

# Improvements & Technological Advancements in ERW/HFIW Tubes Manufacturing

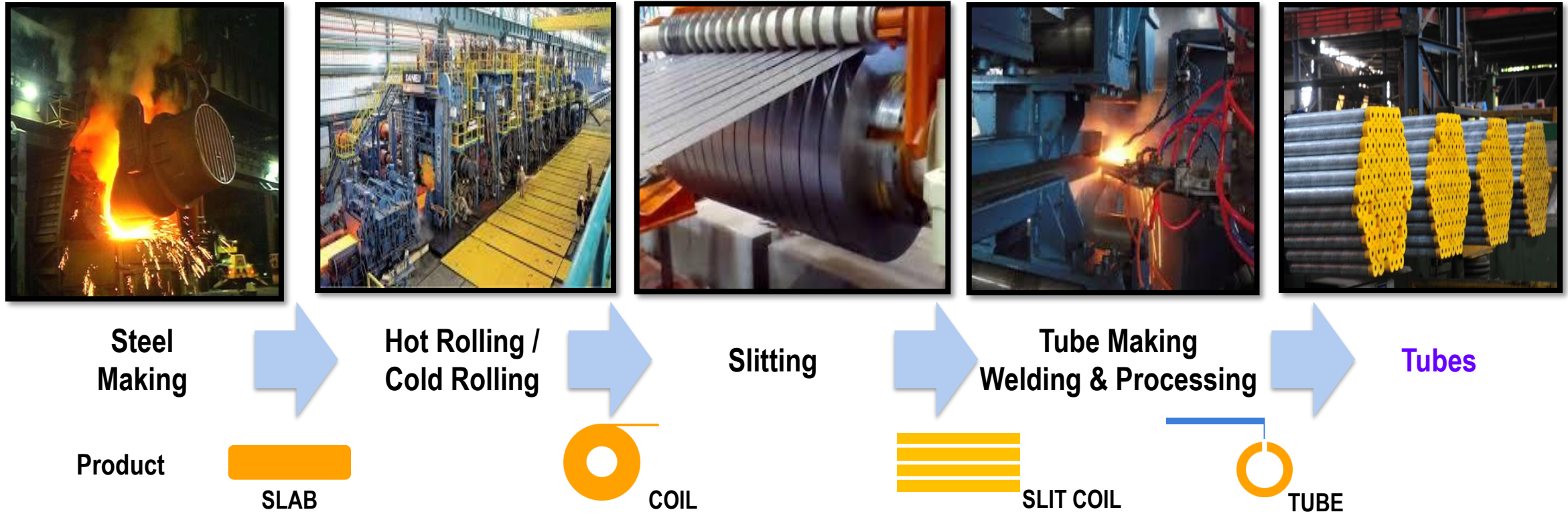
**BB Prasad**

**Tata Steel Limited  
Tubes Strategic Business Unit**

**Date: 21<sup>st</sup> January, 2020**

- ❑ **Overview of Tata Steel, Tubes Division**
- ❑ **Tubes Manufacturing Process- Key Features & improvements**
- ❑ **New Generation Mills**
- ❑ **Emerging Technologies**

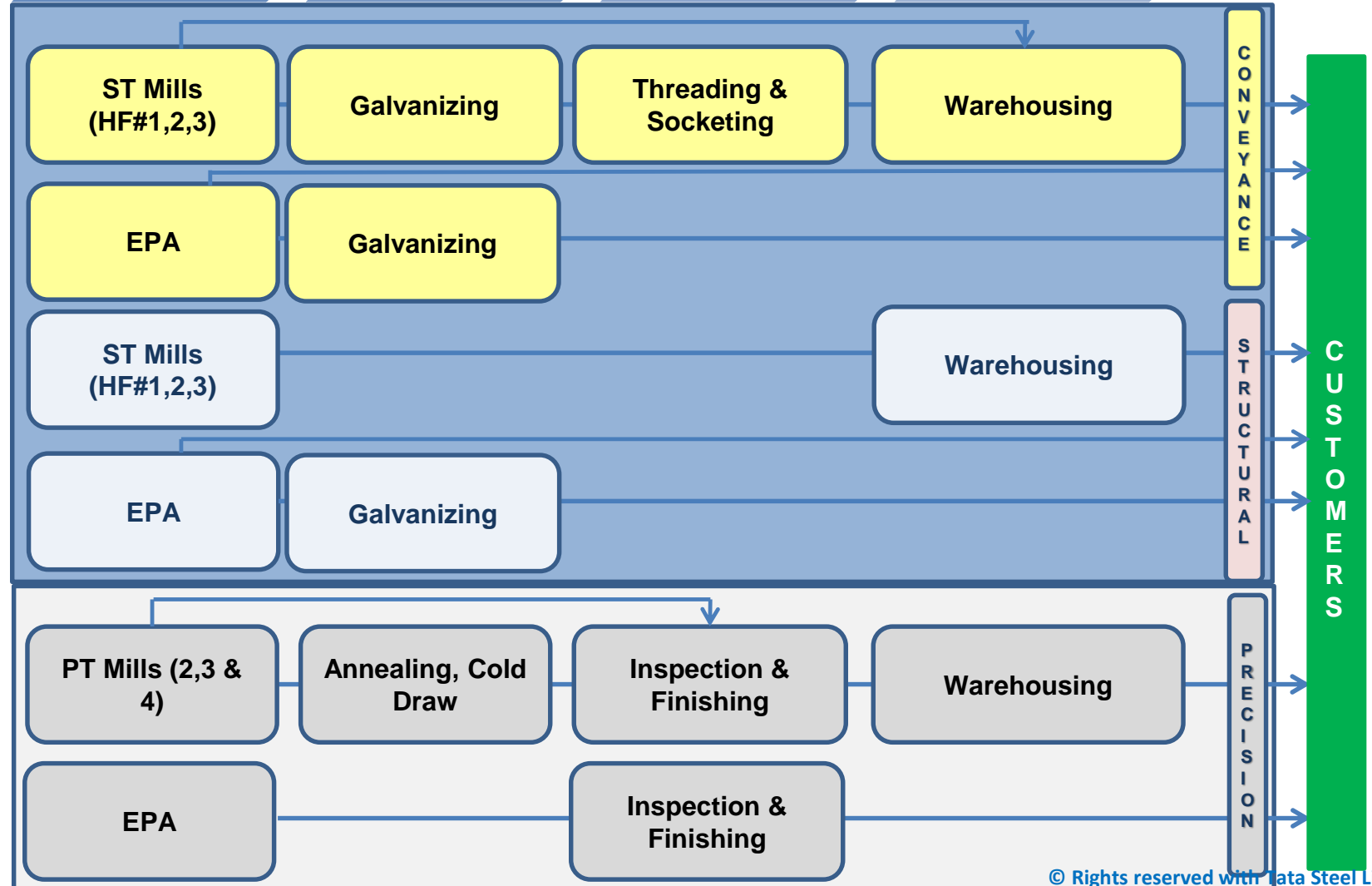
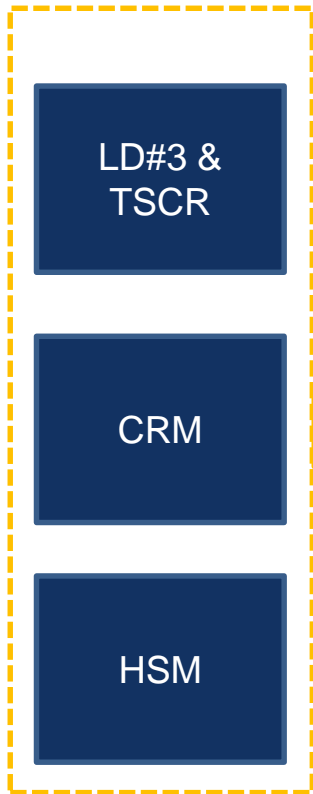
# Overview of Tubes Division



*Tubes Division is a Profit Centre*

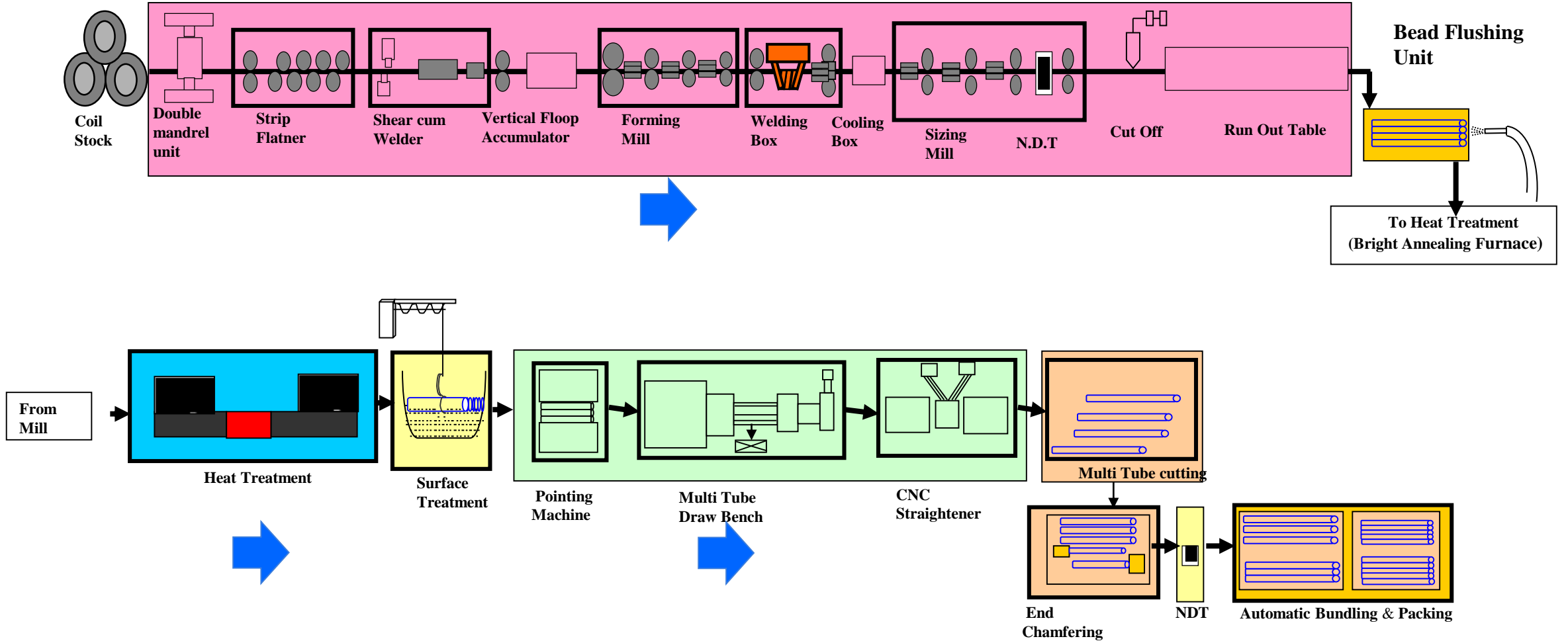
**Tube Business is Downstream to Steel**  
( GTO is ~ 5% of the Tata Steel Ltd (TSL)'s Steel value chain by value)

# Process Flow Tubes Division



Standard Tube Mills  
Precision Tube Mills





# Precision Tube Manufacturing Process Flow



**LEGEND -**

OTO MILLS	LOI THERM PROCESS GMBH	BULTMANN GmbH	MAIR RESEARCH
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## Precision Tubes: Key Mill Features & Improvements

Facility	Key Features	Key Advantages	Key Improvements/Features
Mill & Welder	State of art <b>High Frequency Solid State</b> Welder	<ul style="list-style-type: none"> <li>• <b>Superior weld</b></li> <li>• Free from stitching defects</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Predictive Quality Management (PQM)</b></li> <li>• <b>Mill Setup Process</b></li> </ul> 
Heat Treatment	Fully <b>automatic roller hearth furnace</b> with automatic temperature control and controlled atmosphere	<ul style="list-style-type: none"> <li>• Bright <b>Annealed Tube</b></li> <li>• Homogeneous microstructure</li> <li>• Consistent <b>mechanical properties</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Ammonia Cracking (Nitrogen + Hydrogen)</b></li> <li>• <b>Decarburization control through CH<sub>3</sub>OH</b></li> </ul> 
Surface Treatment	State of Art surface treatment facility with process <b>control parameters such as dipping time, rinsing time, drainage angle</b> , holding time are being controlled through predefined recipe concept	<ul style="list-style-type: none"> <li>• <b>Superior surface finish</b> of cold drawn tubes</li> <li>• Shorter production cycle time</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Predictive Quality Management (PQM)</b></li> </ul>
Cold Drawing	Fully integrated line with online multitube drawing, straightening, cutting, <b>NDT testing and automatic packing</b>	<ul style="list-style-type: none"> <li>• <b>Close dimensional tolerance</b></li> <li>• Superior Surface finish</li> <li>• Customized product</li> <li>• <b>Shorter delivery period</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Laser based carriage alignment system</b></li> </ul>
Straightening	10 Rolls <b>CNC straightener</b>	<ul style="list-style-type: none"> <li>• High degree of straightness</li> <li>• Better control with respect to ovality of tubes</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Predictive Asset Management (PAM)</b></li> </ul> 
Plant Warehouse	<b>Smart Ware House</b>	<ul style="list-style-type: none"> <li>• Easy to store and handle tube bundles. No dent/damage.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Safe handling &amp; improved traceability</b></li> </ul> 

## Comparison between the Conventional & New Generation Mills

S. No.	Area	UOM	Conventional Mill	Latest Mill
1	<b>Safety</b>	Standard	Below TSL Standard	European Standard
2	<b>Automation</b>	Level	Very low	High
3	<b>OD Tolerance</b>	mm	± 0.10	+ 0.05
4	<b>Maximum Tensile Strength</b>	MPa	600	1000
5	<b>Roll Change Duration</b>	min	180-200	90
6	<b>Man Power/Shift</b>	Nos	X	50% of X
7	<b>Burr Free Cutting (Cut-off)</b>	Mpa	Upto 450 Mpa UTS	Upto 1000 Mpa UTS
8	<b>ID Trimming Dia.</b>	mm	28.58 mm and above	19.05 mm and above

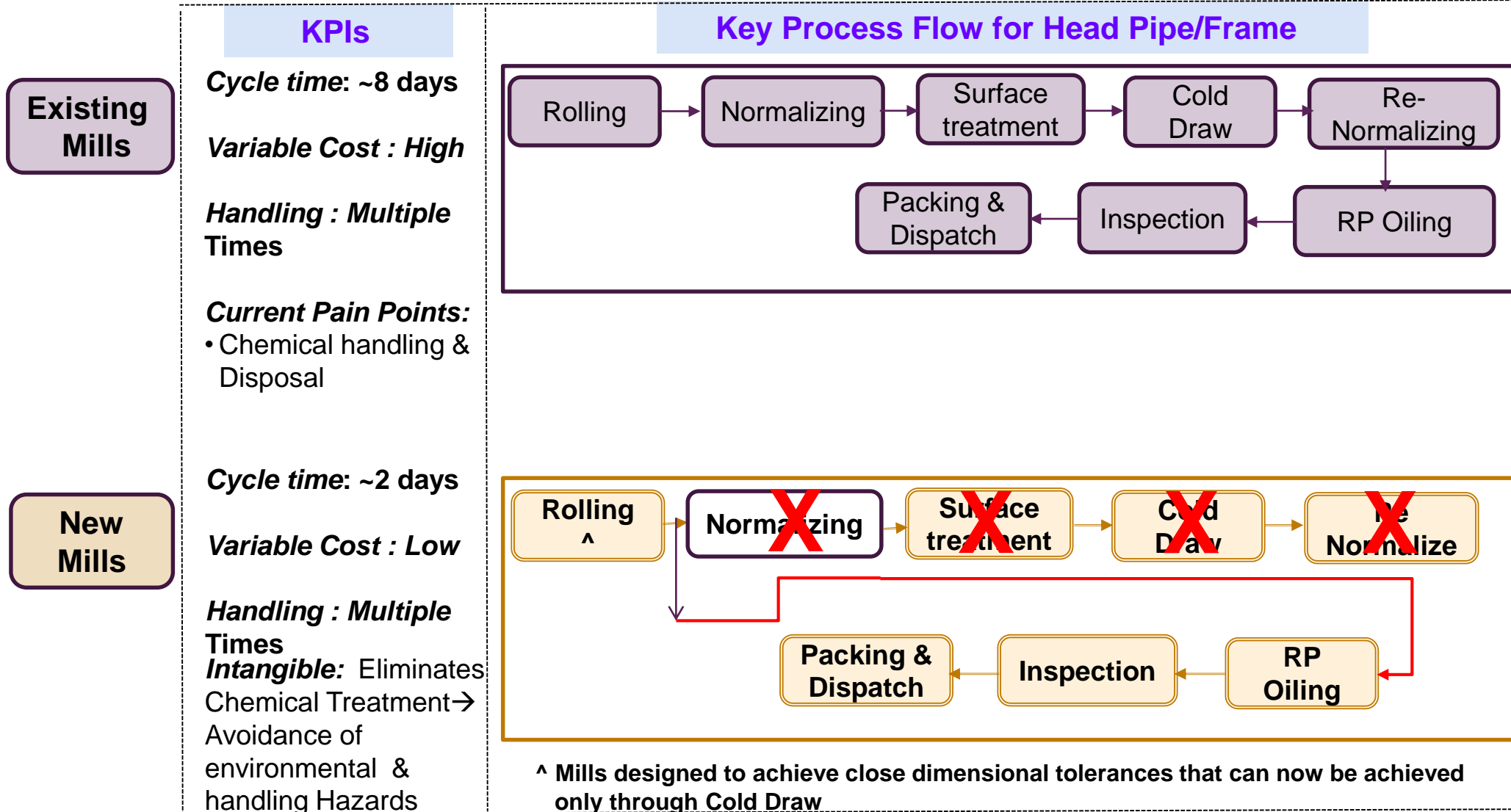
## Key Features in New Generation Mills-Precision Tubes

S. No.	Area	Latest Technology
1	<b>Safety</b>	<ol style="list-style-type: none"> <li>1. Auto Coil loading with Turnstile and coil car, currently it is done manually with C hook.</li> <li>2. Strip Joint Annealer, presently it is done manually by gas torch</li> <li>3. Roll change by Rails</li> </ol>
2	<b>Automation</b>	<ol style="list-style-type: none"> <li>1. Auto Coil Loading &amp; Strip Joining</li> <li>3. Auto Mill Positioning</li> <li>4. Recipe based Strip Joining, HF Welding and mill setting</li> </ol>
3	<b>Mill stand</b>	<ol style="list-style-type: none"> <li>1. Each sizing roll is clamped by a special hydraulically actuated play-free roll quick-clamping system</li> <li>2. Closer Mill stand for better rigidity</li> <li>3. Auto Positioning control of rolls</li> </ol>
4	<b>Welding</b>	<ol style="list-style-type: none"> <li>1. Weld block patented design to take care high t/d ratio</li> <li>2. Squeeze <b>roll pressure</b> and <b>weld temperature</b> measurement</li> <li>3. Weld recipe for different grade and size</li> </ol>





# New Age Mill will replace high cost *Cold Draw* operation of existing mills especially for production of tubes with stringent OD tolerances



## Key Features in New Generation HSU (Hollow Shape Universal) Mill : Structural Tubes [1/3]

### OTO HSU LINE

#### CHANGE RANGE PRODUCTION WITHOUT ROLL CHANGE

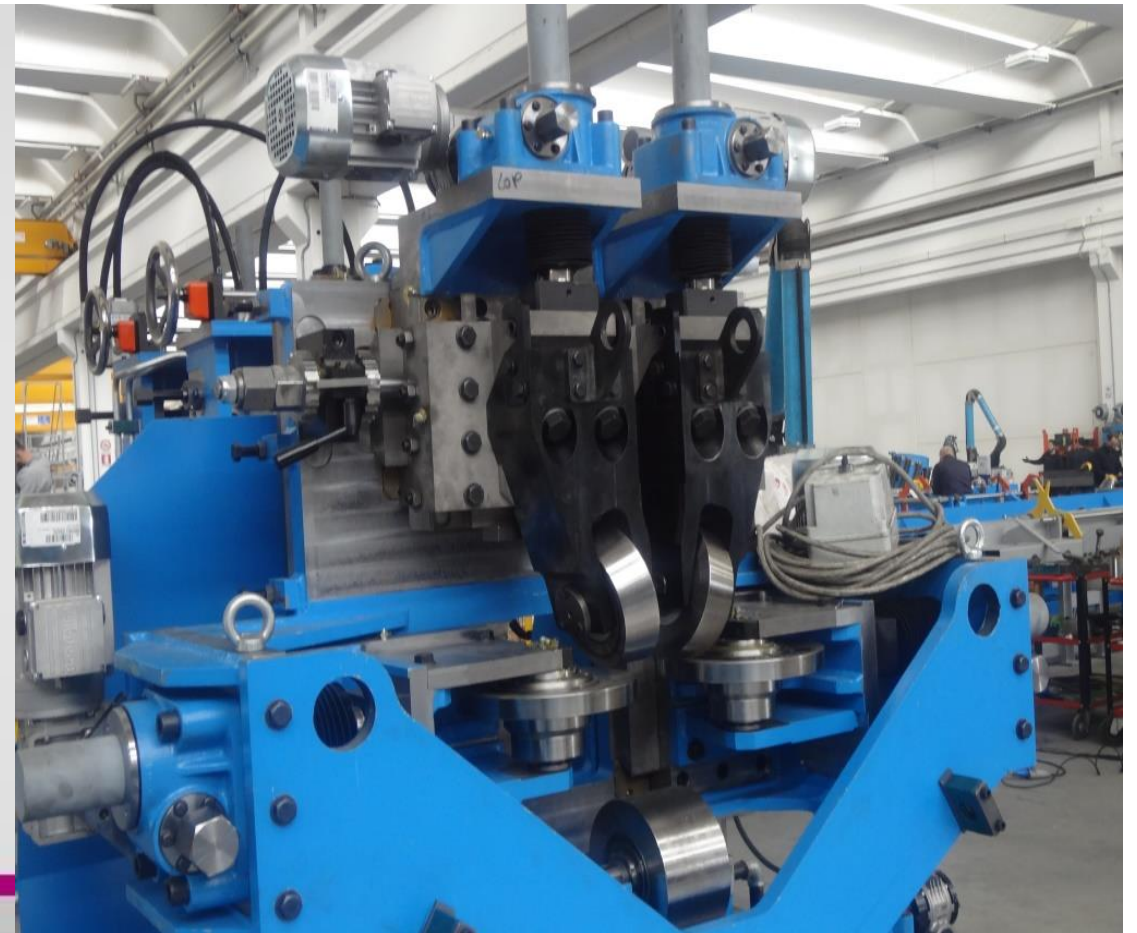
The HSU technology allows frequent change of production **without any rolls change**.

An example:

Change production time from a square profile 140x140 Tk 6mm to a 40x40 Tk 2mm takes 15 min for setting.

Good tube to good tube 30 – 45 min.

The changeover operation can be easily done from **ONLY ONE OPERATOR** by simply entering the new profile dimensions in the HMI.

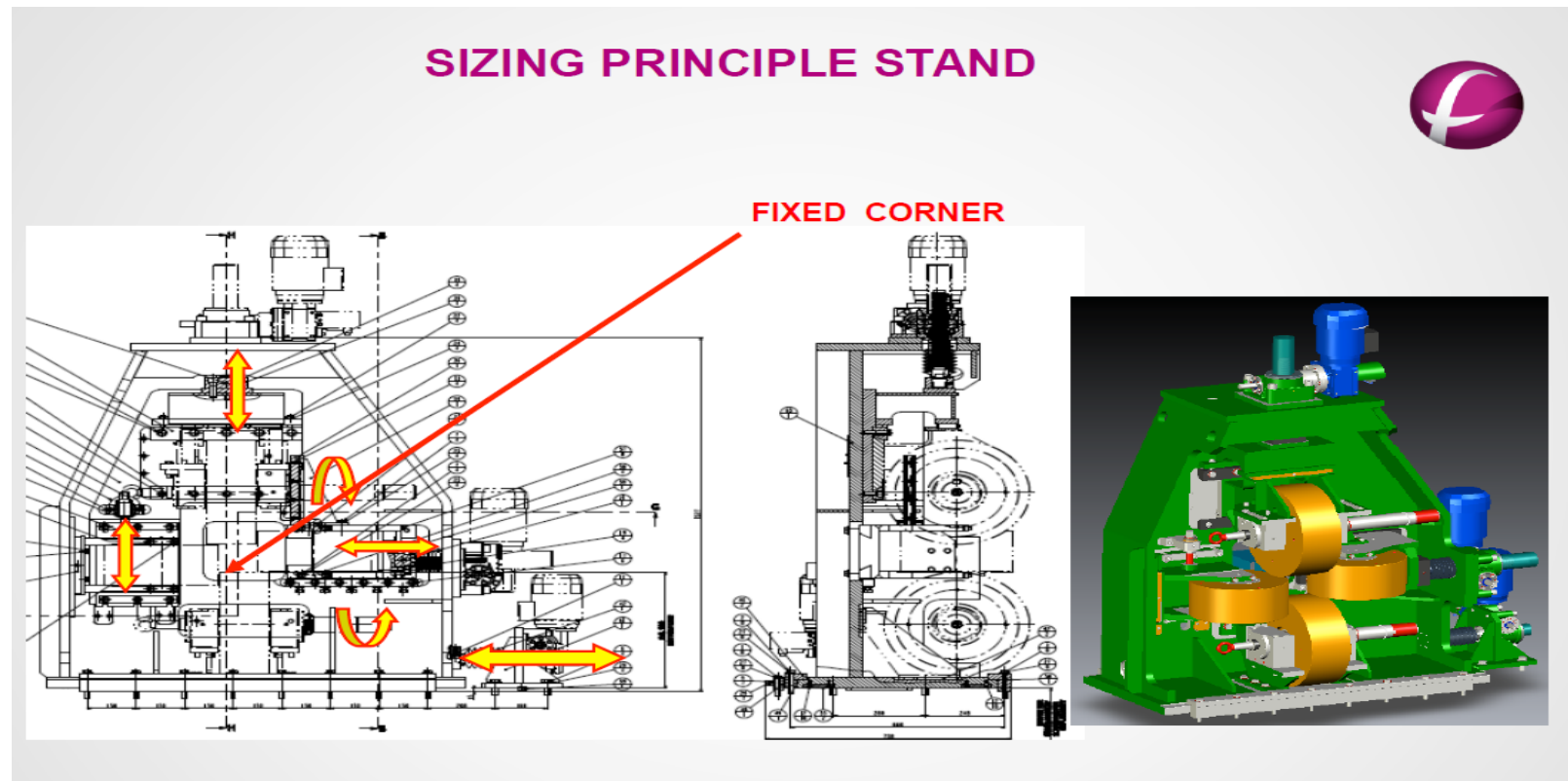


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Fives. 200 ans. de progrès industriel

- ✓ **Set-up change may require changing of 2 top rolls, impeding work coil from one range to another (very fast set-up time due to high automation level and technology)**
- ✓ **Gauge change can be done without stopping the line, if stamp changing is not required**

## Key Features in New Generation Mills – Structural Tubes [2/3]

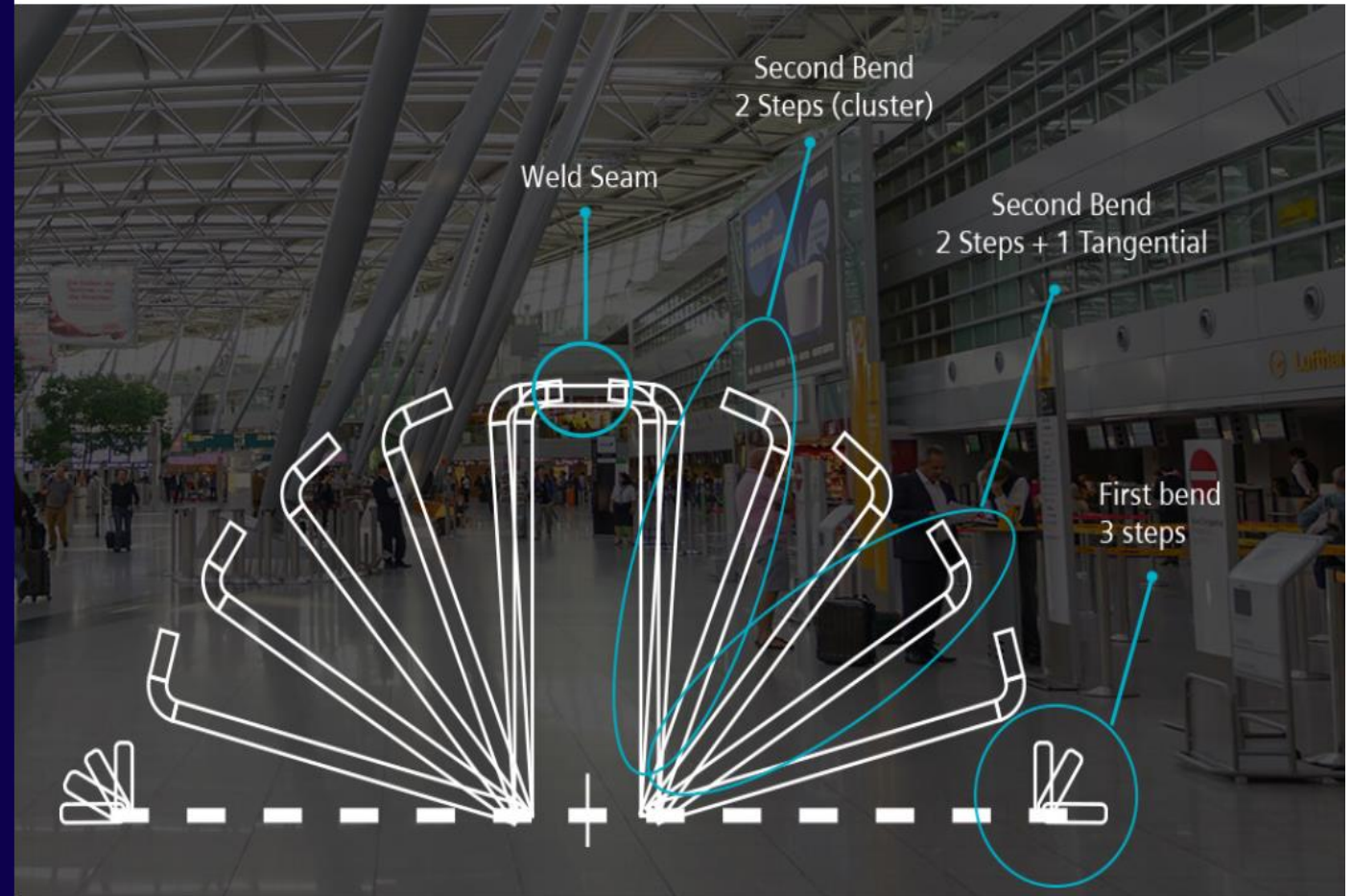


- ✓ Sizing mill is available with *Universal Hydraulic Expansion Technology* (Conventional-with key fixing).
- ✓ It is possible to produce tubes with precise and accurate dimension with Hydraulic Expansion Technology
- ✓ It can also sustain more load and hence possible to produce higher strength materials (UTS) with same accuracy level.

## Key Features in New Generation Mills – Structural Tubes [3/3]

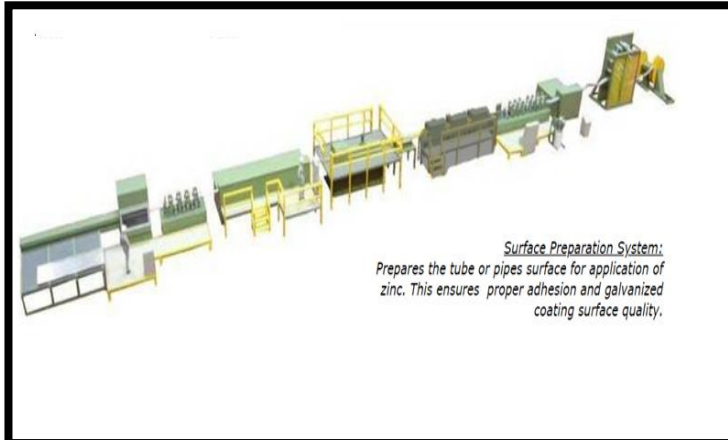
### The DFT Advantage

DFT is the innovative route to tube production which enables the possibility to produce any customized size of Hollow Section, included into the mill range, without roll change. This gives us extreme reduction in set up time. Compared to traditional production processes, this method is completely automatic and computerized. Set up operations are easy, accurate and fast.



## Emerging Technologies- Zinc Tech Tubes

### Technology



### Application



#### Key Features

- ❖ Zinc-tech is a technology to do in line galvanizing developed jointly between Superior technology USA and Daiwa Japan. It is capable for producing colored galvanized Tubes also.

#### Key benefits

- ❖ Flexibility in variable coating with variable length and shapes of Tubes
- ❖ Reduction in conversion cost, lower inventory cost and higher productivity

#### Key Producers

- ❖ 12-15 mills across the globes (older version with TSE)
- ❖ One of the Indian Tube manufacturer has also installed this technology.

## Emerging Technologies-High Aspect Ratio Tubes for Structural & IHB Applications

250x25x1.60mm thick



### Key Features :

- ❖ New technology mills can produce 1:10 aspect ratio
- ❖ Door frame tubes 101x50, 63x25, 38x25 with 1.2 to 2.9 mm thick.

### Key Benefits :

- ❖ Gives wide range available for designers for structural application
- ❖ Replacing flat sections rapidly because of lighter weight. Weight even lower than wood plank
- ❖ Faster rate of heat transfer - use in cooling tower and condenser plants

### Key Producers :

- ❖ Some of the Indian Tube manufacturer have also installed this technology

Door Frame Tube



**Thank You**

# Key Features in New Generation Precision Tube Mills



**Auto Coil Conveyor**



**Strip Joint Annealing**



**Mill with quick roll change**



**Tube Mill**



**ID bead Chopping**



**Mill Coolant Handling**



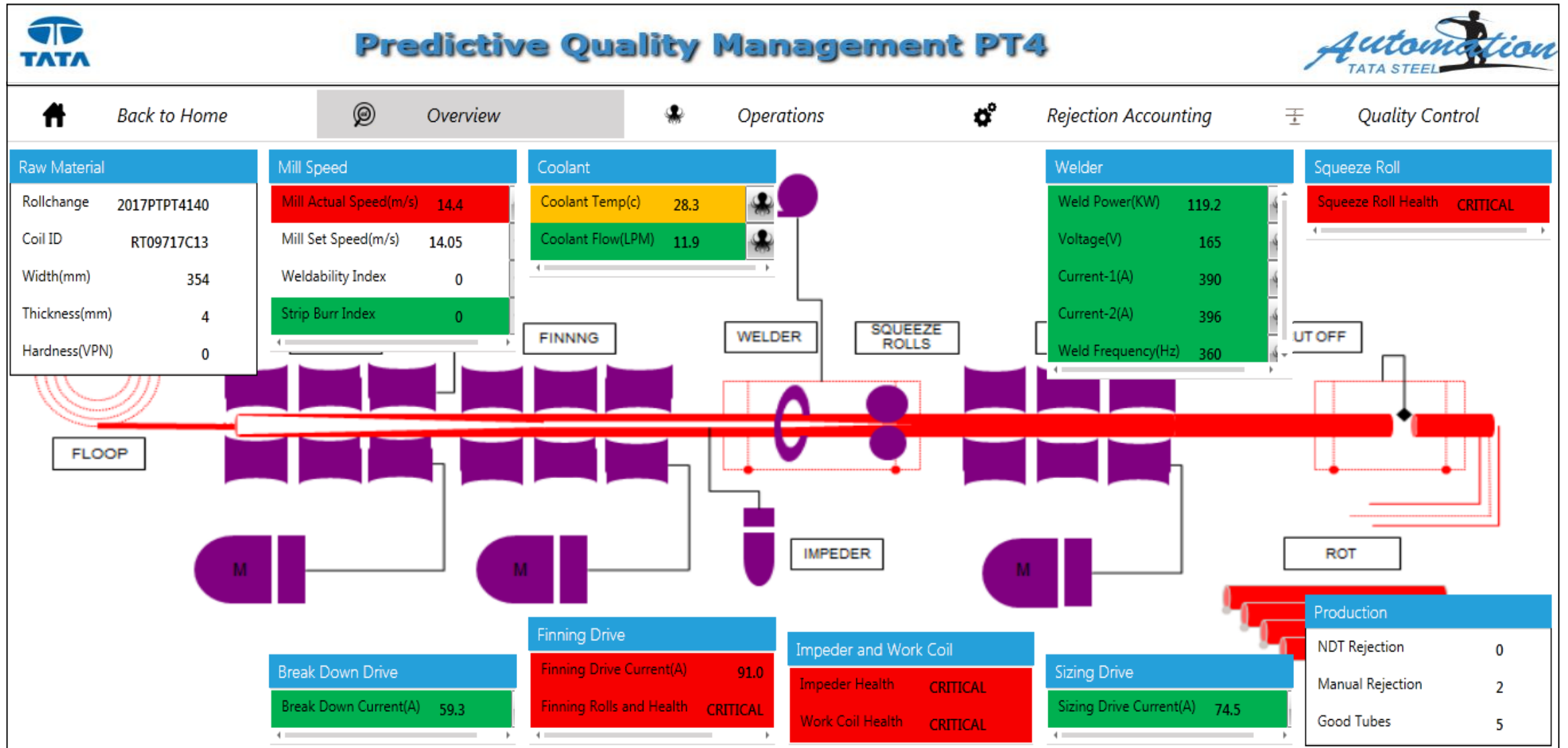
**Cooling Section**




**Auto Packaging**




# Predictive Quality Management (A digital initiative...First of this kind in Tube Industry)



# Online Capturing of Equipment and Process Parameters



## Predictive Quality Management PT4

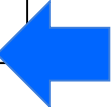


Back to Home
 Overview
 Rejection Accounting
 Quality Control
 Operations

Production Health

Coil ID: W15717A054
Date: 29-Jul-2017
SHIFT A
Campaign: 2017PTPT4150

Raw Material	Machine/Tools	Welding Parameters	Rejection
Strip Width (mm) <span style="float: right; font-size: 1.2em;">126</span>	Breakdown Motor Current <span style="float: right; font-size: 1.2em;">61.12</span> <small>29-Jul-2017 11:52:33 AM</small>	Mill_Actual_Speed <span style="float: right; font-size: 1.2em;">26.28</span> <small>29-Jul-2017 11:52:33 AM</small>	NDT Auto Rejection <span style="float: right; font-size: 1.2em;">2</span>
Strip Thickness (mm) <span style="float: right; font-size: 1.2em;">3.10</span>	Fin Pas Motor Current <span style="float: right; font-size: 1.2em;">72.71</span> <small>29-Jul-2017 11:52:33 AM</small>	Welder Power <span style="float: right; font-size: 1.2em;">117.2</span> <small>29-Jul-2017 11:52:33 AM</small>	ROT Manual Rejection <span style="float: right; font-size: 1.2em;">1</span>
Hardness (VPN) <span style="float: right; font-size: 1.2em;">123.4375</span>	Sizing Motor Current <span style="float: right; font-size: 1.2em;">86.97</span> <small>29-Jul-2017 11:52:33 AM</small>	Welder Frequency <span style="float: right; font-size: 1.2em;">335</span> <small>29-Jul-2017 11:52:33 AM</small>	Good Tubes Detected <span style="float: right; font-size: 1.2em;">70</span>
Weldability (CE) <span style="float: right; font-size: 1.2em;">0.1347</span>	Impeder Coolant Flow (LPM) <span style="float: right; font-size: 1.2em;">18.97</span> <small>29-Jul-2017 11:52:33 AM</small>	Welder Voltage <span style="float: right; font-size: 1.2em;">190</span> <small>29-Jul-2017 11:52:33 AM</small>	
Strip Burr/Edge <span style="float: right; font-size: 1.2em;">0</span>	Impedet Coolant Temperature (Deg_C) <span style="float: right; font-size: 1.2em;">30.63</span> <small>29-Jul-2017 11:52:33 AM</small>	Welder Current1 <span style="float: right; font-size: 1.2em;">318</span> <small>29-Jul-2017 11:52:33 AM</small>	
		Welder Current2 <span style="float: right; font-size: 1.2em;">336</span> <small>29-Jul-2017 11:52:33 AM</small>	



# Initiative 1: Intelligent Operations Assistant for Straightener

TATA STEEL

Overview | Area | Equipment | 23/08/2016

Insight Corner

Division ▼ PT 4 Cold Draw ▼

Equipment ▼ Straightener ▼

### Rolls Adjustments Time

00:49

Mins

### Rolls Adjustments Count

2	9	2	3	3
Roll 1	Roll 3	Roll 5	Roll 7	Roll 9
2	3	0	3	3
Roll 2	Roll 4	Roll 6	Roll 8	Roll 10

### Roll Adjustment Time

Increased roll adjustment time indicates a problem with proportionate Height Adjustment Valve and/or Angle Adjustment.

- More than 20 Mins
- Between 10-20 Mins
- Less than 10 Mins

For further diagnosis please go through Roll Adjustments page. And check Angle and height adjustment time pattern.

Close

### Equipment Lifecycle Status

Equipment 01	<div style="width: 80%; height: 10px; background-color: green;"></div>	Equipment 02	<div style="width: 80%; height: 10px; background-color: green;"></div>
Equipment 03	<div style="width: 10%; height: 10px; background-color: green;"></div>	Equipment 04	<div style="width: 80%; height: 10px; background-color: green;"></div>
Equipment 05	<div style="width: 70%; height: 10px; background-color: green;"></div>	Equipment 06	<div style="width: 10%; height: 10px; background-color: green;"></div>
Equipment 07	<div style="width: 30%; height: 10px; background-color: green;"></div>	Equipment 08	<div style="width: 80%; height: 10px; background-color: green;"></div>
Equipment 09	<div style="width: 20%; height: 10px; background-color: green;"></div>	Equipment 10	<div style="width: 80%; height: 10px; background-color: green;"></div>

Avg. Clamping Hyd. Pump operation Frequency (Per Hour) 18

## Precision HFIW Tube Mill (Make : OTO Mills, Italy)

### Features:

- Solid State Welder-No Heat Fluctuation during welding. Sound Weld & No Stitching
- High Precision ID trimming system with return flow impeders-Better ID finish in ERW/CEW
- Advanced Coolant Filtration System-No PLM, oxide entrapment in weld-Strong Weld
- Online ID bead flushing unit-Cleaned ID or Tubes free of loose ID Bead
- Online NDT (Eddy Current) with auto sorting of defective tubes-Avoidance of filed failure due to bad weld



Rated Capacity : 4000 Tons per month



## Bright Annealing Furnace (Make : LOI, Germany)

### Features :

- Roller Hearth Bright Annealing Furnace
- On-line Control and monitoring of zone wise temperature through PLC
- Heat treatment in inert atmosphere (Nitrogen + Hydrogen)
- Furnace Control based on guidelines of Speed Vs Temperature matrix defined for various steel grades
- Decarburization Control using CH<sub>3</sub>OH



Rated Capacity : 6 Tons per hour



## State of art Cold Draw Bench (Bultman, Germany)....on-line straightening and packaging

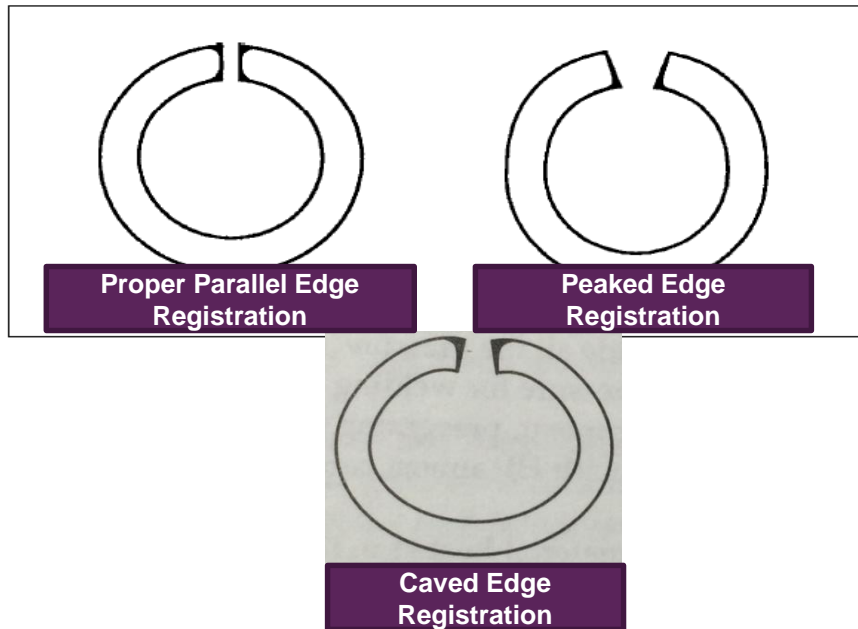
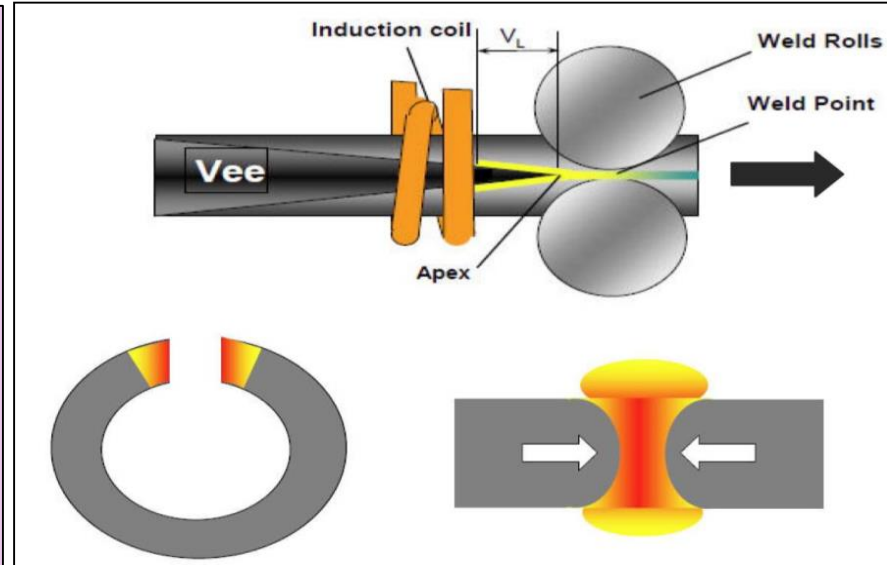
### Features :

- Automatic Loading of Tubes to the draw bench avoiding manual handling
- Facility to draw 3 tubes together
- Laser Based carriage alignment system to ensure uniform draw with reasonably straight and free from chatter marks on tubes
- Integrated with 10 Roll CNC straighter to ensure high degree of straightness
- On-line Eddy Current based NDT and demagnetizing unit.
- On-line packaging of Tubes for long length tubes



## Mill Setup : Transverse Weld Area (TWA) Evaluation

- ❖ Recently introduced in Tube Mills. This is one of the best tests for the initial weld setup
- ❖ This test is simple and quick and conducted every time there is a
  - i. size change or
  - ii. gauge change or
  - iii. whenever the forming mill/fin pass is adjusted
- ❖ This test is done to ensure that the strip edges are coming together flat and parallel into the weld rolls (Squeeze Mill Rolls)-Refer Figure-1. below



### Transverse Weld Area Sample

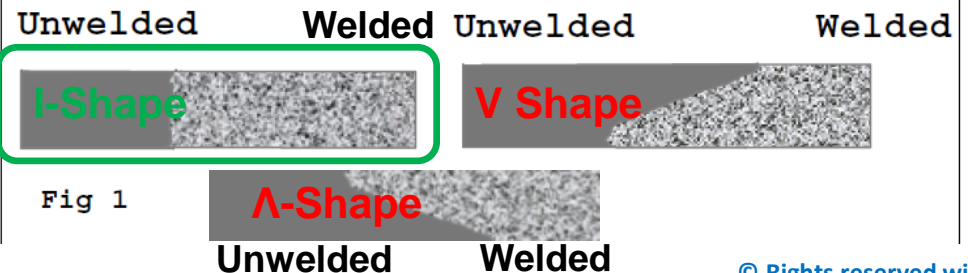
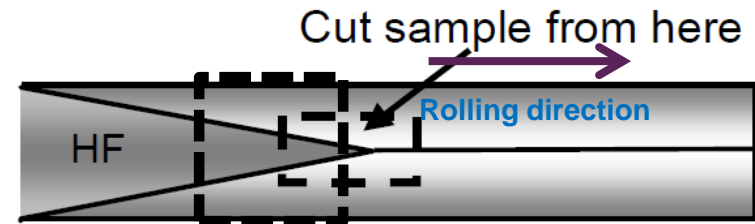


Fig 1

## Mill Setup : Weld Macro Examination

**Superior Quality:  
Weld Quality Control @ rolling Mill (1/2)**

**GOOD**

**WELD MACRO EXAMINATION**

Recommendation for sound weld

Parameters	OD	Middle	ID
HAZ	$h_o = h_i = 1.5 \text{ to } 2.2 h_n$	$h_n = 1 \text{ to } 3 \text{ mm}$	$h_i = h_o = 1.5 \text{ to } 2.2 h_n$
Fusion line	$f_o = f_i = 1.3 \text{ to } 3.0 f_n$	$f_n = 0.04 \text{ to } 0.14 \text{ mm}$	$f_o = f_i = 1.3 \text{ to } 3.0 f_n$
Squeeze angles ( $\alpha$ )	45 to 70 degrees		
PLM	Free from PLM		
Lapping	Zero lapping		
Slanting of fusion line	t/10 mm max		

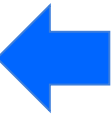


**In-situ Weld Macro Examination facility using Metallurgical Microscope at Express Lab.**

**BAD**

ACCEPTABLE WELD MACRO

UNACCEPTABLE WELD MACRO





# Smart Ware House first of this kind in India....

