled scrap — contact with multiple ultra-sharp edges simultaneously across the palm and fingers.		Bare hands or standard hooks used to extract tangled foil trim scrap. Scrap tangles around itself and around the extraction tool — pulling it free requires force that draws foil edges across the hand or glove surface. Most cut-resistant gloves rated for cold-rolled strip do not provide adequate protection at foil gauge under this extraction force.		Severe laceration from contact with ultra-thin foil trim scrap edges during extraction. Entanglement of the scrap around the worker's fingers. Nip point if extraction force pulls the hand toward the slitter knife housing. Laceration through standard glove materials at foil gauge.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Clear foil slitter trim scrap without any contact with the foil trim scrap edges — using a jaw-grip or paddle tool that extracts the tangled scrap without drawing the edge across the hand surface.			PSC Long-Reach Pickup Tool for jaw-grip extraction of foil scrap bundles — avoids the edge-across-hand contact of hook extraction. PSC Load-It Scraper Head (custom) for pushing compacted foil scrap toward tray exit. Foil-grade cut-resistant gloves (EN388 cut level F minimum) as PPE supplement, not primary control.		
"During foil slitter trim scrap clearance, are the gloves in use rated for foil-gauge aluminium edges — validated against actual foil scrap from your slitter, not assumed from the standard cold-rolled plant glove specification?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Foil Web Separation After Doubling Pass	
LACERATION · ENTANGLEMENT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After the doubling pass, two foil webs must be peeled apart. Workers hold one web and peel the other away — direct contact with the foil edges of both webs simultaneously throughout the peeling motion. This is repetitive, performed on every doubled coil.		Direct hand contact with foil edges during web separation. Peel force varies — where webs stick and release abruptly, the foil edge contacts the hand at speed. The foil edges of both webs are in contact with the separating hand throughout the peeling motion.		Laceration from foil edge contact during the web separation motion — both edges simultaneously. Laceration from sudden peel-release if webs stick and release abruptly. Entanglement if foil wraps around fingers during separation.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Separate doubled foil webs without bare hand contact with the foil edge of either web — using a wedge tool that initiates and guides the peel without the edge contacting the worker's hand at any point.			Foil web separation wedge tool that initiates the peel without finger contact with the foil edge. This is a process-engineered tool specific to the foil doubling operation. Contact PSC for applicable interface engineering guidance.		
"During foil web separation, does the separation method require bare hand contact with the foil edge — and is the separation procedure defined and trained, or improvised by each operator?"					

MEDIUM				Rewinding Core Threading — Foil Leading Edge Repeated Contact	
LACERATION · NIP POINT · CUMULATIVE CONTACT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Threading the foil leading end onto the rewinding core requires direct contact with the foil cut edge. At consumer foil rewinding rates, this is performed hundreds of times per shift. Cumulative laceration from threading is a significant injury source rarely tracked separately.		Direct hand contact with the foil leading edge during core threading. The foil leading end from the slitter cut is the sharpest edge in the foil process. Workers thread this edge onto the core mandrel with a rapid, repeated motion across the full production run.		Laceration from contact with the foil leading edge during threading — contact frequency is the primary driver. Nip point at the rewinding mandrel nip between mandrel and incoming foil. Cumulative laceration across a full shift may represent hundreds of edge contact events.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Thread the foil leading edge onto the rewinding core without bare hand contact with the foil cut edge — using a threading tape or paddle technique that guides the foil leading end onto the core without edge-to-hand contact.			Threading tape or adhesive strip pre-applied to the foil leading end allows placement on the core without finger contact with the foil edge. Threading paddle for guiding the leading end to the mandrel surface without edge contact.		
"How many times per shift does each rewinding operator contact the foil leading edge during core threading — and has that cumulative frequency been assessed as a distinct laceration exposure source?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Foil mill roll change	Work rolls changed with razor-sharp foil residue on roll surfaces; same nip and crush hazard during extraction and insertion as conventional cold mill rolls	HIGH	Laceration · Crush · Pinch	PSC Load Control · PSC Position & Reach
Foil slitter knife change	Foil slitter circular knives removed and replaced; knife edges at extreme sharpness for foil gauge cutting; residual foil scrap in knife housing	HIGH	Laceration · Pinch	PSC Striking & Alignment · PSC Position & Reach
Laminator roll and adhesive maintenance	Laminator rolls and adhesive nozzles accessed for cleaning; chemical exposure; nip rolls at each laminator roll pair	HIGH	Chemical · Nip Point · Laceration	PSC Position & Reach Interfaces
Rewinder mandrel and chuck maintenance	Rewinder mandrel and chuck mechanisms serviced; residual foil wrap on mandrel is razor-sharp; heavy mandrel components	MEDIUM	Laceration · Pinch · Crush	PSC Position & Reach · Striking & Alignment

7 QUICK ASSESSMENT CHECKLIST

- ☐ Is there a defined foil strip break recovery kit at the foil mill — with specific tools for each step of the recovery — rather than improvised bare-hand recovery under production pressure?
- ☐ During foil slitter trim scrap clearance, is the extraction tool capable of removing tangled foil scrap without drawing the foil edge across the hand or glove surface?
- ☐ Are the gloves used for foil trim scrap clearance rated for foil-gauge aluminium edges — validated against actual foil scrap from your slitter?
- ☐ During foil web separation after the doubling pass, is a separation wedge tool used to initiate the peel — so that the foil edge does not contact the worker's hand during separation?
- ☐ During rewinding core threading, has the cumulative number of foil edge contacts per operator per shift been assessed as a distinct laceration exposure source?
- ☐ During foil slitter knife change, are knife sets handled using a tool — not bare hands — during removal from the arbor and transport to the knife store?
- ☐ Are foil coils transferred by crane with an anti-tangle tagline — given that foil coil outer wraps are at foil gauge sharpness during all crane operations?

8 PSC ENGINEERING INTERFACE PORTFOLIO — FOIL ROLLING & PROCESSING

RETRIEVAL INTERFACES — FOIL SCRAP & STRIP BREAK RECOVERY

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Foil strip break recovery — controlled foil end retrieval from mill window without bare hand contact. Foil slitter scrap tray extraction using jaw grip rather than hook extraction that draws foil edges across the hand.	6 ft	PSC-ST	1 · 2 · 4
CLEARANCE PSC Load-It® Scraper Head (Custom)	Pushing compacted foil slitter trim scrap toward collection tray exit. Foil mill floor clearance of oil and foil scrap accumulation during production and after strip break recovery.	3–4 ft	Custom — PSC	2 · Maint.

LOAD CONTROL & STRIKING INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Foil coil crane swing control during transfer between foil annealing, slitting, and rewinding — foil coil outer wrap at foil gauge sharpness.	25 ft, 30 ft	PSC-LGTC-25 / -30	Coil Bay
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts during foil slitter knife arbor work and rewinder mandrel hardware. Foil slitter knives are proportionally sharper than cold mill slitters — the FingerSaver is more critical, not less.	250 mm, 350 mm	PSC-FS-250 / -350	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — FOIL GAUGE CHANGES THE CUT LEVEL CLASSIFICATION

A standard cut-resistant glove tested against cold-rolled strip may not provide meaningful protection against foil-gauge aluminium edges. Glove specifications must be validated against the actual foil gauge in your process.

Most aluminium plant glove specifications are applied across all departments. The cut level that provides protection in the scalper area or coil bay may be inadequate for contact with foil at 0.006–0.1 mm gauge. Foil edges can cut through materials that effectively resist cold-rolled strip — the difference is categorical, not incremental. Plants that produce foil require a separate glove specification for foil handling tasks, validated by contact with actual foil scrap from their slitter rather than assumed from the standard cold-rolled classification.

1 DEPARTMENT OVERVIEW

Surface treatment and coating convert bare aluminium into finished products — anodised architectural sections, coated automotive sheet, painted building panels. These processes introduce a distinct hazard class not present in primary production or rolling: chemical burns from process baths containing caustic soda, sulphuric acid, chromic acid, and solvent-based coatings. Hand exposure in surface treatment combines the chemical burn hazard of process chemistry with the laceration hazard from aluminium strip edges and the suspended load hazard from coil and section handling.

The dominant hand exposure events in surface treatment are chemical contact during bath preparation, maintenance, and sampling; coil and section loading into process tanks and ovens; coating line strip threading; and handling of chemical dosing equipment. In anodising operations, the sulphuric acid bath — typically 18–20% concentration — can cause full-thickness skin burns within seconds of prolonged contact. In coil coating operations, solvent-based coatings present both a chemical burn and a fire risk from accumulation on skin, clothing, and surfaces.

2 MAJOR EQUIPMENT & LOCATIONS

ANODISING TANKS

Large process tanks containing sulphuric acid (18–20%), caustic soda etch solution, and various sealing baths. Workers interact with the tanks during loading and unloading of aluminium sections or sheets on jigs, bath maintenance, and chemical sampling. Tank entry and close approach for jig loading are the primary chemical exposure events.

CHEMICAL BRIGHTENING TANKS

Phosphoric/nitric acid brightening baths for high-gloss anodising applications. Chemical brightening solutions are highly aggressive — contact with bare skin causes rapid and severe chemical burns. Jig loading and unloading require workers to approach the brightening bath surface.

COIL COATING LINE

Continuous line where aluminium coil is cleaned, pre-treated, and painted or laminated. Strip threading, coater roll cleaning, and oven entry zone maintenance require close approach to chemical and thermal hazards. Roll cleaning involves solvent-based coating removal from coater rolls with bare hands or rags in many operations.

CHROMATE/PRE-TREATMENT SECTION

Chemical pre-treatment section applying chromate or chrome-free conversion coatings before painting. Chemical spray and immersion exposure during maintenance and sampling. Chromate solutions are toxic by skin absorption in addition to the burn hazard.

CURING OVEN

Strip coating is cured in a strip oven at 200–250°C. Strip threading through the oven entry zone, thermocouple replacement, and oven maintenance involve close approach to the hot oven interior and to the strip at curing temperature.

CHEMICAL DOSING & STORAGE

Chemical dosing pumps and storage tanks supply process chemistry to the treatment baths. Pump maintenance, tank filling, and line sampling involve handling concentrated chemical solutions — sulphuric acid, caustic soda, phosphoric acid — in the process area alongside active crane and strip handling operations.

3 SURFACE TREATMENT & COATING LINES — TASK FLOW & EXPOSURE POINTS**SURFACE TREATMENT & COATING LINES****COIL OR SECTION LOAD — PROCESS ENTRY**

Coil or section loaded onto process line or jig for treatment

SUSPENDED LOAD · LACERATION · NIP PROXIMITY

CHEMICAL PRE-TREATMENT

Etch, brightening, or conversion coating applied

CHEMICAL BURNS · SPLASH · SKIN ABSORPTION

ANODISING OR PAINTING / COATING

Anodising or paint coating applied to treated surface

CHEMICAL · ELECTRICAL · NIP POINT

CURING OVEN PASS

Coated strip or section passed through curing oven

BURNS — HOT STRIP · NIP POINT

BATH MAINTENANCE & SAMPLING

Process chemistry sampled · tanks replenished

CHEMICAL BURNS · SPLASH · CONFINED ACCESS

SECTION / COIL REMOVAL & TRANSFER

Treated product removed from line · transferred

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Process Bath Chemical Contact — Jig Loading and Anodising Tank Approach	
CHEMICAL BURNS · SPLASH · SKIN ABSORPTION					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Workers load aluminium sections on jigs into the anodising tank, etch tank, and brightening bath by lowering the jig below the bath surface using an overhead crane or manual hoist. The loading approach brings workers over the bath surface — in the splash zone if the jig enters the bath at an angle or too quickly. Bath surface maintenance and chemical sampling require reaching over or adjacent to the open bath.		Close approach to open process bath surface during jig loading by crane. Chemical sampling performed by lowering sample tubes or bottles into the bath by hand. Bath surface inspection performed at close range without a physical guard between the worker and the bath surface. Chemical concentrations: sulphuric acid 18–20% for anodising; 5–15% caustic soda for etch; phosphoric/nitric acid for brightening.		Chemical burns from splash during jig entry into the bath. Skin absorption from chromate pre-treatment solutions without splash event. Chemical burn from inadvertent hand contact with the bath surface or bath rim during jig loading or unloading. Full-thickness acid burns from sulphuric acid or brightening solution contact within seconds of sustained exposure.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Load jigs into process baths without placing the worker's hands or face in the splash zone above the bath surface — using a defined loading approach, powered hoist for jig lowering, and a stand-off chemical sampling system that eliminates the need for the worker to lean over the bath during sampling.			Powered hoist or crane for all jig loading — eliminates manual lowering with hands adjacent to bath surface. Anti-splash loading procedure defining maximum jig entry speed. Remote chemical sampling system or sampling pole that keeps the worker outside the splash zone. No lean-over-bath visual inspection without chemical splash face shield in place.		
"During jig loading into the anodising or etch bath, is the jig lowered by a powered hoist — or is it manually lowered by workers with hands adjacent to the bath surface and face above the splash zone?"					

HIGH				Coater Roll Cleaning — Solvent-Based Coating Removal	
CHEMICAL BURNS · NIP POINT · FIRE RISK					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Coater rolls accumulate coating material that must be cleaned periodically to maintain coating quality. Roll cleaning is performed with solvent-based cleaners — in many coil coating operations, this involves a worker applying solvent with a rag or brush to the rotating roll surface. The rotating roll presents a nip hazard; the solvent presents a chemical and fire hazard; and the coating residue creates a slippery surface on the roll and the surrounding floor.		Rag or brush applied to the rotating coater roll surface with bare hands. Worker's hand is in close proximity to the rotating roll nip zone during cleaning. Solvent accumulates on the worker's hands and clothing during the cleaning operation. In high-speed operations, the roll rotation creates solvent mist in the working zone around the roll.		Chemical burns from prolonged solvent contact with bare skin. Nip point injury if the cleaning rag or brush is caught by the rotating roll and pulls the worker's hand into the roll gap. Fire risk from solvent accumulation on hands, clothing, and the roll surrounds during cleaning. Solvent vapour inhalation from the roll mist zone.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Clean coater rolls without the cleaning rag or brush being held adjacent to the rotating roll nip zone — using a cleaning tool with a grip position that keeps the worker's hands outside the nip zone of the roll and outside the accumulated solvent splash zone.			Long-handled roll cleaning tool that extends the grip position outside the roll nip zone during cleaning. Defined roll cleaning procedure that requires roll stop before hand approach to within 300 mm of the roll surface. Solvent-resistant gloves rated for the specific solvent in use — not general-purpose gloves.		
"During coater roll cleaning, is the roll running or stopped — and if running, is the cleaning method assessed for nip point risk from the rag or brush being caught by the rotating roll?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Coating Line Strip Threading — Oven Entry Zone	
BURNS — HOT ZONE · CHEMICAL · NIP POINT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Threading the strip through the coil coating line entry, including the chemical pre-treatment section and the curing oven entry zone, requires workers to approach the strip near the oven entry and pre-treatment spray sections. The oven entry zone is at curing temperature — 200–250°C — and the pre-treatment spray creates chemical mist in the threading zone.		Long rods or paddles used to guide the strip leading end through the coating line during threading. Workers approach the oven entry zone with the strip leading end at oven face temperature. Pre-treatment spray mist creates chemical exposure in the threading zone. Coating material on the strip leading end may drip or splash during threading.		Burns from contact with the strip at oven entry temperature during threading. Chemical burn from pre-treatment spray mist contact with bare skin. Nip point at each coating line roll pair during threading. Chemical coating material splash during strip threading through the wet coating section.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Thread the strip through the coating line without placing the worker's hands in the oven entry thermal zone or in the pre-treatment spray mist zone — using a threading tool with adequate reach to guide the strip from outside the thermal and chemical exposure zones.			PSC Load-It with S-Head (4–6 ft) for strip leading edge guidance during threading — reach positions the grip hand outside the oven entry temperature zone. Defined threading procedure with chemical splash face shield mandatory throughout the threading sequence.		
"During coating line strip threading, does the threading tool reach allow the worker to guide the strip through the oven entry zone with their grip hand outside the oven face temperature zone?"					

MEDIUM	Chemical Bath Maintenance — Close Access for Cleaning and Inspection CHEMICAL BURNS · CONFINED ACCESS · ERGONOMIC		
WHY THE HAND IS THERE Process baths require periodic internal cleaning — removing aluminium sludge from the bath base, cleaning anode bars and conductors in the anodising tank, and inspecting bath lining integrity. Bath entry or extended reach into the bath requires the worker to approach or enter a space that retains chemical residue even after draining.		CURRENT FIELD INTERFACE Workers reach into drained or partially drained baths using long-handled brushes or hand tools to clean sludge from the bath base. Residual chemical on the bath walls and base is at full process concentration in the sludge. Confined access into the bath requires sustained awkward posture. Anode bar cleaning requires reaching above shoulder height inside the bath.	EXPOSURE TYPE Chemical burns from contact with residual process chemical in the bath sludge or on the bath walls during cleaning. Confined space exposure if the bath is entered for cleaning with residual process gas. Ergonomic strain from sustained awkward reach posture inside the bath. Slip on the chemical-coated bath base.
ENGINEERING OBJECTIVE Clean process baths without bare hand contact with residual process chemical — using long-handled cleaning tools that maintain stand-off from the bath wall and base chemical residue throughout the cleaning operation.		REPRESENTATIVE INTERFACE Long-handled brush and scraper tools for bath base cleaning from above the bath lip without arm entry into the bath interior. Defined bath cleaning procedure requiring full chemical flush before worker approach. Chemical splash face shield and full chemical-resistant arm protection before any reach into the bath interior.	
"During process bath cleaning after draining, is residual chemical concentration on the bath walls and base confirmed below a safe handling threshold before workers reach into the bath interior?"			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Process bath lining repair	Bath lining accessed after draining; residual chemical on walls and base; confined bath geometry; heavy lining panels positioned by hand	HIGH	Chemical · Confined Space · Ergonomic	PSC Position & Reach Interfaces
Anode and cathode bar replacement in anodising tank	Anode bars removed and replaced in anodising tank; electrical connection hardware installed adjacent to the acid bath; heavy bar components; residual acid on bar surfaces	HIGH	Chemical · Electrical · Crush	PSC Striking & Alignment · PSC Position & Reach
Coater roll and applicator maintenance	Coater rolls removed and replaced; heavy roll components; coating and solvent residue on all roll surfaces; nip zones during roll reinstallation	HIGH	Chemical · Crush · Nip Point	PSC Load Control · PSC Position & Reach
Chemical dosing pump maintenance	Dosing pump seals and connections serviced with chemical residue in lines; chemical pressure present in adjacent circuits; confined pump housing access	MEDIUM	Chemical · Pinch · Ergonomic	PSC Position & Reach Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ During jig loading into process baths, is the jig lowered by a powered hoist — not manually with the worker's hands adjacent to the bath surface and face above the splash zone?
- ☐ During chemical sampling, is a sampling pole or remote system used — not a hand-lowered sample tube with the worker leaning over the open bath surface?
- ☐ During coater roll cleaning, is the roll stopped before the cleaning tool approaches within 300 mm of the roll surface — with a defined exclusion period before roll restart?
- ☐ During coating line strip threading, does the threading tool reach allow the grip hand to remain outside the oven entry temperature zone and the pre-treatment spray mist zone?
- ☐ During process bath maintenance after draining, is residual chemical concentration confirmed below a safe threshold before workers reach into the bath interior?
- ☐ Are chemical-resistant gloves specified per chemical type for each bath in the process line — not a single plant-wide glove specification applied to all process chemistries?
- ☐ During anode bar replacement, is the electrical isolation of the anodising rectifier confirmed before workers contact the anode bar connection hardware?

Contact PSC Hand Safety India for application-specific interface guidance.

8 **PSC ENGINEERING INTERFACE PORTFOLIO — SURFACE TREATMENT & COATING LINES**

POSITION & REACH INTERFACES — STRIP THREADING & CHEMICAL ZONE STAND-OFF

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Coating line strip threading — guides strip leading end through oven entry and pre-treatment zones with grip hand outside the thermal and chemical exposure zones. Chemical bath jig lateral guidance during crane descent.	4 ft, 6 ft	PSC-LIT-S006 / S010	3 · Jig

LOAD CONTROL & STRIKING INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for jigs and coil transfers during crane loading and unloading at process tanks and coating lines.	25 ft, 30 ft	PSC-LGTC-25 / -30	1 · Coil
STRIKING PSC FingerSaver™	Holding drifts during anode bar and chemical bath hardware installation. Removes holding hand from strike zone in chemically contaminated maintenance environments.	350 mm, 850 mm	PSC-FS-350 / -850	Maint.

9 **KEY ENGINEERING PRINCIPLE**

PRINCIPLE — CHEMICAL GLOVES MUST MATCH THE CHEMICAL, NOT THE PROCESS

A general-purpose chemical glove does not protect against sulphuric acid, caustic soda, phosphoric acid, and solvent coatings simultaneously. Each process bath requires its own glove specification.

Surface treatment plants typically operate multiple chemical processes in close proximity — anodising acid, caustic etch, chromate pre-treatment, and solvent coatings may all be active within 20 metres of each other. A single plant-wide chemical glove specification applied to all of these provides full protection against none of them. The engineering control is a process-specific glove matrix: the correct glove type for each specific chemical, confirmed against the actual chemical concentrations in use rather than against a general description of the chemical class.

1 DEPARTMENT OVERVIEW

The quality control laboratory and field inspection function are the last points of contact between the aluminium plant and the product before it reaches the customer. QC activities span the full plant — collecting samples from production, preparing samples for testing, running mechanical and chemical analysis, and inspecting finished product in the field. Hand exposure in quality control is characterised by high contact frequency with sharp aluminium sample edges, chemical exposure during wet chemical analysis, and pinch and crush hazards from mechanical testing equipment.

Laboratory technicians preparing metallurgical samples work with freshly cut, ground, and polished aluminium samples that are sharp-edged throughout the preparation sequence. Field inspectors collecting samples from production lines interact with strip, sheet, and coil material at production temperatures and at the sharp-edged condition that exists at each stage of processing. Mechanical test technicians operate tensile testing machines, hardness testers, and bend test fixtures that generate pinch and crush hazards during specimen loading and unloading.

2 MAJOR EQUIPMENT & LOCATIONS

SAMPLE CUTTING STATION

Metallographic samples cut from production material using a cut-off saw or band saw. Sample edges immediately after cutting are extremely sharp — sheared or abrasive-cut aluminium edges present the same laceration risk as production trim scrap. Sample handling after cutting and during mounting preparation is the highest laceration frequency activity in the QC laboratory.

METALLOGRAPHIC PREPARATION EQUIPMENT

Mounting press, grinding wheels, and polishing wheels for metallographic sample preparation. Mounting press generates high clamping force. Grinding and polishing wheels present abrasive contact and entanglement hazards. Polishing cloths on rotating wheels can catch gloves and clothing.

FIELD INSPECTION STATION

Field inspectors collect samples from production lines — strip samples cut from running or stopped coils, surface samples from sheet stacks, and dimensional checks on profiles. Field collection involves handling material at production temperature and condition, with the same laceration exposure as the production operators at that point in the process.

MECHANICAL TESTING MACHINES

Tensile testing, hardness testing, and bend testing equipment. Loading and unloading test specimens in grips, hardness anvils, and bend fixtures requires hands to approach the testing zone. Grip tightening on tensile specimens places the hands near the specimen grip zone during the clamping sequence. Bend test fixtures present pinch and crush hazards during specimen loading.

CHEMICAL ANALYSIS LABORATORY

Wet chemical analysis using acids (hydrochloric, hydrofluoric, nitric) for dissolution and preparation of analysis solutions. Hydrofluoric acid — used in some aluminium analysis procedures — is particularly hazardous as it penetrates skin without immediate pain, causing deep tissue damage that may not be apparent until hours after exposure.

COIL AND SHEET SAMPLE TRANSPORT

Samples collected from production and transported to the laboratory are typically large — coil samples may be 500 mm wide strip sections; sheet samples may be full-width sheets. Transport of these sharp-edged samples from production to laboratory requires the same handling approach as production material of the same type.

3 QUALITY CONTROL & INSPECTION LABORATORY — TASK FLOW & EXPOSURE POINTS**QUALITY CONTROL & INSPECTION LABORATORY****SAMPLE COLLECTION FROM PRODUCTION**

Field inspector collects sample from production line

LACERATION — SHARP SAMPLE · PRODUCTION HAZARDS

SAMPLE TRANSPORT TO LABORATORY

Sharp-edged sample transported to QC laboratory

LACERATION · ERGONOMIC · SUSPENDED LOAD

SAMPLE CUTTING — METALLOGRAPHIC PREP

Sample cut to test size · edges extremely sharp after cut

LACERATION — CUT EDGE · ABRASIVE · ENTANGLEMENT

MECHANICAL TESTING

Tensile, hardness, and bend tests performed

PINCH — GRIPS & FIXTURES · CRUSH · ERGONOMIC

CHEMICAL ANALYSIS

Wet chemical dissolution and analysis

CHEMICAL BURNS · HF HAZARD · SPLASH

RESULT REPORTING & SAMPLE DISPOSAL

Test results recorded · sample disposed or archived

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Sample Cutting — Sharp Aluminium Edge After Cut-Off Saw or Band Saw							
LACERATION · ABRASIVE · ENTANGLEMENT											
WHY THE HAND IS THERE				CURRENT FIELD INTERFACE				EXPOSURE TYPE			
Metallographic samples are cut from production material using a cut-off saw or band saw. The sample immediately after cutting has an extremely sharp machined edge on all cut faces. The sample must then be handled during deburring, mounting preparation, and labelling — a sequence that involves multiple contacts with the sharp cut edges.				Bare hands used to handle samples after cutting — the laboratory environment creates a false sense that sample handling is lower risk than production material handling. Cut aluminium samples are sharp-edged and the edges do not blunt between cutting and mounting. The small size of metallographic samples means hands must approach the sample closely for all handling operations.				Laceration from contact with sharp cut edges during sample handling after the cut-off saw or band saw. Abrasive contact if the hand contacts the grinding wheel or polishing wheel during sample preparation. Entanglement of glove material in the rotating grinding or polishing wheel during metallographic preparation.			
ENGINEERING OBJECTIVE				REPRESENTATIVE INTERFACE							
Handle metallographic samples after cutting using a sample grip or tong rather than bare hands — maintaining stand-off from the cut edge during all post-cutting handling operations up to the point where the sample is mounted in a metallographic mounting press.				Sample handling tongs for metallographic samples after cutting — keeps hands outside the cut edge contact zone during deburring, labelling, and mounting preparation. Defined sample handling procedure requiring tong use from cut to mounted. Anti-entanglement glove specification for grinding and polishing operations — no loose-weave gloves near rotating preparation wheels.							
"From the moment the metallographic sample is cut until it is fully mounted and the cut edges are encapsulated, is a tool used for all handling — or are cut samples handled by bare hand between the saw and the mounting press?"											

HIGH				Tensile Test Specimen Loading — Grip Zone Pinch Hazard	
PINCH — GRIPS & FIXTURES · CRUSH					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Loading tensile test specimens into the tensile testing machine grips requires workers to seat the specimen in both the upper and lower grip jaws and then tighten the grips to the clamping pressure required. The grip closing sequence — where the grip jaws close on the specimen — places the worker's hands in the grip zone. If the specimen slips or misaligns during clamping, the grip may close on the worker's fingers rather than the specimen.		Direct hand manipulation of the tensile test specimen in the grip jaws during loading and tightening. The grip jaws on a tensile testing machine close with significant clamping force — 5–50 kN depending on the machine and the specimen size. Workers hold the specimen in alignment in the grip zone during the initial jaw close while simultaneously operating the grip tightening mechanism.		Pinch between the grip jaw and the specimen or the grip housing if the worker's hand is in the grip zone when the jaw closes. Crush if the grip assembly falls during specimen loading. Laceration from the machined specimen edge if the specimen is released suddenly during loading.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Load tensile test specimens into grip jaws without placing the worker's hands inside the grip zone during jaw closure — using a specimen alignment guide that holds the specimen in the correct position during jaw tightening without requiring the worker's hand to be between the jaws.			Specimen alignment fixture or guide that holds the specimen in the grip zone during jaw tightening without requiring the worker's hand. Defined grip loading procedure requiring one hand outside the grip zone whenever the grip tightening mechanism is operated. No simultaneous specimen holding and grip tightening with both hands in the grip zone.		
"During tensile specimen loading, is any part of the worker's hand inside the grip zone when the grip jaws are tightened — and does the specimen alignment method require this, or is it a habit that a fixture could eliminate?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH	Hydrofluoric Acid Handling — Chemical Analysis of Aluminium		
	CHEMICAL BURNS · SKIN ABSORPTION · DELAYED INJURY		
	WHY THE HAND IS THERE Some aluminium alloy analysis procedures require dissolution in hydrofluoric acid. HF is uniquely hazardous compared to other acids used in aluminium analysis — it penetrates skin without immediate pain, causing deep fluoride ion penetration into tissue that may not manifest as visible injury for hours after exposure. By the time pain is felt, significant tissue damage may have already occurred.	CURRENT FIELD INTERFACE HF handling with chemical-resistant gloves and face shield — the standard laboratory procedure. The hazard in HF handling is not the procedure itself but the residual contact that occurs around the procedure: HF on the outside of the glove transferred to skin during glove removal, HF splash that contacts unprotected skin areas outside the glove or apron, and HF contact that does not produce immediate pain and is therefore not treated promptly.	EXPOSURE TYPE Deep chemical burns from HF penetration — systemic fluoride toxicity from significant skin exposure is a medical emergency. Burns that do not manifest immediately after exposure and may not be treated promptly as a result. Skin contact from HF on the outside of chemical gloves during glove removal.
	ENGINEERING OBJECTIVE Handle hydrofluoric acid using double-glove technique — outer gloves removed without skin contact with the outer surface; inner gloves retained and washed before removal. Calcium gluconate gel available at the HF handling station for immediate first aid application. No HF handling without a second person present.	REPRESENTATIVE INTERFACE Double-glove technique for all HF handling. Calcium gluconate gel (2.5%) at the HF workstation — not in the first aid room. Written HF emergency procedure posted at the workstation. Second-person supervision requirement for all HF use. Full splash risk assessment before procedure, not after.	
	<i>"Is calcium gluconate gel available at the HF handling workstation — not only in the first aid room — and is HF always handled with a second person present who is aware of the delayed injury presentation?"</i>		

MEDIUM			
Field Sample Collection from Production Strip or Sheet			
LACERATION · PRODUCTION HAZARDS · BURNS			
WHY THE HAND IS THERE Field inspectors collect samples from production lines — cutting strip sections from running or stopped coils, collecting surface samples from sheet stacks, and measuring profile dimensions at the extrusion press or finishing line. These activities expose the inspector to the same laceration, thermal, and suspended load hazards that exist at the production point — but the inspector may not be as familiar with those hazards as the production operator who works there daily.		CURRENT FIELD INTERFACE Bare hands or production-standard gloves used by field inspectors for sample collection. The inspector visiting a production area may use whatever tools are available at the production point — which may be no more than the improvised tools used by the production operator. The inspector's reduced familiarity with the production hazard geometry means that the exposure may be higher than for the regular operator at the same task.	
ENGINEERING OBJECTIVE Field inspectors should carry sample collection tools that provide stand-off from the material edge during collection — and should not rely on improvised or production-operator tools for sample handling in the production environment.		EXPOSURE TYPE Laceration from handling production material at the production hazard level — strip, sheet, and coil samples have the same sharp edges as the production material. Burns from contact with production material that is at production temperature at the sample collection point. Exposure to all production area hazards (suspended loads, nip points, chemical) at reduced familiarity.	
		REPRESENTATIVE INTERFACE PSC Long-Reach Pickup Tool for field sample collection at strip and sheet surfaces. Defined field inspector tool kit — carried by the inspector on every production visit — that provides the same stand-off capability as the production operator's standard interface tools. Field inspector PPE specification that matches the production area PPE level, not the laboratory standard.	
<i>"Do field inspectors carry their own stand-off tools for sample collection from production material — or do they rely on whatever tools are available at the production point, including improvised tools used by the operator?"</i>			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Cut-off saw and band saw blade change	Saw blade removed and replaced; blade at cutting sharpness; aluminium swarf in saw housing; heavy circular blade components	HIGH	Laceration · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach
Tensile machine grip and load cell calibration	Grips and load cell accessed for calibration; high-force hydraulic components; calibration weights handled manually	HIGH	Crush · Pinch · Ergonomic	PSC Position & Reach Interfaces
Grinding and polishing wheel change	Grinding and polishing wheels removed and replaced; wheel edges sharp; wheel mounting hardware tightened adjacent to wheel face	MEDIUM	Laceration · Abrasive · Pinch	PSC Striking & Alignment Interfaces
Chemical analysis vessel and acid pump maintenance	Acid dissolution vessels serviced; acid pump seals replaced; chemical residue in vessel and pump; confined access	HIGH	Chemical · Pinch · Ergonomic	PSC Position & Reach Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ From the moment a metallographic sample is cut until it is fully mounted, is a tong or sample grip used for all handling — not bare hands on the cut aluminium edges?
- ☐ During tensile specimen loading, is any part of the worker's hand inside the grip zone when the grip jaws are tightened — and has a specimen alignment fixture been considered to eliminate this?
- ☐ Is calcium gluconate gel available at the HF handling workstation — not only in the first aid room — and is HF always handled with a second person present?
- ☐ Do field inspectors carry their own stand-off sample collection tools on every production visit — not relying on whatever tools are available at the production point?
- ☐ Are the gloves used for laboratory chemical handling specified per chemical type — with separate specifications for HF, sulphuric acid, caustic soda, and solvent-based reagents?
- ☐ During cut-off saw blade change, are blade edges handled using a tool — not bare hands — during removal from and installation in the saw housing?
- ☐ Is the field inspector PPE specification matched to the production area being visited — not to a lower laboratory standard that does not reflect the production hazard level?

Contact PSC Hand Safety India for application-specific interface guidance.

8 PSC ENGINEERING INTERFACE PORTFOLIO — QUALITY CONTROL & INSPECTION LABORATORY

POSITION & REACH & RETRIEVAL INTERFACES				
INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
RETRIEVAL PSC Long-Reach Pickup Tool	Field sample collection from production strip and sheet. Sample retrieval from cutting stations without bare hand contact with cut aluminium edges. Metallographic sample handling tong equivalent for sample prep sequence.	6 ft	PSC-ST	1 · 4
POSITION & REACH PSC Load-It® Push/Pull (S-Head)	Field inspector coil and sheet sample lateral management in production areas. Sample transport guidance when large strip or sheet samples are carried through production areas.	4 ft, 6 ft	PSC-LIT-S006	4

STRIKING & ALIGNMENT INTERFACES				
INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
STRIKING PSC FingerSaver™	Holding drifts during cut-off saw blade installation and tensile machine maintenance. Laboratory hardware installation where impact tools are used adjacent to sharp aluminium sample material.	250 mm, 350 mm	PSC-FS-250 / -350	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — THE LABORATORY IS NOT A LOW-HAZARD ENVIRONMENT

The QC laboratory handles sharp aluminium samples, strong acids, and high-force testing equipment. The calm, controlled laboratory environment does not reduce the hazard severity of any of these.

Cut aluminium samples are as sharp as production trim scrap. HF acid causes injuries that are not felt at the moment of exposure. Tensile machine grips close with forces measured in tonnes. None of these hazards are reduced by the fact that the laboratory is quieter, better-lit, and more controlled than the production floor. Engineering controls in the laboratory — sample handling tongs, specimen alignment fixtures, HF workstation protocols — must match the severity of the actual hazard, not the apparent low-risk environment in which they are used.

1 DEPARTMENT OVERVIEW

The roll shop reconditions work rolls and backup rolls between production campaigns — grinding the roll surface to restore the required crown profile and surface finish, inspecting the roll surface for fatigue cracks and damage, replacing bearings and chocks, and preparing rolls for return to the mill. Roll shop operations involve some of the heaviest components in the plant — backup rolls may weigh 30 tonnes each — and the roll grinding operation requires close approach to a rotating roll surface at grinding wheel speed. The hand exposure pattern in the roll shop is dominated by crush from crane handling of heavy rolls, laceration from sharp roll surface damage, and nip point exposure from the roll grinder.

Roll shop operations support every rolling mill in the plant — hot mill, cold mill, foil mill, and finishing line rolls all pass through the roll shop for maintenance between campaigns. Roll change frequency depends on the product and the mill, but busy rolling operations may see multiple roll changes per shift. The roll shop therefore operates continuously alongside production, handling components that have just been removed from running mills and are at production temperature.

2 MAJOR EQUIPMENT & LOCATIONS

ROLL GRINDING MACHINE

Precision cylindrical grinding machine for reconditioning work rolls and backup rolls. The grinding wheel rotates at high speed against the roll surface as the roll traverses. Workers approach the grinder for dressing the grinding wheel, checking roll dimensions, and setting the grinding parameters. The grinding zone and the roll traverse table present simultaneous nip and abrasive hazards.

ROLL HANDLING CRANE

Dedicated overhead crane for moving rolls between the mill, the roll shop, and roll storage. Roll weights range from 500 kg for small work rolls to 30 tonnes for large backup rolls. All crane operations in the roll shop involve heavy suspended loads in close proximity to workers performing other roll shop tasks.

ROLL STORAGE STANDS

Horizontal roll storage stands holding rolls between campaigns. Rolls in storage on stands retain their production temperature for several hours after mill removal. Workers approach roll storage stands for roll selection, surface inspection, and preparation before re-installation in the mill.

BEARING AND CHOCK SERVICE AREA

Area where roll bearings and chocks are removed, inspected, and replaced. Chocks are heavy steel housings that support the roll journals — removing and replacing bearings requires working inside the confined chock housing geometry with large, heavy components.

ROLL SURFACE INSPECTION STATION

Dedicated lighting and surface inspection area for post-grinding roll surface assessment. Workers approach the roll surface closely for visual inspection of surface finish and to run a surface roughness probe along the roll face. The roll surface at this point has been ground to a precise finish and may have sharp residual grinding marks.

ROLL MARKING AND MEASUREMENT

Dimensional measurement of roll diameter, crown profile, and surface roughness after grinding. Workers use manual contact measurement tools on the roll surface. The roll may still be at slightly elevated temperature from the grinding operation at this point.

3 ROLL SHOP — TASK FLOW & EXPOSURE POINTS**ROLL SHOP****ROLL REMOVAL FROM MILL — CRANE TRANSFER**

Roll removed from mill housing by crane · transferred to roll shop

SUSPENDED LOAD · CRUSH · BURNS — HOT ROLL

ROLL SURFACE INSPECTION — PRE-GRIND

Roll surface assessed for damage before grinding

LACERATION — ROLL SURFACE DAMAGE · NIP

ROLL GRINDING

Roll ground to target profile and surface finish

NIP — GRINDER · ABRASIVE · ENTANGLEMENT

POST-GRIND INSPECTION AND MEASUREMENT

Surface finish and profile confirmed after grinding

LACERATION — GROUND ROLL EDGE · ERGONOMIC

BEARING AND CHOCK SERVICE

Bearings removed, inspected, and replaced in chock

CRUSH · PINCH — CHOCK GEOMETRY

ROLL RETURN TO MILL — CRANE TRANSFER

Reconditioned roll transferred by crane to mill housing

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Roll Grinding — Approach to Grinding Zone for Wheel Dressing and Dimension Check	
NIP — GRINDER · ABRASIVE · ENTANGLEMENT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
The roll grinding machine rotates the roll at controlled speed while the grinding wheel traverses the roll face. Workers approach the grinder to dress the grinding wheel, check roll dimensions during the grinding campaign, and adjust grinding parameters. The approach to the grinder brings the worker within the nip zone between the rotating roll and the grinding wheel and within the abrasive particle ejection zone of the grinding operation.		Workers approach the roll grinder with the roll rotating and the grinding wheel traversing — reaching past the grinding wheel guard to check roll dimensions or to access the wheel dressing mechanism. Hand-held measurement tools (micrometers, surface probes) applied to the roll surface while the roll is still rotating. Grinding wheel dressing performed with the wheel running at grinding speed.		Nip between the rotating roll and the grinding wheel if the worker's hand enters the grinding zone. Abrasive particle impact from the grinding wheel if the approach is within the ejection zone. Entanglement of clothing or hand in the rotating roll if the worker reaches over the roll during the grinding campaign. Laceration from sharp grinding wheel surface if the hand contacts the wheel.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Approach the roll grinder for dimension checking and wheel dressing only when the roll and grinding wheel are at defined safe approach conditions — not at grinding speed — and using measurement tools that maintain stand-off from the rotating roll surface.			Defined grinding machine safe approach conditions — roll speed threshold below which dimension checking and wheel dressing are permitted. Non-contact or touch-trigger gauging system for roll dimensions during grinding that eliminates the need for manual hand-held measurement on the rotating roll surface. Wheel dressing tool with a grip position outside the grinding zone.		
"During roll grinding, when are manual dimension checks performed — while the roll is rotating at grinding speed, or only when the roll speed has been reduced to a defined safe measurement condition?"					

HIGH				Crane Roll Handling — Heavy Roll Guidance During Transfer and Storage Landing	
SUSPENDED LOAD · CRUSH · BURNS — HOT ROLL					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Rolls removed from the mill are still at production temperature when they arrive in the roll shop. The crane transfer from the mill to the roll shop involves a heavy suspended load — 500 kg to 30 tonnes — that must be guided to its storage stand or grinding machine. Workers guide the roll during crane descent to the storage stand, prevent roll swing during travel, and confirm correct seating on the stand after landing.		Bare hands or improvised rod used to guide heavy rolls during crane descent to storage stands and to the grinding machine tailstock and headstock supports. Roll at production temperature at the moment of shop arrival. Roll surface damage (surface cracks, spalling) on worn rolls creates sharp protrusions on the roll surface that create additional laceration hazard during guidance.		Crush between the crane-suspended roll and the storage stand or grinding machine supports during landing. Burns from contact with the hot roll surface during guidance. Laceration from contact with roll surface damage (spalling, cracks) during guidance of a worn roll before inspection and regrind. Struck-by the roll if it swings during crane travel at the elevated roll weight.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide crane-suspended rolls to storage stands and grinding machine mounts without placing the worker's hands in the crush zone between the descending roll and the stand or machine supports — using a tagline for swing control and a stand-off tool for lateral guidance throughout the crane cycle.			PSC LoadGuider Anti-Tangle Tagline for roll swing control during crane travel. PSC Load-It (S-Head, 4–6 ft) for roll lateral guidance during crane descent to storage stand and grinding machine mount — worker positioned outside the crush zone throughout. No hand contact with roll surface while roll is at production temperature.		
"When a hot roll arrives at the roll shop by crane, at what point is the first hand contact made with the roll surface — and is the roll temperature at that point confirmed below a safe handling threshold?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Bearing Removal and Replacement in Roll Chock	
CRUSH · PINCH — CHOCK GEOMETRY · ERGONOMIC					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Roll bearings are removed from and installed in the roll chock (bearing housing) using a hydraulic press or manual driving tools. The chock housing geometry is confined — hands must enter the chock bore or approach the chock end face during bearing alignment. Bearings are heavy precision components — large backup roll bearings may weigh 100–300 kg. The confined geometry of the chock housing combined with the heavy bearing weight creates simultaneous crush and pinch exposure.		Hands used to align bearings during hydraulic press or driving tool installation. Workers reach into the chock bore to align the bearing before the press or drift is applied. The chock housing constrains access geometry, requiring the worker to maintain a sustained position adjacent to the pressing or driving direction. Bearing removal by driving tools requires holding the drift adjacent to the hammering direction.		Crush between the bearing and the chock bore if the bearing cants during press-in and the worker's hand is at the bore end. Pinch between the bearing outer race and the chock housing if the bearing shifts during alignment. Ergonomic strain from sustained awkward reach into the chock bore during bearing alignment. Struck-by the drift if it disengages during driving.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Align roll bearings in the chock bore using an alignment fixture rather than bare hands — so that the press or driving tool can be applied without requiring the worker's hands to be adjacent to the pressing or driving direction.			Bearing alignment sleeve or fixture that holds the bearing concentric with the chock bore during press-in without requiring the worker's hand in the chock end face. PSC FingerSaver™ for holding drifts during bearing driving — removes the holding hand from the striking direction. Defined maximum hand approach distance from the bearing press axis during press-in.		
"During bearing installation in the roll chock, is a bearing alignment sleeve used to hold the bearing concentric during press-in — or does a worker hold the bearing by hand during the initial press stroke?"					

MEDIUM	Roll Surface Inspection — Pre-Grind Damage Assessment LACERATION — ROLL SURFACE DAMAGE · ERGONOMIC		
WHY THE HAND IS THERE Before regrinding, the roll surface is inspected for fatigue cracks, spalling, and surface damage that requires specific grinding action. The inspection requires close visual and tactile approach to the roll surface — workers run their fingers along the roll face to feel surface anomalies that may not be visible under workshop lighting. Roll surface damage — spalling, edge cracking, or build-up welding residue — creates sharp protrusions that cut the inspecting hand.	CURRENT FIELD INTERFACE Hand dragged along the roll surface during tactile inspection for damage. Roll surface damage creates sharp protrusions that are the specific feature the inspector is trying to locate — meaning the hand contacts the sharpest point on the roll surface during the inspection motion. Workers lean over the roll on the storage stand to reach the full roll face width during inspection.	EXPOSURE TYPE Laceration from contact with sharp roll surface damage during tactile inspection — the inspection method causes contact with the most dangerous points on the roll surface. Ergonomic strain from sustained lean posture over the roll storage stand during full-face-width inspection. Caught-between the roll and the storage stand if the roll rolls on the stand during inspection.	
ENGINEERING OBJECTIVE Inspect roll surfaces for damage using visual and instrument methods that do not require bare hand contact with the roll surface — using a stiff brush or non-contact probe for tactile anomaly detection rather than the bare hand.		REPRESENTATIVE INTERFACE Stiff inspection brush for roll surface anomaly detection — brushing the roll surface at speed reveals surface protrusions as a catch without bare hand contact with the sharp protrusion. Non-contact eddy current or magnetic particle inspection for subsurface crack detection — eliminates close approach to the roll surface. Defined roll chock restraint on storage stands to prevent roll movement during inspection.	

"During pre-grind roll surface inspection, is a brush or instrument used for tactile surface anomaly detection — or is the bare hand dragged along the roll face to feel for damage at the sharpest points on the roll surface?"

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Grinding wheel change and dressing tool replacement	Grinding wheel removed and replaced with wheel at full abrasive surface; heavy wheel component; wheel flange hardware tightened adjacent to wheel face; residual aluminium and abrasive in grinding machine	HIGH	Abrasive · Crush · Pinch	PSC Striking & Alignment · PSC Position & Reach
Roll storage stand and cradle maintenance	Stand cradles and adjusters serviced; heavy cradle components; stands at floor level requiring sustained stooped posture; adjacent crane operations with rolls overhead	MEDIUM	Crush · Ergonomic · Struck-By	PSC Position & Reach Interfaces
Hydraulic press maintenance for bearing work	Hydraulic press seals and connections serviced; press cylinder under pressure in adjacent circuits; heavy press components; confined press geometry	HIGH	Crush · Hydraulic · Pinch	PSC Position & Reach Interfaces
Roll marking and identification hardware	Roll end face marking tools applied by hand on storage stand; roll on stand may roll; marking hardware driven by hand tool adjacent to roll journal end face	MEDIUM	Crush · Struck-By · Ergonomic	PSC Striking & Alignment Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ During roll grinding, are manual dimension checks performed only when the roll speed has been reduced to a defined safe measurement condition — not while the roll is at grinding speed?
- ☐ When a hot roll arrives from the mill, is the roll temperature confirmed before the first hand contact — and is swing control in place during the full crane transfer sequence?
- ☐ During bearing installation in the roll chock, is a bearing alignment sleeve used to hold the bearing concentric during press-in — not a worker's hand at the chock end face?
- ☐ During roll surface inspection, is a stiff brush or instrument used for anomaly detection — not the bare hand dragged along the roll face at the sharpest points on the surface?
- ☐ Is an anti-tangle tagline used on every crane roll transfer in the roll shop — including transfers between storage stands and the grinding machine, not only between mill and shop?
- ☐ During bearing driving operations, is the drift held with a FingerSaver or similar holder — not the bare hand adjacent to the driving direction?
- ☐ During grinding wheel change, are wheel flange hardware bolts tightened with a defined torque sequence — not by a worker leaning over the wheel face to reach the flange bolts?

Contact PSC Hand Safety India for application-specific interface guidance.

8 **PSC ENGINEERING INTERFACE PORTFOLIO — ROLL SHOP**

LOAD CONTROL INTERFACES — ROLL CRANE HANDLING

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for work rolls and backup rolls during all crane transfers in the roll shop — from mill to shop, between storage stands, and from storage to grinding machine and back.	25 ft, 30 ft	PSC-LGTC-25 / -30	2 · All
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head)	Roll lateral guidance during crane descent to storage stands and grinding machine supports. Worker positioned outside the crush zone throughout crane descent.	4 ft, 6 ft	PSC-LIT-S006 / S010	2

STRIKING & ALIGNMENT INTERFACES — BEARING AND ROLL SHOP MAINTENANCE

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
STRIKING PSC FingerSaver™	Holding drifts during bearing driving, roll marking hardware installation, and roll shop general maintenance impact operations. Removes holding hand from the striking direction in all impact operations in the roll shop maintenance environment.	350 mm, 850 mm	PSC-FS-350 / -850	3 · Maint.

9 **KEY ENGINEERING PRINCIPLE**

PRINCIPLE — THE ROLL SHOP HANDLES THE HEAVIEST COMPONENTS CLOSEST TO THE WORKER

Roll shop crane operations involve the heaviest loads in the plant — handled in a workshop space with other workers, storage stands, and grinding machines in close proximity to the crane swing arc.

In the production areas, crane operations take place in large bays with defined exclusion zones. In the roll shop, crane operations take place in a workshop with benches, storage stands, and workers conducting other tasks within metres of the lift. The same anti-tangle tagline and stand-off guidance principle that applies in the production coil bay applies in the roll shop — but the consequences of a roll swing incident in the confined roll shop space are compounded by the proximity of other workers and equipment to the swing arc.

1 DEPARTMENT OVERVIEW

Mechanical maintenance teams work across every department of the aluminium plant — servicing the equipment that production departments operate. The hand exposure in mechanical maintenance differs from production in two important ways: maintenance workers enter spaces that are normally guarded during production (confined access to drives, guard-removed maintenance on machinery), and maintenance tasks are non-routine by nature, meaning improvised tools and adapted methods are common. The combination of confined access, residual energy in systems, and improvised tooling creates a concentrated hand exposure environment that is distinct from the production hazard pattern.

The most consistent hand exposure in plant-wide mechanical maintenance is from impact tool operations — workers holding chisels, drifts, and punches by hand adjacent to the hammer strike. This single exposure pattern — hands within the arc of a missed hammer blow — generates a disproportionate share of hand injuries across maintenance departments in heavy industry worldwide. The PSC FingerSaver™ was designed specifically for this exposure. The second most consistent exposure is from confined-access work on drives, gearboxes, and pipe systems where residual stored energy (hydraulic, spring, thermal, electrical) can release unexpectedly during maintenance approach.

2 MAJOR EQUIPMENT & LOCATIONS

DRIVES AND GEARBOXES

Drive motors, gearboxes, and couplings throughout the plant — powering rolling mills, conveyors, fans, pumps, and cranes. Maintenance access to drives and gearboxes requires removing guards and covers, working in confined gearbox housings with heavy gear components, and managing residual stored energy in the drive system.

PIPE WORK AND VALVE SYSTEMS

Process pipe work carries coolant, hydraulic fluid, rolling oil, steam, compressed air, and process gases throughout the plant. Pipe maintenance and valve replacement require working on pressurised systems, in confined pipe galleries, and adjacent to process fluids at elevated temperature and pressure.

CONVEYOR SYSTEMS

Belt and roller conveyors for material transfer throughout the plant. Conveyor maintenance involves working on drive stations with nip points, replacing belt sections with tensioned belt systems, and clearing material jams with the conveyor stationary but with material load still present on the belt.

CRANE AND HOIST MAINTENANCE

Overhead crane bridge and hoist maintenance requires working at height on the crane bridge while the crane is isolated. Bridge rail maintenance, hoist wire rope and sheave replacement, and travel drive maintenance involve heavy components at height with limited working space on the crane bridge.

WORKSHOP MACHINERY

Workshop lathes, drill presses, milling machines, and bench grinders for machining maintenance parts. Workshop machinery presents nip point, entanglement, and rotating tool hazards that are fully established in engineering literature but remain a consistent source of hand injuries in maintenance workshops throughout industry.

STRUCTURAL AND BUILDING MAINTENANCE

Structural steelwork, building cladding, and platform maintenance across the plant. Structural maintenance involves working at height, handling heavy structural components by crane, and using impact tools for bolt removal and installation in confined structural access geometries.

3 MECHANICAL MAINTENANCE — TASK FLOW & EXPOSURE POINTS**MECHANICAL MAINTENANCE****ISOLATION AND PERMIT TO WORK**

Energy isolation confirmed · permit to work issued

RESIDUAL ENERGY · STORED PRESSURE**ACCESS — GUARDS AND COVERS REMOVED**

Guards removed · maintenance access established

EXPOSED DRIVES · NIPS · ROTATING PARTS**DISASSEMBLY — FASTENERS, DRIFTS, CHISELS**

Fasteners removed · components driven or chiselled

STRUCK-BY — MISSED BLOW · PINCH · LACERATION**COMPONENT REMOVAL — CRANE OR MANUAL**

Heavy components removed by crane or manual lift

CRUSH · SUSPENDED LOAD · ERGONOMIC**REPAIR / REPLACEMENT AND REASSEMBLY**

Parts replaced · reassembled · torqued to specification

PINCH · STRUCK-BY · CRUSH**REINSTATEMENT AND TEST**

Guards refitted · permit closed · function test

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH	Impact Tool Operations — Holding Drift or Chisel Adjacent to Hammer Strike		
	STRUCK-BY — MISSED BLOW · PINCH · LACERATION		
	WHY THE HAND IS THERE Mechanical maintenance requires frequent use of impact tools — driving drifts and punches to remove bearings and pins, chiselling seized fasteners, knocking in shaft keys, and driving wedges and shims. In each case, the standard working method is for one worker to hold the drift or chisel in position while a second worker strikes it with a hammer. The holding hand is within the arc of a missed hammer blow throughout the striking sequence.	CURRENT FIELD INTERFACE Bare hand used to hold drifts, punches, chisels, and wedges during hammer striking — the standard working practice in most mechanical maintenance teams. The holding hand is 50–100 mm below the hammer impact point. At force levels required for maintenance tasks (2–5 kg hammer), a missed or glancing blow to the holding hand causes severe crush or laceration injury.	EXPOSURE TYPE Crush or laceration to the holding hand from a direct or glancing missed hammer blow. Pinch between the drift and the workpiece if the drift shifts during striking. Laceration from the drift edge if the drift rotates in the hand during the striking sequence. The injury mechanism is entirely predictable — the holding hand is in the hazard zone on every hammer blow.
	ENGINEERING OBJECTIVE Hold drifts, punches, chisels, and wedges during hammer striking without placing the holding hand within the arc of the hammer blow — using a rated holding tool that grips the drift below the impact point and is released from the hand's strike arc.	REPRESENTATIVE INTERFACE PSC FingerSaver™ for holding all drifts, chisels, punches, and wedges during hammer striking throughout the maintenance department. Available in 250 mm, 350 mm, 375 mm, and 850 mm lengths for different access geometries. The holding hand remains outside the hammer arc at all length options. This is the primary PSC interface for mechanical maintenance across all departments.	
<i>"In your mechanical maintenance team, does every technician carry a drift-holding tool for impact operations — or is the bare-hand holding method the standard practice on every job where a drift or chisel is used?"</i>			

HIGH			
Confined Access Maintenance on Drives and Gearboxes			
CRUSH · RESIDUAL ENERGY · PINCH — GEAR MESH			
WHY THE HAND IS THERE Gearbox maintenance requires removing the gearbox cover and working inside the housing to inspect, adjust, and replace gears, shafts, and bearings. The confined gearbox housing geometry requires sustained awkward hand and arm posture adjacent to gear mesh zones. Residual stored energy in the drive — kinetic energy in heavy flywheel-coupled drives, spring energy in brake mechanisms, and stored pressure in hydraulic couplings — may not be fully released by the isolation procedure.		CURRENT FIELD INTERFACE Hands inserted into the gearbox housing to align components, reach fastener positions, and guide heavy gear and shaft components during removal. The gear mesh zones are present throughout the gearbox interior — any hand position inside the housing is proximate to a gear mesh zone. Residual energy in hydraulic couplings and brake springs may not be evident from the isolation confirmation.	
ENGINEERING OBJECTIVE Confirm full energy release — including hydraulic coupling pressure and brake spring preload — before any hand entry into the gearbox housing. Use long-reach tools to position components inside the housing without requiring the hand to enter the gear mesh zone for alignment.		EXPOSURE TYPE Crush between gears if a residual energy release causes the drive to move during maintenance access. Pinch between the gear mesh if the hand is at the gear contact zone. Ergonomic strain from sustained awkward posture inside the gearbox housing. Laceration from sharp gear tooth edges during component handling.	
		REPRESENTATIVE INTERFACE Defined energy release verification procedure specific to each drive type before gearbox cover removal. PSC Long-Reach Pickup Tool for component retrieval from inside gearbox housing without hand entry. PSC FingerSaver™ for holding alignment pins and shims during installation without hands inside the gear mesh zone.	
<i>"Before gearbox cover removal for maintenance access, is the residual energy in the hydraulic coupling and brake spring mechanism confirmed released — not assumed released by the main isolation alone?"</i>			

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Conveyor Belt Jam Clearance — Material Removal with Belt Tensioned	
CAUGHT-BETWEEN · CRUSH · NIP POINT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Material jams on conveyor belts require the material to be cleared before the belt can be restarted. The conveyor belt is stopped with the jam present, but the belt tension and the material load on the belt mean that stored energy is present in the system. Workers reach under or beside the belt and between the belt and the structure to clear the jammed material using hands or rods.		Hands or arms inserted into the space between the belt and the conveyor structure or between the belt and the drive/return drum to clear jammed material. The belt tension and material weight create a pinching hazard at any point where the belt or material can move toward the structure during the clearance operation. The drive drum nip zone is present at the drum positions even with the conveyor stopped.		Caught-between the belt and the conveyor structure if the belt moves during manual material clearance. Crush from the material load on the belt if the material shifts during clearance. Nip point at the drive or return drum if the hand enters the drum tangent zone during clearance. Residual belt tension snap-back if the jam is released suddenly.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Clear conveyor belt jams without placing hands or arms in the space between the belt and the conveyor structure — using a long-handled tool that reaches the jammed material from outside the belt tangent zone and outside the drum nip zone.			PSC Load-It with S-Head (4–6 ft) for pushing and clearing jammed material from the belt surface from outside the nip zone. PSC Long-Reach Pickup Tool for retrieving jam material pieces that need to be extracted from the belt-to-structure gap. Defined conveyor jam clearance procedure requiring belt tension release before hand approach to the material.		
"During conveyor belt jam clearance, is a defined belt tension release step performed before any hand approach to the jammed material — and is the clearance tool rated for the material weight and the belt tension loads present?"					

HIGH				Pipe and Valve Maintenance — Pressurised Line Approach	
CHEMICAL INJECTION · CRUSH · BURNS — HOT FLUID					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Pipe work and valve maintenance across the aluminium plant involves working on systems that carry coolant, hydraulic fluid, rolling oil, steam, and compressed air. Pressure isolation and drainage before maintenance work are standard requirements, but the confirmation of zero-pressure condition before joint opening or valve removal is not always instrument-verified — workers rely on visual observation of fluid drainage or on the isolation tag rather than a pressure gauge reading at the work point.		Workers open pipe joints and remove valves based on isolation confirmation by tag rather than by pressure gauge reading at the work point. In complex pipe systems with multiple isolation points, residual trapped pressure may remain in the section between the isolation valve and the work point. Joint opening under residual pressure causes sudden fluid ejection at whatever temperature and pressure remains in the trapped section.		Chemical injection injury from high-pressure hydraulic fluid ejection if a hydraulic line is opened under residual pressure. Burns from hot coolant or steam ejection if a cooling or steam line is opened with residual trapped pressure. Crush from pipe component release if a flanged joint is unbolted under pressure and springs open. The injury mechanism is sudden and without warning at the moment of joint opening.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Verify zero pressure at the work point with a gauge reading on the work-point side of the isolation before any pipe joint or valve is opened — not by drain observation alone or isolation tag confirmation alone.			Defined pipe maintenance zero-pressure verification procedure requiring gauge reading at the work point before joint opening — not isolation tag confirmation alone. Slow-release joint opening sequence for any pressurised system where zero-pressure cannot be fully confirmed before the first bolt is removed.		
<i>"During pipe maintenance in your plant, is zero pressure confirmed by a gauge reading at the work point before any joint is opened — or is the isolation tag and drain observation accepted as sufficient confirmation of zero pressure?"</i>					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Workshop lathe and drill press tooling change	Cutting tool removed and replaced with spindle at rest; sharp cutting tool edges; toolpost hardware tightened adjacent to tool face; swarf from previous operation in work area	HIGH	Laceration · Pinch · Struck-By	PSC Striking & Alignment Interfaces
Crane bridge and hoist rope replacement	Wire rope removed and replaced at height on crane bridge; heavy rope drum; confined bridge working space; adjacent crane operations if multiple cranes in bay	HIGH	Crush · Working at Height · Struck-By	PSC Load Control · PSC Position & Reach
Pump impeller and seal replacement	Pump disassembled for impeller and seal access; pump casing at process fluid temperature; residual fluid in casing; confined pump housing geometry	HIGH	Chemical · Burns · Pinch	PSC Position & Reach · PSC Striking & Alignment
Structural bolt removal — seized fasteners	Seized structural fasteners removed using impact gun, crow bar, or chisel; adjacent structural components; working at height in some locations; residual fastener tension release	MEDIUM	Struck-By · Crush · Working at Height	PSC Striking & Alignment Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ Does every technician in the mechanical maintenance team carry a PSC FingerSaver™ or equivalent holding tool — so that bare-hand drift holding is never the only available option on any job?
- ☐ Before gearbox cover removal, is residual energy in hydraulic couplings and brake spring mechanisms confirmed released — verified by instrument, not assumed from the main isolation?
- ☐ During conveyor belt jam clearance, is a defined belt tension release step completed before any hand approach to the jammed material on the belt?
- ☐ Before any pipe joint or valve is opened for maintenance, is zero pressure confirmed by a gauge reading at the work point — not by isolation tag or drain observation alone?
- ☐ Is the PSC FingerSaver™ used for all chisel and drift holding operations in the workshop as well as in the plant field maintenance environment?
- ☐ During crane bridge maintenance, are tools and components secured before beginning work to prevent dropped objects striking workers on the plant floor below?
- ☐ During pump disassembly, is the pump casing flushed and temperature confirmed before the worker's hands enter the casing bore for impeller removal?

Contact PSC Hand Safety India for application-specific interface guidance based on your plant configuration.

8 PSC ENGINEERING INTERFACE PORTFOLIO — MECHANICAL MAINTENANCE

STRIKING & ALIGNMENT — THE PRIMARY MECHANICAL MAINTENANCE INTERFACE

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding all drifts, punches, chisels, wedges, and pin holders during hammer striking throughout all mechanical maintenance operations across the full aluminium plant. The primary PSC interface for the plant-wide maintenance team.	250 mm, 350 mm, 375 mm, 850 mm	PSC-FS-250 / -350 / -375 / -850	1 · All

POSITION & REACH · RETRIEVAL · LOAD CONTROL

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull (S-Head)	Conveyor belt jam clearance from outside the nip zone. Component positioning in confined gearbox and pump housing access. Structural component guidance during crane-assisted maintenance.	4 ft, 6 ft	PSC-LIT-S006 / S010	3
RETRIEVAL PSC Long-Reach Pickup Tool	Component retrieval from inside gearbox housings. Fastener and tool retrieval from confined pipe gallery and structural access. Conveyor material clearance from belt-to-structure gap.	6 ft	PSC-ST	2 · 3
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for crane-assisted component handling during plant-wide mechanical maintenance — drives, pumps, structural components, and crane bridge maintenance.	25 ft, 30 ft	PSC-LGTC-25 / -30	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — THE HOLDING HAND IS IN THE HAZARD ZONE ON EVERY HAMMER BLOW

The practice of holding a drift or chisel by hand during hammer striking places the holding hand within the arc of a missed blow on every strike in every impact tool operation. It is the most consistently preventable hand injury mechanism in mechanical maintenance.

Every drift-holding operation with a bare hand is a single-point-of-failure event — a missed or glancing blow on any one of however many strikes the job requires is sufficient to cause injury. The FingerSaver converts this from a statistical certainty over a maintenance career into an engineered stand-off. The investment required — one tool per technician — is minimal relative to the consistency of the hazard it addresses. Making FingerSaver carriage a standard item for every mechanical maintenance technician, equivalent to their spanner set, is the most direct single action available to a maintenance manager to reduce hand injury frequency across the full team.

1 DEPARTMENT OVERVIEW

Electrical and instrumentation maintenance teams work across every department of the aluminium plant — maintaining the power distribution, motor control, instrumentation, and control systems that underpin every production process. Hand exposure in E&I maintenance is shaped by two hazard classes that do not appear in production or mechanical maintenance: electrical shock from inadvertent contact with live conductors, and arc flash from short circuit events at the conductor or switchgear level. These hazards require specific engineering controls that are distinct from the mechanical and thermal controls described in other chapters.

Alongside the electrical hazards, E&I maintenance workers encounter conventional mechanical hand exposure — pinch and crush from heavy switchgear components, laceration from sharp enclosure edges, and chemical exposure from battery acid and cable insulation materials. In motor termination work and switchgear maintenance, the combination of electrical hazard with confined enclosure access and heavy component weights creates a concentrated exposure environment that requires both electrical isolation and mechanical handling controls simultaneously.

2 MAJOR EQUIPMENT & LOCATIONS

MOTOR CONTROL CENTRES (MCCS) AND SWITCHGEAR

Motor control centres and medium-voltage switchgear panels throughout the plant. Maintenance access for contactor replacement, fuse replacement, and connection tightening requires working inside live or recently de-energised panels. The panel enclosure geometry — confined, with live busbars adjacent to the work zone in multi-feeder MCCs — is the primary electrical hazard location for E&I technicians.

DRIVE MOTORS

Drive motors throughout the plant powering rolls, fans, pumps, and conveyors. Motor terminal box access for connection tightening, terminal block replacement, and winding resistance checks requires working inside the motor terminal box with conductor terminations at close range. Heavy motor components during motor change-out generate mechanical handling hazard alongside the electrical isolation requirement.

CABLE TRAYS AND CABLE MANAGEMENT

Cable trays, conduit, and cable management systems throughout the plant. Cable pulling and termination work in cable trays requires working in confined tray geometry with adjacent live cables. Cable stripping and termination creates laceration exposure from the cable stripping knife and from sharp conductor ends.

INSTRUMENTATION AND TRANSMITTERS

Process instrumentation — pressure transmitters, flow meters, level sensors, and temperature elements — throughout the plant. Instrumentation maintenance involves working on process connections that may be pressurised, at temperature, or in contact with process fluids. Transmitter and sensor replacement requires breaking process connections alongside instrument electrical connections.

BATTERY AND UPS SYSTEMS

Battery rooms and UPS systems providing backup power for control systems. Battery maintenance — connection tightening, electrolyte checking, and battery replacement — involves chemical exposure from battery acid, electrical exposure from the battery short circuit hazard, and heavy battery weights during replacement.

CONTROL PANELS AND PLCS

Control panel maintenance and PLC hardware replacement in the plant control rooms. Panel work involves working inside live or partially de-energised control enclosures with DC and AC conductors at close range. Heavy panel door and sub-rack components during access create mechanical pinch and crush hazard alongside the electrical exposure.

3 ELECTRICAL & INSTRUMENTATION MAINTENANCE — TASK FLOW & EXPOSURE POINTS**ELECTRICAL & INSTRUMENTATION MAINTENANCE****ISOLATION AND ELECTRICAL PERMIT**

Electrical isolation confirmed · permit to work issued

RESIDUAL STORED CHARGE · CAPACITOR DISCHARGE**PANEL OR ENCLOSURE ACCESS**

Panel door opened · enclosure access established

EXPOSED CONDUCTORS · ARC FLASH BOUNDARY**WORK ON TERMINATIONS AND COMPONENTS**

Connections tightened · components replaced

ELECTRICAL CONTACT · PINCH · LACERATION**CABLE WORK — STRIPPING AND TERMINATION**

Cable stripped · terminated at connection point

LACERATION — CABLE KNIFE · CONDUCTOR END**INSTRUMENTATION — PROCESS CONNECTION**

Instrument process connection broken or made

CHEMICAL · PRESSURE INJECTION · BURNS**REINSTATEMENT AND FUNCTIONAL TEST**

Isolation released · function tested

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Panel and Switchgear Maintenance — Working Adjacent to Live Busbars							
ELECTRICAL CONTACT · ARC FLASH · PINCH											
WHY THE HAND IS THERE In multi-feeder MCCs and medium-voltage switchgear, de-energising one feeder for maintenance does not de-energise the adjacent busbars that supply other feeders. Workers maintaining a de-energised feeder circuit inside the MCC are physically adjacent to live busbars serving the other circuits. The confined panel geometry places the worker's hands and arms within the minimum approach distance to the live busbars during the maintenance task.				CURRENT FIELD INTERFACE Panel access with adjacent live busbars after single-feeder isolation. Workers approach the de-energised feeder terminals with the live busbars within arm's reach. Standard industry practice in many operations relies on the visual identification of de-energised versus live conductors by terminal marking and isolation lock-out without a physical barrier between the live busbars and the maintenance work zone.				EXPOSURE TYPE Electrical contact with adjacent live busbars during maintenance of the de-energised feeder. Arc flash from inadvertent short circuit of the live busbars by tools or conductors handled during maintenance. Pinch between heavy switchgear components during panel access. Burns from arc flash thermal energy at the short circuit point.			
ENGINEERING OBJECTIVE Establish a physical barrier between live busbars and the maintenance work zone in multi-feeder MCCs before any work begins — insulated shrouding, cover plates, or perspex barriers that prevent inadvertent contact with adjacent live conductors during the maintenance task.				REPRESENTATIVE INTERFACE Insulated busbar shrouding installed over all adjacent live busbars before any maintenance work in the panel. Defined minimum working distance from live conductors — marked physically in the panel, not only in the procedure. Arc flash PPE specification matched to the incident energy at the work point.							
<i>"Before maintenance work begins inside a multi-feeder MCC, are all adjacent live busbars physically shrouded — or is the live-versus-de-energised status managed only by visual identification and the isolation tag?"</i>											

HIGH				Motor Terminal Box Work — Termination Tightening and Replacement	
ELECTRICAL CONTACT · PINCH — TERMINAL HARDWARE · LACERATION					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Motor terminal tightening and terminal block replacement requires opening the motor terminal box and working inside the box with the motor isolated but with the terminal box conductors and earth connections visible. In motors that are connected to drives with DC link capacitors, residual DC voltage may be present at the motor terminals for minutes after the drive is de-energised even with the motor isolated at the MCC.		Terminal box opened after MCC isolation. Workers tighten terminal connections or replace terminal blocks with hands inside the terminal box at close range to the motor terminal studs. In VFD-driven motors, residual DC voltage from the drive capacitor may not be visible from the terminal box and is not confirmed by the MCC isolation alone.		Electrical contact with motor terminals at residual DC voltage from drive capacitor if the isolation procedure does not include VFD capacitor discharge confirmation. Pinch between the terminal box cover and the motor frame during box opening. Laceration from sharp terminal box edges during access. Contact with earth terminal residual charge in unearthed systems.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Confirm zero voltage at the motor terminal box by direct measurement before any hand entry into the terminal box — not by MCC isolation confirmation alone, particularly for VFD-driven motors where drive capacitor discharge must be separately confirmed.			Defined motor terminal access procedure requiring voltage measurement at motor terminals before hand entry into the terminal box — not MCC isolation tag alone. Capacitor discharge confirmation time or measurement for all VFD-driven motors as part of the isolation procedure. Insulated terminal screwdrivers for all terminal tightening work inside the motor terminal box.		
"For VFD-driven motors, does your motor terminal box access procedure include a specific capacitor discharge confirmation step before hands enter the terminal box — with a measured voltage at the terminal, not a timed wait?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH	Cable Stripping and Termination — Cable Knife Laceration LACERATION — CABLE KNIFE · CONDUCTOR END · ERGONOMIC		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	Cable stripping requires removing the outer sheath and insulation from multi-core cables before termination. The cable stripping knife is one of the most consistently hazardous tools in E&I maintenance — the stripping motion draws the knife toward the hand holding the cable. The stripped conductor ends are sharp copper or aluminium points. Termination at connection blocks requires inserting the stripped conductor into a confined terminal while controlling both the conductor and the tightening tool simultaneously.	Rotary or fixed-blade cable stripper applied to the cable outer sheath with the hand holding the cable on the other side of the blade. In many field installations, a penknife or utility knife is used rather than a purpose-designed cable stripper. The conductor end after stripping is a sharp, stiff metal point at the diameter of the conductor bundle.	Laceration from the cable stripping knife if the blade slips during the stripping motion and contacts the holding hand. Puncture from the sharp conductor end during bending and insertion into the terminal block. Ergonomic strain from sustained awkward posture during cable stripping in confined tray and duct access geometries. Laceration from sharp cable tray edges during cable installation.
	ENGINEERING OBJECTIVE	REPRESENTATIVE INTERFACE	
Strip cables using a purpose-designed cable stripper that controls the blade depth and prevents the blade from travelling past the cable sheath into the holding hand — not a utility knife or penknife used with free-hand stripping motion.		Purpose-designed rotary cable stripper with depth-controlled blade for all cable stripping operations. Defined conductor bend radius guide for inserting stripped conductors into confined terminal blocks without hand contact with the sharp conductor end. Insulated conductor installation tool for terminal block insertion.	
"Do E&I technicians use a purpose-designed rotary cable stripper for all cable stripping work — or is a utility knife or penknife the standard stripping tool in your maintenance team?"			
MEDIUM	Battery Maintenance — Chemical and Electrical Exposure CHEMICAL — BATTERY ACID · ELECTRICAL SHORT CIRCUIT · CRUSH		
	WHY THE HAND IS THERE	CURRENT FIELD INTERFACE	EXPOSURE TYPE
	Battery room maintenance — connection tightening, electrolyte level checking, and battery replacement — involves chemical exposure from sulphuric acid electrolyte, electrical exposure from the battery short circuit hazard (batteries cannot be isolated), and heavy battery weights during replacement. The battery short circuit hazard is present throughout all battery room work and is not controlled by any isolation — the energy stored in the battery is always available at the terminals.	Connection tightening using standard spanners on battery terminal posts with the battery fully charged and the terminals live. Electrolyte checking by removing cell vent caps by hand and inserting a hydrometer with hands adjacent to the open cell — sulphuric acid electrolyte on the hydrometer and on the cell rim.	Short circuit by a conductive spanner bridging adjacent battery terminals during connection tightening — battery short circuits generate thousands of amperes and produce severe arc burns. Chemical burns from battery acid electrolyte during cell venting and hydrometer checking. Crush from heavy battery during replacement handling. Battery case damage from tool drop generating electrolyte spill.
	ENGINEERING OBJECTIVE	REPRESENTATIVE INTERFACE	
Perform battery connection work with insulated tools only — no uninsulated spanners or screwdrivers in the battery room. Electrolyte checking using a sealed hydrometer system or remote monitoring that does not require opening the cell vents by hand adjacent to the electrolyte surface.		Insulated battery spanners for all connection tightening in the battery room. Sealed hydrometer system or optical battery monitoring for electrolyte status without cell vent opening. Chemical-resistant gloves and face shield for all electrolyte-adjacent work. Defined tool exclusion zone around battery terminals to prevent conductive tool bridging.	
"In the battery room, are all tools used for connection tightening insulated — and is there a defined rule against non-insulated tools in the battery room at any time, regardless of the specific task being performed?"			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
HV switchgear racking and circuit breaker removal	Circuit breaker racked out and removed for maintenance; heavy breaker weight; live adjacent busbars in multi-way panels; confined switchgear cell geometry	HIGH	Electrical · Crush · Arc Flash	PSC Position & Reach Interfaces
Transformer bushing and connection maintenance	Transformer bushings and HV connections accessed for maintenance; high-voltage system; confined transformer bay; heavy bushing components	HIGH	Electrical · Crush · Arc Flash	PSC Position & Reach Interfaces
Instrument process connection — break and remake	Instrument process connection (impulse line or direct mount) broken for maintenance; line may be pressurised or at process temperature; process fluid in impulse line	HIGH	Chemical · Pressure Injection · Burns	PSC Position & Reach Interfaces
UPS battery replacement	Battery removed and replaced by hand in rack-mounted UPS; battery weight up to 30 kg; battery terminals live throughout; confined UPS rack geometry	HIGH	Electrical Short Circuit · Crush · Chemical	Specialised Battery Handling Equipment

7 QUICK ASSESSMENT CHECKLIST

- ☐ Before maintenance work inside a multi-feeder MCC, are all adjacent live busbars physically shrouded — not managed only by visual identification and isolation tag?
- ☐ For VFD-driven motors, does the motor terminal box access procedure include a measured voltage at the motor terminals — not a timed capacitor discharge wait or MCC isolation alone?
- ☐ Do all E&I technicians use a purpose-designed rotary cable stripper — not a utility knife or penknife for cable stripping in the field or workshop?
- ☐ In the battery room, are all tools used for connection tightening insulated — with a defined exclusion of uninsulated tools from the battery room at all times?
- ☐ Before any instrument process connection is broken for maintenance, is the line pressure confirmed zero at the work point — not assumed zero from the process isolation alone?
- ☐ During HV switchgear racking and circuit breaker removal, is the arc flash PPE level matched to the calculated incident energy at the switchgear work point?

Contact PSC Hand Safety India for application-specific interface guidance based on your plant configuration.

8 **PSC ENGINEERING INTERFACE PORTFOLIO — ELECTRICAL & INSTRUMENTATION MAINTENANCE**

POSITION & REACH INTERFACES — CONFINED ENCLOSURE AND PANEL WORK

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull (S-Head)	Heavy switchgear component guidance during HV circuit breaker removal and panel component extraction. Transformer bushing guidance during crane-assisted maintenance. Motor positioning during crane-assisted motor change-out.	4 ft, 6 ft	PSC-LIT-S006 / S010	Maint.
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for heavy motor and switchgear components during crane-assisted E&I maintenance across the plant.	25 ft, 30 ft	PSC-LGTC-25 / -30	Maint.

STRIKING & ALIGNMENT INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts and alignment pins during switchgear and motor mounting hardware installation. E&I maintenance structural hardware work where impact tools are used adjacent to electrical enclosures.	250 mm, 350 mm	PSC-FS-250 / -350	Maint.

9 **KEY ENGINEERING PRINCIPLE**

PRINCIPLE — ELECTRICAL ISOLATION CONFIRMS THE SWITCH STATE, NOT THE ENERGY STATE

An isolation tag confirms that a switch has been opened. It does not confirm that all stored electrical energy in the circuit — capacitor charge, residual DC in VFD drives, induced voltage from adjacent live systems — has been discharged. Zero energy must be verified at the work point, not assumed from the switch state.

The isolation tag is a confirmation of a deliberate action — opening a switch. It is not a measurement of the energy condition at the work point. Drive capacitors, motor back-EMF, and inductive coupling from adjacent live systems can all maintain voltage at an isolated terminal for measurable time periods after the isolation switch is opened. The engineering control is a voltage measurement at the work point — a deliberate act that confirms the energy state rather than inferring it from the switch state. No hand entry into any electrical enclosure before voltage is confirmed zero at the point of entry.

1 DEPARTMENT OVERVIEW

Utilities and services maintain the infrastructure that every production and support department in the aluminium plant depends on — compressed air, cooling water, steam, nitrogen and process gases, effluent treatment, and HVAC. Utilities maintenance workers interact with pressurised systems, hot fluid systems, chemical treatment systems, and high-volume air handling systems across the full plant footprint. The hand exposure in utilities work is dominated by pressure injection and hot fluid burns from pipe system maintenance, chemical exposure from water treatment and effluent systems, and gas cylinder handling throughout the plant.

Gas cylinder handling is one of the most physically consistent hand exposure sources in the utilities function — cylinders must be moved, connected, and disconnected across the full plant area for nitrogen, hydrogen, compressed air, and specialty gases. The standard method of moving a cylinder by gripping the valve is both the most common and the most mechanically hazardous approach — a cylinder tipped during valve-grip handling falls with the full weight of the cylinder and valve on whatever is in the fall path.

2 MAJOR EQUIPMENT & LOCATIONS

COMPRESSED AIR SYSTEM

Compressed air generation, distribution, and maintenance — compressors, receivers, distribution mains, and point-of-use connections. Compressed air at typical plant pressures (6–10 bar) presents a pressure injection risk if the line is opened under pressure. Drain valve operation on receivers and drip legs exposes workers to high-pressure condensate and oil/water mixture.

COOLING WATER SYSTEM

Cooling towers, pumps, heat exchangers, and distribution for process cooling throughout the plant. Cooling water maintenance involves working on pressurised water systems, chemical dosing, and heat exchanger cleaning. Tower maintenance involves working at height and in confined basin geometries.

STEAM SYSTEM

Steam generation, distribution, and condensate return. Steam system maintenance involves the most severe burn hazard in the utilities function — high-pressure, high-temperature steam from inadvertent line opening under pressure causes deep scald burns within seconds. Condensate systems at near-boiling temperature present a secondary burn hazard at all drain and trap points.

GAS CYLINDER STORAGE AND DISTRIBUTION

Nitrogen, hydrogen, compressed air, and specialty gas cylinders throughout the plant. Cylinder storage, connection, and transport requires handling cylinders weighing 50–80 kg with a valve fitting at the top. Cylinder transport by hand without a cylinder trolley — valve-grip pulling — is the most common cylinder handling method and the most hazardous.

EFFLUENT TREATMENT PLANT

Effluent treatment for aluminium plant process water — pH correction, coagulation, and sedimentation. Chemical dosing of acid and alkali for pH adjustment. Pump and dosing system maintenance involves working with concentrated acid and caustic in the dosing area. Sludge handling from the settling tanks generates manual handling and chemical exposure simultaneously.

HVAC — VENTILATION AND AIR HANDLING

Heating, ventilation, and air conditioning systems across the plant, particularly in the cast house, potroom, and annealing areas where process gases and fume require controlled extraction. Fan, duct, and filter maintenance in high-temperature process exhaust systems involves confined access and residual hot gas exposure.

3 UTILITIES & SERVICES — TASK FLOW & EXPOSURE POINTS**UTILITIES & SERVICES****ISOLATION AND PRESSURE / ENERGY RELEASE**

System isolated · pressure confirmed zero at work point

RESIDUAL PRESSURE · HOT FLUID

ACCESS — PIPE JOINTS, VALVES, EQUIPMENT

Access established to pipe joint or equipment

CONFINED SPACE · HOT SURFACE · CHEMICAL

MAINTENANCE TASK — REPLACEMENT OR REPAIR

Component replaced or repaired at work point

PRESSURE INJECTION · BURNS · PINCH

GAS CYLINDER HANDLING — MOVEMENT AND CONNECTION

Gas cylinders moved · connected or disconnected

CYLINDER FALL · VALVE SHEAR · CHEMICAL

CHEMICAL DOSING — WATER TREATMENT

Chemicals dosed to water treatment system

CHEMICAL BURNS · SPLASH · CONFINED ACCESS

REINSTATEMENT AND PRESSURE TEST

System reinstated · pressure tested

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Steam System Maintenance — Zero Pressure Verification Before Joint Opening	
BURNS — HIGH-PRESSURE STEAM · CRUSH · PRESSURE INJECTION					
WHY THE HAND IS THERE Steam pipe maintenance requires opening flanged joints or removing valves from the steam distribution system. Steam at typical plant pressures (3–16 bar) at saturation temperature (144–204°C) causes immediate and severe full-thickness burns on contact. The consequences of opening a steam joint under residual pressure are among the most severe in plant maintenance. Isolation and drain procedures exist, but residual pressure in complex steam systems — particularly in trap bypass lines and dead legs — may not be released by the main isolation alone.		CURRENT FIELD INTERFACE Flanged joints unbolted after steam isolation and drain confirmation. In complex steam systems with multiple trap bypass lines, dead legs, and heat exchanger connections, residual steam or condensate under pressure may be trapped between the isolation valve and the work point. The standard drain confirmation — observing condensate flow from the drain valve — confirms only that the main run has been drained, not that all connected dead legs and bypass lines are at zero pressure.		EXPOSURE TYPE Severe burns from high-pressure steam ejection if a joint is opened under residual pressure — steam at 8 bar exits a joint opening at over 170°C with a jet velocity that causes deep burns within fractions of a second of skin contact. Pressure injection if residual steam pressure forces condensate into skin tissue through a small opening. Crush from the pipe flange components if the joint springs under trapped pressure during unbolting.	
ENGINEERING OBJECTIVE Verify zero pressure and zero temperature at the work point by local pressure gauge and temperature measurement before the first bolt is broken on any steam system joint — not by drain observation or isolation tag alone. Slow-release joint opening sequence on all flanged joints even after zero-pressure confirmation.			REPRESENTATIVE INTERFACE Local pressure gauge fitted at the work point or portable gauge used to confirm zero pressure before bolt break-out begins. Defined slow-release joint opening sequence — first bolt loosened slightly, then wait for any residual steam release before full unbolting. Steam burn PPE — face shield plus full-length steam-resistant arm protection — worn throughout the joint opening sequence.		
<i>"Before the first bolt is broken on a steam system joint, is zero pressure confirmed by a gauge reading at the work point — not by drain observation or main line isolation tag alone?"</i>					

HIGH				Gas Cylinder Handling — Movement Without Cylinder Trolley	
CYLINDER FALL · VALVE SHEAR · CRUSH — FOOT					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Gas cylinders throughout the plant must be moved between storage and point of use. Cylinders weigh 50–80 kg and are tall, narrow, and top-heavy — with the valve fitting at the highest point. The standard cylinder moving method in many operations is to tilt the cylinder and roll it on its base rim by gripping the valve body — a method that puts the full cylinder weight on the valve and places the worker's hand at the top of a 1.5-metre, 60 kg pendulum if the cylinder falls.		Cylinder moved by tilting and rolling on the base rim using the valve as the grip point. The valve fitting is not a designed lifting or carrying point. If the cylinder tips beyond the tilt angle during transport, the fall energy is applied through the valve body to the worker's grip hand. If the cylinder falls and the valve shears on impact with the floor, the stored cylinder pressure releases immediately through the open valve orifice.		Foot crush from the cylinder base if the cylinder falls during transport. Hand and arm crush from the valve and cylinder body if the cylinder falls toward the worker. Valve shear if the falling cylinder impacts a fixed object — releasing compressed gas at full cylinder pressure. Laceration from the cylinder valve fitting if the grip hand is in the valve area during a fall.	
ENGINEERING OBJECTIVE		REPRESENTATIVE INTERFACE			
Move gas cylinders only with a cylinder trolley or cradle that supports the cylinder at its centre of gravity rather than relying on the valve as the grip and balance point — and never by hand-grip on the valve body during transport.		PSC GasGrab® Cylinder Lifter for moving gas cylinders in the plant — engages the cylinder body at the centre of gravity rather than the valve. Defined cylinder transport procedure requiring trolley use for all movements greater than 2 metres. Cylinder cap on valve at all times when cylinder is not connected.			
"In your utilities team, how are gas cylinders moved between storage and point of use — and is valve-grip rolling of cylinders ever the standard method for cylinders heavier than 20 kg?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH				Cooling Tower and Water Treatment Chemical Handling	
CHEMICAL BURNS · SPLASH · CONFINED ACCESS					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Cooling water treatment requires dosing of biocides, scale inhibitors, corrosion inhibitors, and pH correction chemicals — typically sulphuric acid and caustic soda — into the cooling tower basin. Chemical dosing during routine treatment and during manual batch dosing for corrective treatment involves handling concentrated chemical solutions. Tower basin maintenance for descaling and cleaning involves working in a confined basin with chemical-contaminated water and scale.		Chemical dosing by hand-pouring concentrated treatment chemicals from handling containers into the dosing system. Workers approach open cooling tower basins during chemical addition, batch treatment, or basin cleaning. Chemical containers at treatment concentrations — 30–98% sulphuric acid for pH correction — handled by hand grip on the container body during decanting.		Chemical burns from concentrated sulphuric acid or caustic soda during dosing or decanting. Splash from the tower basin during chemical addition — the basin may be operating with hot water during treatment. Confined access burns and chemical exposure during tower basin descaling and cleaning. Slip on chemically contaminated basin surfaces during cleaning.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Add water treatment chemicals using a closed dosing system or a decanting tool that eliminates hand contact with concentrated chemical solutions — and approach tower basin cleaning with a defined entry procedure for the confined basin access.			Closed loop chemical dosing system for routine treatment chemicals — eliminates hand contact with concentrated chemicals during routine dosing. Pump-transfer system for concentrated acid and caustic decanting — eliminates hand-pour method. Chemical-resistant suit, gloves, and face shield for all confined tower basin access.		
"During cooling water chemical treatment, are concentrated chemicals added using a closed dosing system — or are they decanted by hand-pour into the dosing tank with the worker's hands adjacent to concentrated acid or caustic?"					

MEDIUM				HVAC Fan and Duct Maintenance — Residual Motion After Stop	
ENTANGLEMENT · LACERATION — FAN BLADE · HOT EXHAUST					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
HVAC fan maintenance — belt replacement, blade cleaning, and bearing service — requires access to the fan impeller after the fan has been stopped and isolated. Fan impellers retain residual motion for extended periods after the drive is isolated — particularly large impellers with significant rotational inertia. Workers entering the fan access panel may approach the impeller before residual rotation has ceased.		Workers open the fan access panel and approach the impeller to begin maintenance work. Residual impeller rotation after isolation is not always confirmed zero before access. Fan blade cleaning by hand with the impeller stationary — bare hand drawn along fan blade surface for cleaning. Confined duct access for downstream ductwork maintenance in process exhaust systems at residual process temperature.		Entanglement of hand or clothing in the fan impeller if residual rotation is present at the moment of access. Laceration from fan blade edges during cleaning if the impeller begins to rotate from draught or from residual motion during the cleaning contact. Burns from residual hot gas in process exhaust duct sections at elevated temperature.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Confirm zero impeller rotation by physical observation with the access panel closed before opening the access — and apply a physical brake or blockage to the impeller before hand entry into the fan housing for blade cleaning or inspection.			Defined impeller-stopped confirmation procedure before access panel opening — observation window or indirect confirmation. Physical impeller brake or blockage (safety prop or wedge) applied to the impeller before hand entry into the fan housing for maintenance. Defined hot exhaust duct cool-down period confirmed before entry into connected ductwork sections.		
"Before opening the fan access panel for maintenance, is zero impeller rotation confirmed by a defined observation method — and is a physical impeller block in place before any hand entry into the fan housing?"					

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Compressor valve and seal replacement	Compressor valve seats and seals accessed at maintenance intervals; compressor at production temperature; confined crankcase geometry; compressed air residual pressure in adjacent circuits	HIGH	Burns · Pressure · Confined Space	PSC Position & Reach Interfaces
Heat exchanger tube cleaning and plugging	Tube bundle accessed for cleaning and defective tube plugging; tube faces at process temperature; confined shell and tube geometry; chemical cleaning agents in tube bore	HIGH	Chemical · Burns · Confined Space	PSC Position & Reach Interfaces
Cooling tower basin cleaning — confined space entry	Tower basin entered for descaling and cleaning; confined space; chemical-contaminated water residue; biological hazard from legionella control treatments	HIGH	Chemical · Confined Space · Biological	PSC Position & Reach Interfaces
Steam trap removal and replacement	Steam trap removed for maintenance or replacement; trap at steam temperature; trap body and connections under condensate pressure; confined pipe gallery access	HIGH	Burns — Steam · Chemical · Confined Space	PSC Striking & Alignment · PSC Position & Reach

7 QUICK ASSESSMENT CHECKLIST

- ☐ Before the first bolt is broken on any steam system joint, is zero pressure confirmed by a gauge reading at the work point — not by drain observation or isolation tag alone?
- ☐ Are all gas cylinders moved using a cylinder trolley or GasGrab lifter — with valve-grip rolling prohibited for all cylinders heavier than 20 kg?
- ☐ During cooling water chemical dosing, are concentrated chemicals added using a closed or pump-transfer system — not by hand-pour decanting?
- ☐ Before opening a fan access panel for maintenance, is zero impeller rotation confirmed and a physical impeller block in place before any hand entry into the fan housing?
- ☐ During cooling tower basin cleaning, is a confined space entry procedure followed — including atmosphere testing before entry and defined communication with a standby person?
- ☐ During steam trap maintenance, is the trap body temperature confirmed at ambient before the trap body or connections are touched by hand?
- ☐ Are gas cylinder valves capped when cylinders are not connected — and is this enforced for all cylinders in transit through the plant, not only for cylinders in the cylinder store?

Contact PSC Hand Safety India for application-specific interface guidance based on your plant configuration.

8 PSC ENGINEERING INTERFACE PORTFOLIO — UTILITIES & SERVICES

SPECIALISED INTERFACES — GAS CYLINDER AND STEAM SYSTEM

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
SPECIALISED PSC GasGrab® Cylinder Lifter	Moving gas cylinders throughout the plant — engages the cylinder body at the centre of gravity rather than the valve body. Eliminates valve-grip rolling for all cylinder sizes handled in the plant.	215 mm, 230 mm, 254 mm	PSC-GG-215 / -230 / -254	2
POSITION & REACH PSC Load-It® Push/Pull (S-Head)	Pipe component guidance during crane-assisted steam system and cooling system maintenance. HVAC duct component guidance during crane-assisted installation.	4 ft, 6 ft	PSC-LIT-S006 / S010	Maint.

LOAD CONTROL & STRIKING INTERFACES

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for heavy pipe and HVAC components during crane-assisted utilities maintenance across the plant.	25 ft, 30 ft	PSC-LGTC-25 / -30	Maint.
STRIKING & ALIGNMENT PSC FingerSaver™	Holding drifts during pipe flange stud installation, valve body alignment driving, and HVAC structural hardware. Utilities maintenance impact tool operations throughout the plant.	350 mm, 850 mm	PSC-FS-350 / -850	Maint.

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — STEAM AND COMPRESSED GAS CANNOT BE MADE VISIBLE BY ISOLATION. THEY MUST BE MEASURED.

An isolation valve closed and tagged confirms a deliberate action. It does not confirm the energy state in the pipe at the work point. Only a gauge measurement at the work point confirms zero pressure — not the isolation tag, not drain observation, not elapsed time.

Steam and compressed gas are invisible at the moment of release. The worker opening a joint under residual steam pressure receives no warning signal before the burn occurs. This is fundamentally different from mechanical systems where the component under stored energy visibly deflects when the load is removed. The steam and gas hazard requires an additional step that mechanical systems do not — pressure measurement at the work point, as a deliberate, instrument-verified act, before the joint is opened. This step cannot be substituted by any other confirmation method.

1

DEPARTMENT OVERVIEW

HAND SAFETY FIRST® · A PSC HAND SAFETY BRAND

Material handling, logistics, and despatch are the final operations before the aluminium product leaves the plant. Workers in these areas interact with the finished product at every stage of outbound preparation — moving coils and sheet packs from warehouse storage to the despatch bay, loading onto trucks and rail wagons by crane, and managing the strapping, wrapping, and documentation that complete the despatch sequence. The hand exposure pattern in material handling reflects those in the coil bay and finishing areas — suspended load crane guidance and sharp coil and sheet edges — but at higher speed and with less familiarity with the specific product being loaded at each despatch cycle.

A Department-by-Department Engineering Guide to Identifying and Reducing Hand Exposure Across All Areas of Primary and Secondary Aluminium Production, 22 Departments, First Edition 2026

The despatch environment also involves external drivers and logistics personnel who may enter the loading bay without the plant-specific training of production employees. The introduction of overhead crane operations, truck traffic, and external visitors in the loading bay creates one of the highest concurrent hazard density areas in the plant. Coil and sheet packs are at their heaviest and most fragile surface condition at the despatch point — any damage during loading generates both a commercial and a safety consequence, and the pressure to load quickly can override the careful rigging and guidance practice required for safe crane operations.

2

MAJOR EQUIPMENT & LOCATIONS

Engineer the Hand Out of the Hazard™

The Last 300 mm Rule™

DESPATCH BAY OVERHEAD CRANE

EOT overhead crane for loading coils, sheet packs, and extrusion bundles onto trucks and rail wagons. The despatch bay crane operates in a shared space with truck and forklift traffic — the most complex concurrent hazard environment in the plant. Loaded truck positions below the crane path during loading mean that truck cab areas may be in the crane swing zone during coil loading.

COIL AND SHEET WAREHOUSE STORAGE

Warehouse storage for finished coils and sheet packs awaiting despatch. Coils are stored in defined bay positions on coil stands or on the floor in rows. Picking coils for a despatch order requires crane access to specific storage positions — navigating the overhead crane between other stored coils in the warehouse creates proximity hazards during picking crane operations.

TRUCK AND RAIL LOADING BAY

Loading bay positions for trucks and rail wagons accepting crane-loaded product. Truck beds and rail wagon floors create a variable landing height and surface for crane-loaded product. Workers guide the crane load to the truck bed or wagon — standing in the truck or wagon body during the final guidance phase, beneath the overhead crane load.

FORKLIFT TRUCKS AND PALLET MOVERS

Forklifts for moving pallet-loaded product and lighter coil packs within the warehouse and despatch bay. Forklift mast and fork arms present pinch and crush hazards during load approach. Forklift traffic and pedestrian traffic share the despatch bay floor during loading operations.

STRAPPING AND WRAPPING EQUIPMENT

Strapping machines and wrapping tables in the despatch preparation area. Final strapping before despatch requires the same coil outer wrap edge contact as finishing line strapping. Wrapper film and paper application to coil and sheet pack outer surfaces before final strapping.

WEIGHBRIDGE AND DOCUMENTATION AREA

Weighbridge for truck and coil weighing before despatch. Documentation area where despatch paperwork is prepared. Workers moving between the weighbridge area and the loading bay cross the forklift and truck traffic zone repeatedly during each despatch cycle.

3 MATERIAL HANDLING, LOGISTICS & DESPATCH — TASK FLOW & EXPOSURE POINTS**MATERIAL HANDLING, LOGISTICS & DESPATCH****WAREHOUSE ORDER PICKING — CRANE SELECTION**

Despatch order received · coil or sheet picked by crane

SUSPENDED LOAD · LACERATION · CRANE PROXIMITY

COIL / SHEET TRANSFER TO DESPATCH BAY

Product moved to despatch bay by crane or forklift

SUSPENDED LOAD · FORKLIFT · STRUCK-BY

FINAL STRAPPING AND WRAPPING

Product strapped and wrapped for despatch

LACERATION — OUTER WRAP EDGE · PINCH

TRUCK OR RAIL LOADING — CRANE GUIDANCE

Product loaded to truck or rail by crane · worker guides in truck

SUSPENDED LOAD — WORKER IN TRUCK BELOW · CRUSH

SLING AND RIGGING REMOVAL POST-LOADING

Slings removed from loaded product on truck or wagon

LACERATION · CRUSH — LOAD SETTLE · CAUGHT-BETWEEN

TRUCK DEPARTURE — LOAD SECURED

Load confirmed secured · truck departs loading bay

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS

HIGH				Truck Loading — Worker in Truck Body Beneath Crane Load	
SUSPENDED LOAD · CRUSH · STRUCK-BY					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
Loading coils and sheet packs onto trucks requires the crane load to be guided into the correct position on the truck bed. Workers enter the truck body — climbing onto the truck deck or into the truck bed — to guide the crane-suspended load to its correct landing position on the truck. The worker is directly beneath the crane load, inside the truck body, during the final guidance phase before the load lands.		Workers in the truck body guide the crane-suspended coil or sheet pack to its landing position using bare hands or rods — standing beneath the suspended load throughout the final guidance sequence. The truck cab area is at the end of the truck body closest to the crane swing zone. No anti-tangle tagline is in use for the final truck-body guidance phase in most operations.		Crush from the crane-suspended load if it swings toward the worker in the confined truck body. Crush between the load and the truck body sidewall if the load is too wide for the truck body. Struck-by the crane load if it drops or is released prematurely. The worker in the truck body has very limited options for rapid exit if the load swings — the truck sidewalls constrain lateral movement.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Guide crane-suspended loads into the truck body from outside the truck body using stand-off tools that allow the worker to remain on the ground or on the truck edge during the final guidance phase — not inside the truck body beneath the suspended load.			Anti-Tangle Tagline for load swing control during crane travel and descent to the truck. PSC Load-It (S-Head, 6 ft) for final load guidance into the truck body from the truck edge rather than from inside the truck body beneath the load. Defined exclusion protocol: no worker inside the truck body until the crane load is seated on the truck bed and crane slack is confirmed.		
"During truck loading by crane, is any worker inside the truck body while the crane load is still suspended above the truck — and is this practice covered by your lifting plan or JSA for truck loading operations?"					

HIGH				Coil Sling and Rigging Removal After Truck Loading	
LACERATION · CRUSH — LOAD SETTLE · CAUGHT-BETWEEN					
WHY THE HAND IS THERE		CURRENT FIELD INTERFACE		EXPOSURE TYPE	
After the crane load is landed on the truck bed, slings and lifting belts must be removed before the crane can move to the next pick. Workers climb onto the truck or reach across the load to access the sling loops at the top of the coil and to disengage the crane hook. Sling removal from a coil that has just landed may involve pulling the sling from under the coil's edge weight — a task that brings hands adjacent to the sharp outer wrap edge and to the load settle zone.		Workers reach over or around the coil outer wrap to access the sling loop at the top of the coil eye. The sharp outer wrap edge is at hand level during the sling disengagement reach. If the coil is not fully stable on the truck bed, it may shift or settle during sling removal — catching the worker's hand between the coil and the sling rigging.		Laceration from contact with the sharp coil outer wrap edge during sling removal reach. Crush between the coil and the sling if the coil settles during sling removal and the hand is between the coil edge and the sling loop. Caught-between the coil and the truck sidewall or load securing equipment if the coil shifts during sling disengagement.	
ENGINEERING OBJECTIVE			REPRESENTATIVE INTERFACE		
Remove slings from crane-landed coils using a tool that disengages the sling loop from the crane hook without requiring the worker's hand to reach past or over the sharp coil outer wrap edge — from a position outside the coil load settle zone.			PSC TRT-3P Extendable Tagline Retriever for sling loop disengagement from crane hook after coil landing on truck — extends to the sling loop from floor position outside the truck body. PSC Load-It XT-Hook for pulling sling loops free from the coil eye area without bare hand contact with the coil outer wrap edge.		
"After a coil is landed on the truck bed, is the sling removed using a tool that keeps the worker's hand outside the coil outer wrap edge — or does sling removal require reaching past the sharp outer wrap?"					

5 MANUAL TASKS & HAND EXPOSURE SCENARIOS — CONTINUED

HIGH	Warehouse Order Picking — Crane Navigation Between Stored Coils		
	SUSPENDED LOAD · CRUSH · LACERATION — COIL EDGES		
WHY THE HAND IS THERE Picking coils for a specific despatch order from warehouse storage requires the crane to navigate between rows of stored coils to access the required coil position. Workers guide the crane hook and lifting equipment into the narrow gap between stored coils for attachment to the required coil. The gap between stored coils is at coil-body width — 300–600 mm in many storage configurations — giving limited clearance for hand operations during hook and sling positioning.	CURRENT FIELD INTERFACE Workers reach between stored coils to position crane hooks and slings on the required coil. The adjacent stored coils create crush zones on both sides of the reach. The coil outer wrap edges of the stored coils are at hand level throughout the reach. In narrow-aisle storage, the worker may need to squeeze between adjacent coils to reach the target coil attachment point.	EXPOSURE TYPE Crush between the crane hook or sling and the adjacent stored coil if the hook swings during positioning in the narrow-aisle gap. Laceration from contact with the outer wrap edges of the adjacent stored coils during reach. Caught-between the crane hook and the adjacent coil if the crane operator moves the hook while the worker's hand is in the coil gap.	
ENGINEERING OBJECTIVE Position crane hooks and slings on warehouse-stored coils without placing the worker's hands in the gap between adjacent stored coils — using a hook positioning tool that reaches into the narrow aisle from outside the coil gap.		REPRESENTATIVE INTERFACE PSC TRT-3P Extendable Tagline Retriever for positioning crane hooks and sling loops onto coils in narrow-aisle warehouse storage — extends into the gap from outside the coil row. PSC Load-It XT-Hook for hook engagement in the coil eye from outside the storage gap. Defined minimum coil storage aisle width that allows hook attachment from outside the gap.	
"During warehouse order picking, can the crane hook be attached to a coil in storage without the worker's hands entering the gap between adjacent stored coils — or does the current storage aisle width require hand-entry into the gap for every pick?"			

MEDIUM			
Forklift and Pedestrian Conflict in Shared Loading Bay			
STRUCK-BY — FORKLIFT · CAUGHT-BETWEEN · CRUSH			
WHY THE HAND IS THERE The despatch loading bay is a shared space — overhead crane loading operations, forklift movements, truck access, and external driver movement occur simultaneously. Workers on foot in the loading bay are exposed to forklift traffic from behind, from the side, and at the mast and fork arm level. External truck drivers entering the loading bay are unfamiliar with the hazards of the specific area and may move into forklift and crane swing zones without awareness.		CURRENT FIELD INTERFACE No defined pedestrian lane separate from forklift travel routes in many loading bay layouts. Workers step into the forklift travel zone to observe crane loading operations and to check truck load securing. External drivers walk between their truck cab and the loading documentation area crossing the forklift route. The crane swing zone overhead and the forklift travel zone on the floor may overlap in the despatch bay layout.	
EXPOSURE TYPE Struck-by forklift if the forklift operator does not observe a worker stepping into the travel route. Caught-between the forklift and a fixed structure if a worker is in the forklift travel zone during a reversing manoeuvre. Crush from the crane-suspended load if an external driver walks under the crane path during loading. Struck-by the crane load if a forklift load is struck by the overhead crane swing arc.			
ENGINEERING OBJECTIVE Define a physical pedestrian route through the loading bay that is separated from the forklift travel route and the crane swing zone — marked on the floor and enforced for all personnel in the loading bay including external drivers.		REPRESENTATIVE INTERFACE Defined pedestrian lane marked on the loading bay floor — physically separated from forklift travel route and outside the crane swing zone. External driver briefing procedure before entry into the loading bay — covers crane operations, forklift routes, and exclusion zones. Forklift travel speed limit in the loading bay enforced as part of the site induction for all loading bay operators.	
"In your loading bay, is the pedestrian route physically separated from the forklift travel route — and are external truck drivers briefed on crane swing zones and forklift hazards before they enter the loading bay?"			

6 NON-ROUTINE & MAINTENANCE EXPOSURE

TASK	HAND EXPOSURE	SEVERITY	EXPOSURE TYPE	PSC INTERFACE CATEGORY
Despatch crane hook and sling inspection and replacement	Crane hook and slings inspected and replaced; hook at height on crane saddle; replacement hardware installed with hands in hook travel zone	HIGH	Laceration · Crush · Working at Height	PSC Load Control · PSC Position & Reach
Coil storage stand and rack maintenance	Stand cradles and adjusters serviced; heavy stand components; adjacent crane operations with coils overhead; stands on warehouse floor in crane swing zone	MEDIUM	Crush · Struck-By · Ergonomic	PSC Position & Reach Interfaces
Strapping machine maintenance	Strapping machine feed and seal mechanism serviced; sharp strapping material residue in mechanism; pinch hazard at seal jaw	MEDIUM	Laceration · Pinch	PSC Striking & Alignment Interfaces
Weighbridge and floor maintenance	Weighbridge platform and approach ramp maintained; forklift and truck traffic continues during maintenance; weighbridge sensors accessed in platform underside recess	MEDIUM	Struck-By · Crush · Ergonomic	PSC Position & Reach Interfaces

7 QUICK ASSESSMENT CHECKLIST

- ☐ During truck loading by crane, is any worker inside the truck body while the crane load is still suspended — and does your lifting plan explicitly prohibit this?
- ☐ After coil landing on the truck, is the sling removed using a tool that keeps the worker's hand outside the coil outer wrap edge — not by bare hand reach past the sharp outer wrap?
- ☐ During warehouse order picking, can crane hooks be attached to stored coils without the worker's hands entering the gap between adjacent stored coils in the aisle?
- ☐ In the loading bay, is the pedestrian route physically separated from the forklift travel route — with external truck drivers briefed before they enter the loading bay?
- ☐ Is an anti-tangle tagline used on every crane lift in the despatch bay — including on lighter pallet loads where swing during crane travel could reach external driver positions?
- ☐ During coil strapping before despatch, does the strapping method prevent bare hand or forearm contact with the sharp coil outer wrap edge on every coil strapped?
- ☐ Are coil storage stand aisle widths defined as a minimum that allows crane hook attachment from outside the aisle gap — enforced as a storage layout standard?

Contact PSC Hand Safety India for application-specific interface guidance based on your plant configuration.

8 PSC ENGINEERING INTERFACE PORTFOLIO — MATERIAL HANDLING, LOGISTICS & DESPATCH

LOAD CONTROL INTERFACES — DESPATCH BAY CRANE OPERATIONS

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
LOAD CONTROL PSC LoadGuider® Anti-Tangle Tagline	Swing control for coils and sheet packs during all crane operations in the despatch bay and warehouse. Directly addresses the need for workers inside the truck body for load guidance during truck loading.	25 ft, 30 ft	PSC-LGTC-25 / -30	1 · 3
LOAD CONTROL PSC TRT-3P Extendable Tagline Retriever	Attaching and removing sling loops from coils in warehouse storage aisles and on truck beds — without hand entry into the coil gap or past the coil outer wrap edge.	6–12 ft	PSC-TRT-3P	2 · 3

POSITION & REACH INTERFACES — TRUCK AND WAREHOUSE GUIDANCE

INTERFACE	APPLICATION	SIZES	PART NUMBERS	SCENARIOS
POSITION & REACH PSC Load-It® Push/Pull Tool (S-Head & XT-Hook)	Final crane load guidance into truck body from truck edge — worker remains outside the truck body beneath the load. Warehouse coil guidance during narrow-aisle pick operations.	2–6 ft	PSC-LIT-S006 / XT-J002 / XT-J003	1 · 2 · 3

9 KEY ENGINEERING PRINCIPLE

PRINCIPLE — THE DESPATCH BAY IS THE LAST LINE OF DEFENCE BEFORE THE PRODUCT AND THE HAZARD LEAVE THE PLANT TOGETHER

Every coil that leaves the plant passes through the despatch bay. The crane guidance practices, sling management, and loading bay pedestrian controls established there become the template for how the customer handles the same product when it arrives.

A customer unloading a truck at their facility has no knowledge of the specific hazards of aluminium coil outer wrap edges, crane swing arcs, or the need for stand-off tools during guided landing. They will replicate, roughly, whatever method was used to load the product at the despatch bay. A plant that loads with taglines and stand-off tools demonstrates — through the loading process — how to handle the product safely. A plant that loads with bare hands teaches the customer to do the same.

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PUBLISHED BY

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PSC Engineering Interface Master

Consolidated reference of all PSC engineering interfaces cited in this guide. Part numbers, sizes and specifications must be validated with PSC Hand Safety India before procurement. Cells marked "Validation required" indicate items where the manuscript reference is incomplete or requires product confirmation.

A1 STRIKING & ALIGNMENT INTERFACES

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
PSC FingerSaver™	Striking & Alignment	250 mm · 350 mm · 375 mm · 850 mm	PSC-FS-250 · PSC-FS-350 · PSC-FS-375 · PSC-FS-850	Holding drifts, punches, chisels, wedges during hammer striking. All 22 chapters — Maintenance sections throughout.

A2 POSITION & REACH INTERFACES — LOAD-IT® FAMILY

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
PSC Load-It® Push/Pull Tool — S-Head	Position & Reach	4 ft · 6 ft	PSC-LIT-S006 · PSC-LIT-S010	General load guidance, coil guidance, pipe component positioning. Ch 03 05 06 07 08 09 10 11 12 13 14 16 18 19 20 21 22.
PSC Load-It® Push/Pull Tool — M-Head	Position & Reach	1 ft · 2 ft	PSC-LIT-M002 · PSC-LIT-M008 · PSC-LIT-M010	Strip threading at hot and cold rolling mills, close-approach guidance. Ch 09 10 15.
PSC Load-It® Push/Pull Tool — L-Head	Position & Reach	6 ft · 8 ft	PSC-LIT-L006 · PSC-LIT-L008	Crane hook guidance, general long-reach positioning. Ch 14.
PSC Load-It® XT-Hook — J-Type	Position & Reach	2 ft · 3 ft	PSC-XT-J002 · PSC-XT-J003	Hook-head engagement with rigging, sling loops, coil saddles. Ch 11 14 22.
PSC Load-It® MagHead Fixed	Position & Reach	2 ft · 3 ft · 4 ft	PSC-LIT-MG002 · PSC-LIT-MG003 · PSC-LIT-MG004	Magnetic attachment to ferrous components. Ch 09.
PSC Load-It® MagHead Extendable	Position & Reach	2–8 ft	PSC-LIT-MAG-FG-008	Magnetic positioning at variable reach. 550 lb capacity. Ch 09 18.
PSC Load-It® Scraper Head (Custom)	Application-Specific	1 ft – 12 ft (custom)	Custom configuration — UMC not yet assigned	Swarf clearance, paste removal, scrap pushing from confined and hard-to-reach areas. Stainless steel, 1–12 ft shaft. Ch 08 10 15.

A3 LOAD CONTROL INTERFACES

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
PSC LoadGuider® Anti-Tangle Tagline	Load Control	25 ft · 30 ft	PSC-LGTC-25 · PSC-LGTC-30	Suspended load swing control for all crane operations throughout the plant. All 22 chapters.
PSC TRT-3P Extendable Tagline Retriever	Load Control	6–12 ft	PSC-TRT-3P	Attaching slings and taglines at height without hand entry into crush zone. Ch 11 14 22.
PSC SafeGuider®	Load Control	2 ft – 10 ft	PSC-STGT range (exact part numbers to be confirmed — 2 ft to 10 ft available)	Suspended-load guidance and movement control on heavy crane operations. Available in 2 ft to 10 ft lengths. Ch 03 04 05 06 07.

A4 RETRIEVAL INTERFACES

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
PSC Long-Reach Pickup Tool	Retrieval	6 ft	PSC-ST	Retrieving sharp and small pieces from confined or hazardous locations. Ch 08 09 10 11 13 14 15 17 18 19 21.

A5 SPECIALISED INTERFACES

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
PSC GasGrab® Cylinder Lifter	Specialised	215 mm · 230 mm · 254 mm	PSC-GG-215 · PSC-GG-230 · PSC-GG-254	Moving gas cylinders without valve-grip handling. Ch 12 21.
PSC Guide-It®	Position & Reach	72 in · 96 in (6 ft · 8 ft)	PSC-GIT-72 · PSC-GIT-96	Heavy-duty push/pull tool (yellow) for rigid contact guidance — latch removal, hook engagement, and load steering where direct push/pull force is needed. Distinct from LoadGuider® (green tagline tool for swing control). Guide-It and LoadGuider are often used together on the same lift. Ch 03 04 05 06 07 22.

A6 HAND SAFETY EQUIPMENT REFERENCED

PRODUCT NAME	FUNCTION	STANDARD SIZES	PART NUMBERS	PRIMARY APPLICATION / CHAPTERS
Ironclad KONG SDX2 Glove	PPE — Cut Protection	Standard sizes	ANSI A2 · EN388: 4242AP	General cut protection. <i>Note: PPE is a residual control. Confirm suitability for specific task chemical and thermal conditions.</i>
Ironclad KONG KDC5 Glove	PPE — Cut Protection	Standard sizes	ANSI A7 · EN388: 4X44FP	High cut-level protection for sharp aluminium edges. <i>Note: Not a chemical barrier — validate before use on chemical exposure tasks.</i>

Items Requiring Final Confirmation Before Print Release

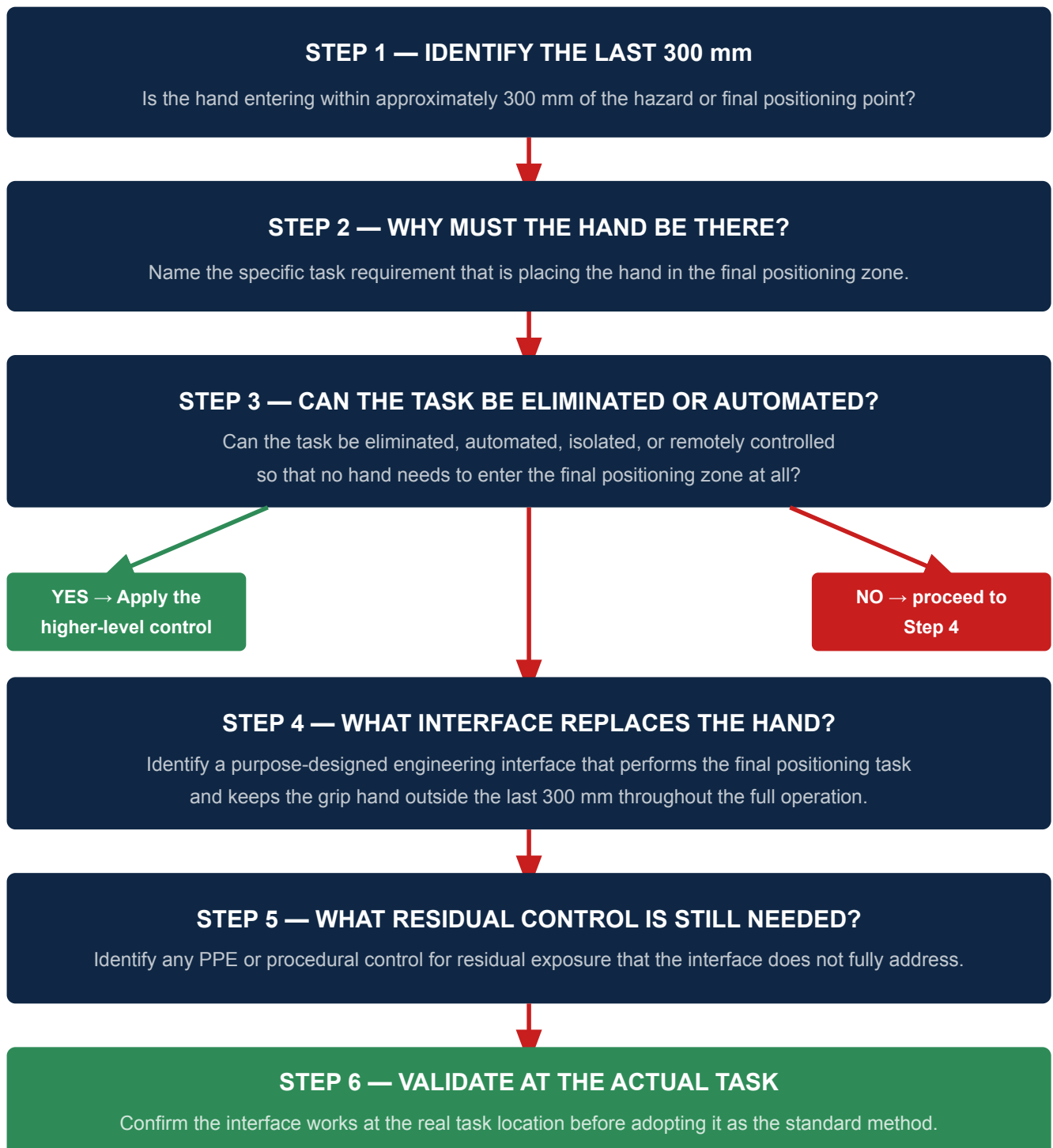
- **PSC Load-It® Scraper Head** — Custom configuration confirmed available (1–12 ft, stainless steel). UMC not yet assigned — confirm before print release.
- **PSC SafeGuider®** — Confirmed available 2 ft to 10 ft. Individual part numbers (PSC-STGT range) to be confirmed against current product register before print.
- **PSC Guide-It®** — Part numbers PSC-GIT-72 and PSC-GIT-96 to be verified against current product register.
- **PSC Load-It® Wide-V Head** — Excluded from this edition. Product not yet field-trialled for aluminium ingot guidance applications.
- All part numbers in this appendix should be verified against the current PSC product register before print release.

The Last 300 mm Rule™ — Field Reference

A single-page decision reference for use at the task location. Apply before any manual interaction with a hazard zone, suspended load, hot surface, nip point, or chemical source.

B THE LAST 300 MM RULE™ — FIELD DECISION REFERENCE

Use this sequence before any task that requires a worker's hand to approach within approximately 300 mm of a hazard — the final positioning zone where most hand injuries occur. The rule is not about the total distance from the hazard. It is about that last 300 mm.



The Last 300 mm Rule™ is a PSC Hand Safety doctrine. It does not replace the plant's formal risk assessment process.

Department Hand-Exposure Assessment Register

A blank reproducible register for recording hand-exposure assessments by department. Copy and complete one register per department walkdown. This register is a working document — it is not a substitute for the plant's formal risk assessment record.

C ASSESSMENT REGISTER — PAGE 1 OF 2

Department	Equipment / Location	Task	Why the Hand is There	Current Interface	Exposure Type	Engineering Gap? (Y/N)	Proposed Engineering Control
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	
						☐ Y ☐ N	

Assessment conducted by: _____ Date: _____ Department: _____

C ASSESSMENT REGISTER — PAGE 2 OF 2 (ACTION TRACKING)

Department	Task	Proposed Engineering Control	Interface / Tool Selected	Responsible Person	Target Date	Status
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed
						Open / In Progress / Closed

This register is a working field document. Transfer confirmed actions to the plant's formal corrective-action management system.

Glossary

Definitions of terms used in this guide. Definitions are operational rather than regulatory and are specific to the context in which each term is used throughout the 22 chapters.

D GLOSSARY OF TERMS

Caught-Between	An injury or exposure mechanism in which the hand or fingers are trapped between two objects — typically a moving load and a fixed structure, or two converging components. Common at coil landing, crane guidance, and baler feed zones.
Chemical Barrier Glove	A glove constructed from a material that has been tested and rated to resist the permeation of a specific chemical compound through the glove material. A mechanical protection glove and a chemical barrier glove are not interchangeable — a glove must be specified for both mechanical and chemical requirements where both hazards are present.
Crush Zone	The space between two objects within which a hand or body part could be compressed if the objects move toward each other. In this guide: the space between a crane-suspended load and the landing surface during crane descent; between a press ram and the die housing; between a cathode block and the pot-shell wall.
Engineering Gap	The absence of a purpose-designed tool or interface for a specific task, resulting in workers using improvised tools or bare hands. An engineering gap exists when the task requires the hand to enter a hazard zone and no engineered alternative has been provided.
Engineering Interface	A purpose-designed tool or device that performs the final positioning, guiding, or handling function of a task — keeping the worker's hand outside the hazard zone throughout the operation. Not synonymous with PPE.
Exclusion Zone	A defined physical area adjacent to a hazard from which all workers are excluded during a specific phase of an operation — typically a crane lift, a casting pour, or a press cycle. Distinguished from a stand-off distance by being a defined spatial boundary rather than a measured clearance.
Final Positioning Zone	The space within approximately 300 mm of the hazard or the intended landing or contact point of a load, component, or tool. Most hand injuries occur during the final positioning phase of a task — see The Last 300 mm Rule™.
Hand Exposure	Direct or near-direct contact between a worker's hand and a hazard — a nip point, a suspended load, a hot surface, a sharp edge, or a chemical source. In this guide, hand exposure includes both contact events and proximity events where contact is the credible next step.
Laceration	A cut or deep skin breach caused by contact with a sharp edge. In aluminium processing, lacerations are most commonly caused by cold-rolled strip edges, sheared trim scrap, foil edges, and fractured spent lining material. The severity ranges from superficial to deep-tissue, depending on edge sharpness and contact force.
Line of Fire	The path along which a stored energy release, a moving load, or a projectile would travel if released or launched. A worker in the line of fire is at risk of being struck by the energy release. In this guide: the path of a crane swing, the trajectory of ejected trim scrap, or the direction of a pressurised fluid release.
LOTO	Lockout/Tagout — an energy isolation procedure in which energy sources are physically locked out and tagged to prevent inadvertent energisation during maintenance. LOTO is referenced in this guide as a prerequisite for maintenance access but is governed by the plant's own LOTO procedure, not by this guide.
Nip Point	The point of convergence between two moving surfaces — typically a roll and a fixed surface, or two counter-rotating rolls — into which a hand or fingers could be drawn. Nip points are present at all rolling mill stands, driven roll tables, conveyor drive drums, coiler mandrels, and calendar roll pairs. Contact with a nip point at operating speed does not allow withdrawal time.
Representative Interface	A PSC product or engineering approach cited in this guide as a suitable interface for a described task. A representative interface is a starting point for application engineering — it must be validated against the specific task geometry, component dimensions, temperature, and chemical conditions at the plant before adoption.
Residual Control	A control that remains necessary after all higher-level controls have been applied. In this guide, PPE is a residual control — it addresses exposure that the engineering interface does not eliminate. Residual controls do not replace engineering controls; they supplement them.
Stand-Off Distance	The measured distance between the worker's grip hand and the hazard — a nip point, a hot surface, a chemical bath, or a suspended load — maintained by the length or geometry of the engineering interface in use. The Last 300 mm Rule™ defines the critical zone within which stand-off becomes insufficient and a closer interface or a different control is required.
Suspended Load	Any load that is crane-suspended, hoist-suspended, or otherwise elevated above its resting surface and subject to gravitational, inertial, or swing forces. In this guide, suspended loads include production coils, anodes, cathode blocks, furnace hoods, heavy maintenance components, and scrap bundles. No worker should be in physical contact with a suspended load during crane travel.
The Last 300 mm Rule™	A PSC Hand Safety doctrine stating that the final 300 mm of any approach to a hazard — the distance within which the hand is performing the final positioning or guiding function — is the zone of highest injury risk. The engineering response is to provide an interface that positions the grip hand outside this zone while still completing the task. See Appendix B for the full field decision sequence.