


Presenter Name: **NABID ANJUM KHAN**



Paper name: **Performance improvement of Steel ladle life by modelling operating**

	<b>PRESENT AFFILIATION</b>	<b>SENIOR MANAGER – REFRACTORY, TSK</b>
	<b>AREAS OF INTEREST</b>	<b>REFRCTORIES FOR IRON &amp; STEEL INDUSTRIES</b>
	<b>Education</b>	<ul style="list-style-type: none"><li>• Perusing PhD. from Ceramic Engineering, NIT Rourkela</li><li>• B. Tech in Ceramic engineering, NIT Rourkela -2007</li><li>• Diploma in Ceramic Technology form UGIE Rourkela - 2002.</li></ul>
<b>Experience</b>	More than 15 years of experience as Refractory personnel, worked at various Steel plants (~13 years) like TATA STEEL -Kalinganagar, JSW-Monnet, JSPL-Raigarh, Ispat Industries-Dolvi & Petrochemical industries (2.5 years) Reliance -Jamnagar.	
<b>Projects:</b>	<ul style="list-style-type: none"><li>• Blast Furnace &amp; Stoves – 2581m<sup>3</sup>, 583m<sup>3</sup></li><li>• Lime Kiln – Maerz 300 TPD Circular &amp; Rectangular, 600 TPD Circular</li><li>• CONARC furnace (210 T), Electric Arc Furnace (100T, 250T), Converter (310T)</li><li>• Steel Ladle (100T, 185T, 310T), HML (60T, 100T, 310T), Torpedo (300T, 330T)</li><li>• Reheating Furnace – 5 Nos –(Devy, Tenova, Fives Stein)</li></ul>	
<b>Publication/ Patent</b>	<ul style="list-style-type: none"><li>• 3 Nos international paper publication's (American Ins. Of Physics, IREFCON-13, &amp; IREFCON-16)</li><li>• 7 Nos Domestic level publication's (Steel Tech, IRMA, ROCM, LEO Workshop, Jindal Tech)</li></ul>	

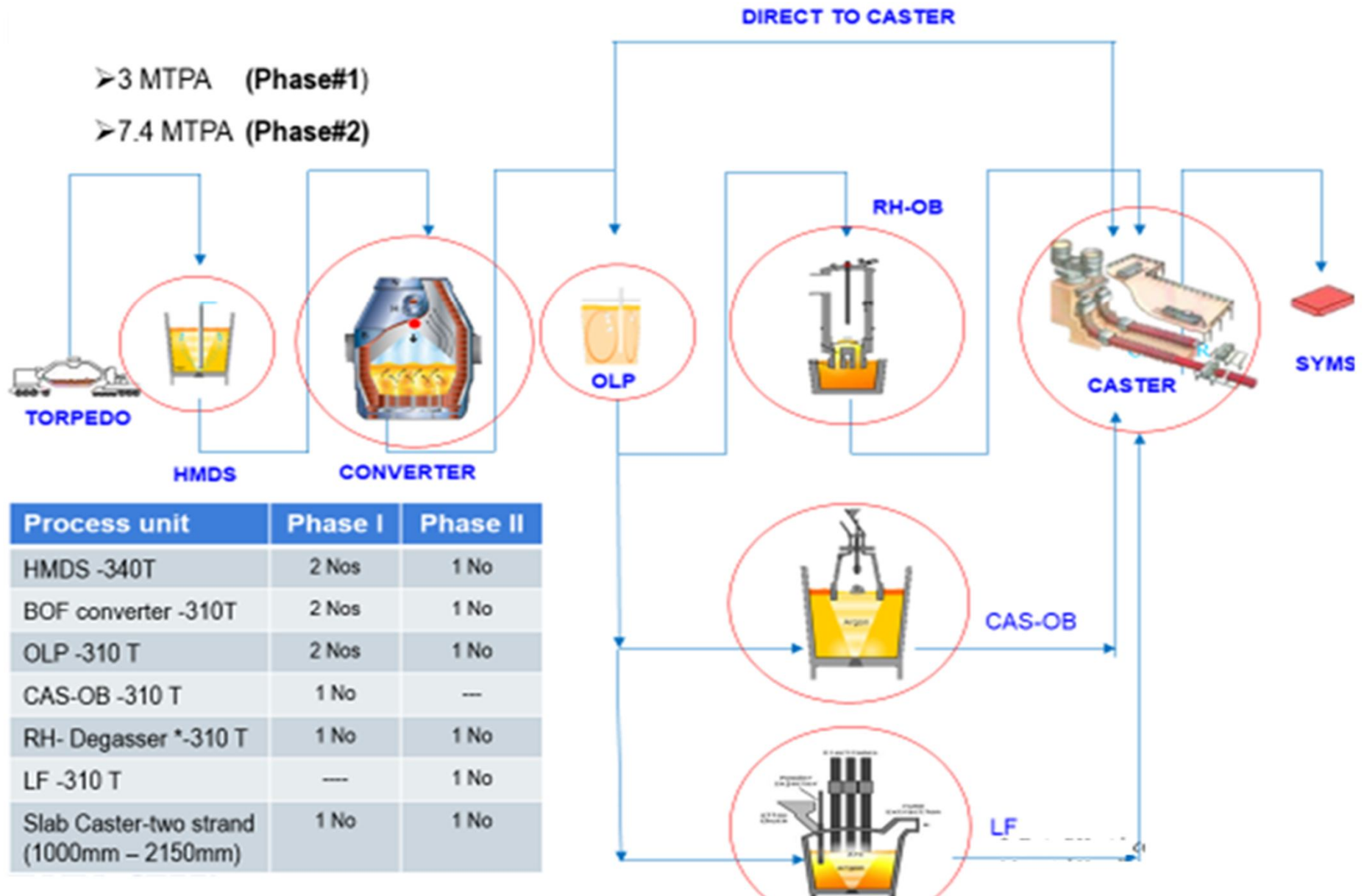
# Performance improvement of Steel ladle life by modelling operating parameters

**TATA STEEL Kalinganagar**

## Team Members

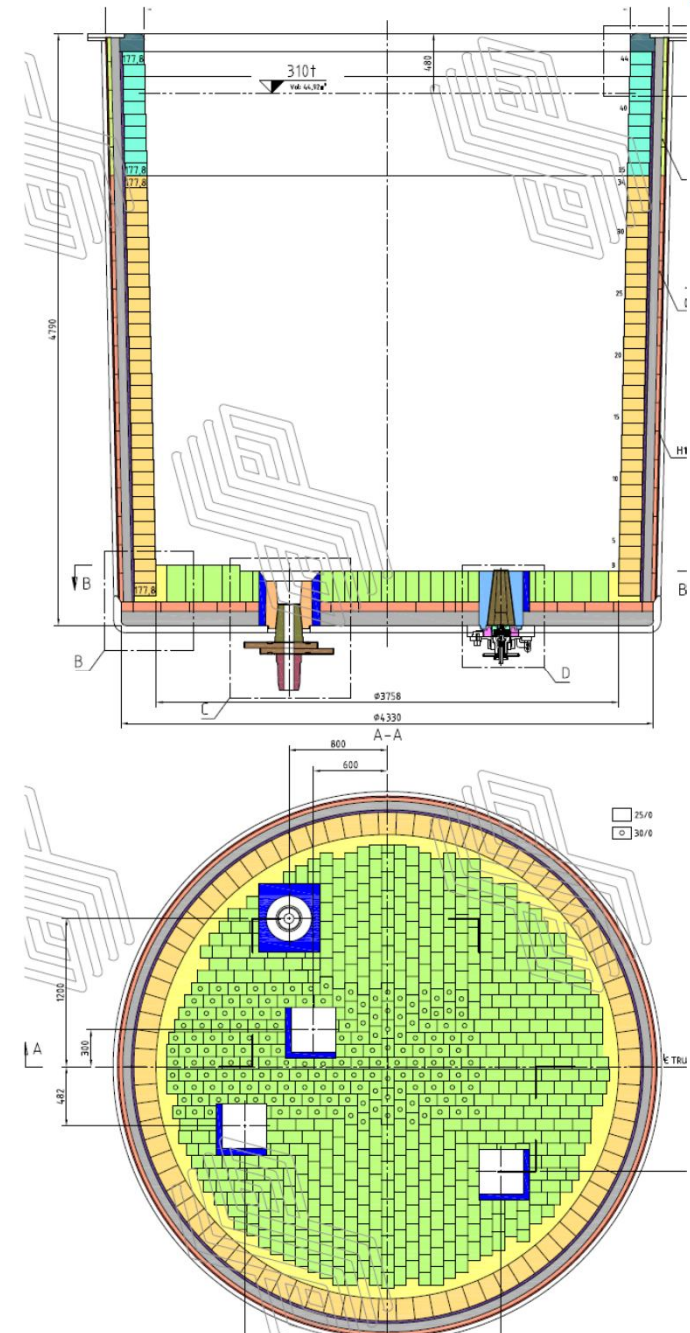
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Prasanta Panigrahi,  
Sujat Ali Khan

# Process Route



# Steel Ladle Refractory Lining Details

Ladle Capacity	310 ton
Fleet Size	14
No of Ladles in Circulation	6
Metal Zone	Spinel
Slag Zone	Mag-C
Bottom	AMC
No of Plug	3
Life	150 heats
No of Repairs	2



## Ladle life depends on :

- Ladle design
- Quality of refractories
- Installation of Refractories
- Operational Parameters
- Refractories Maintenance during circulation
- Shop logistics

## Ladle lower life analysis :

**Post Mortem analysis** – Various parameters responsible for  
lower life – Time taking

**To predict the remaining life during ladle circulation**

## Model Functionality

- Predicting the Remaining useful life (RUL) of Ladle
- Identifying the features, which has an impact on Ladle life both at overall (historical data ) and real time data
- Providing directional recommendations on controllable features which improve the Ladle life
- Enhanced Ladle Management
- Enhanced ladle life.

## Model Training

Model Training date range : 1 year

Model Testing date range : 3 months

Total Heat IDs observed : 10,490

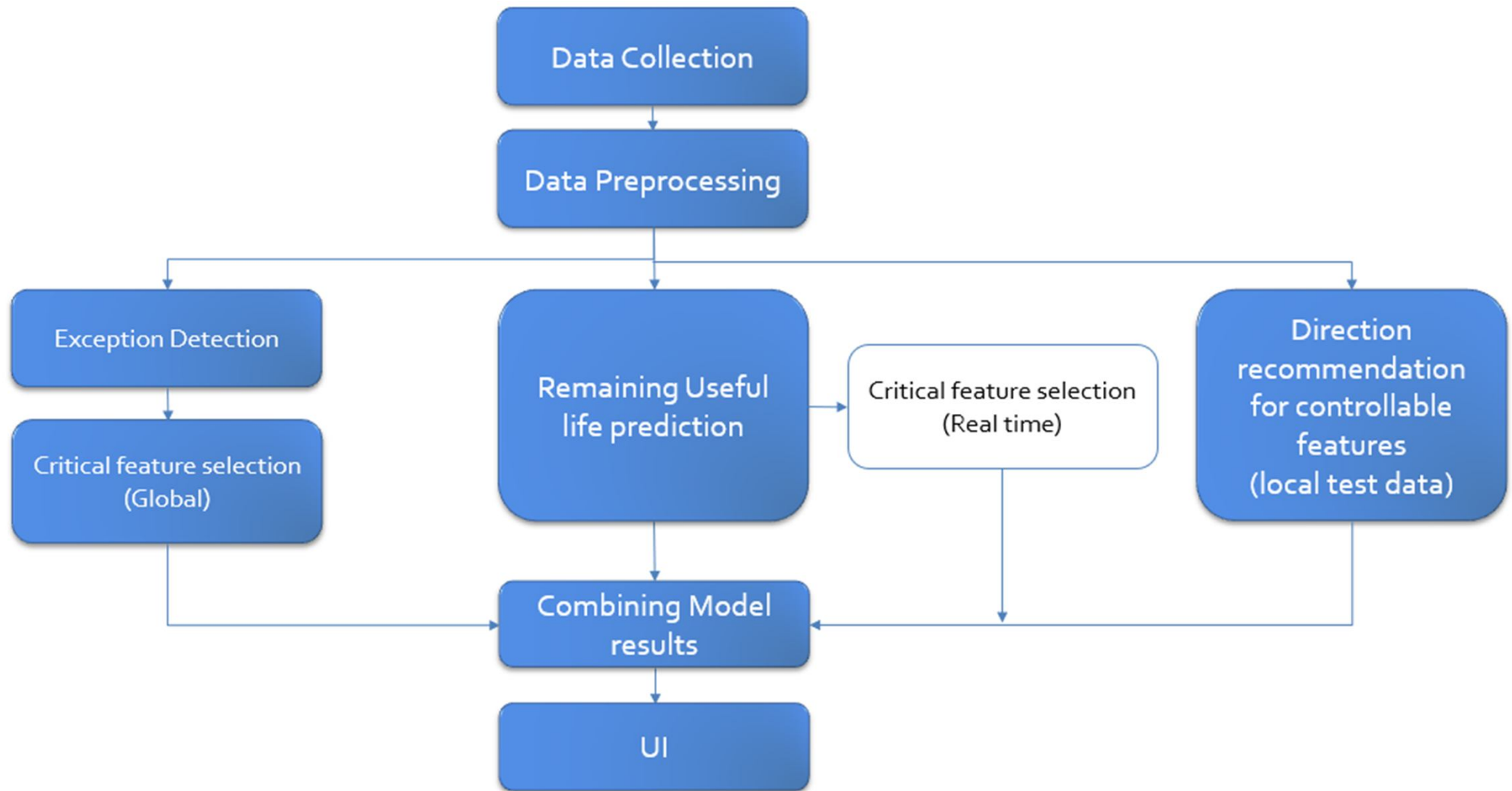
No of operating parameters considered : 668

Total Ladle slag zone replacement observed : 223

Model Testing slag zone Campaign observed - 48

Data collected for all sections, grades etc

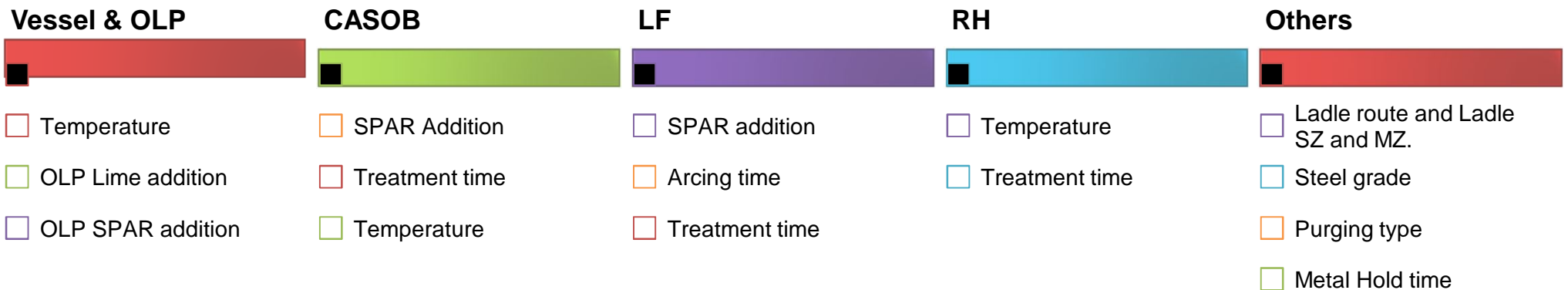






## Data collection

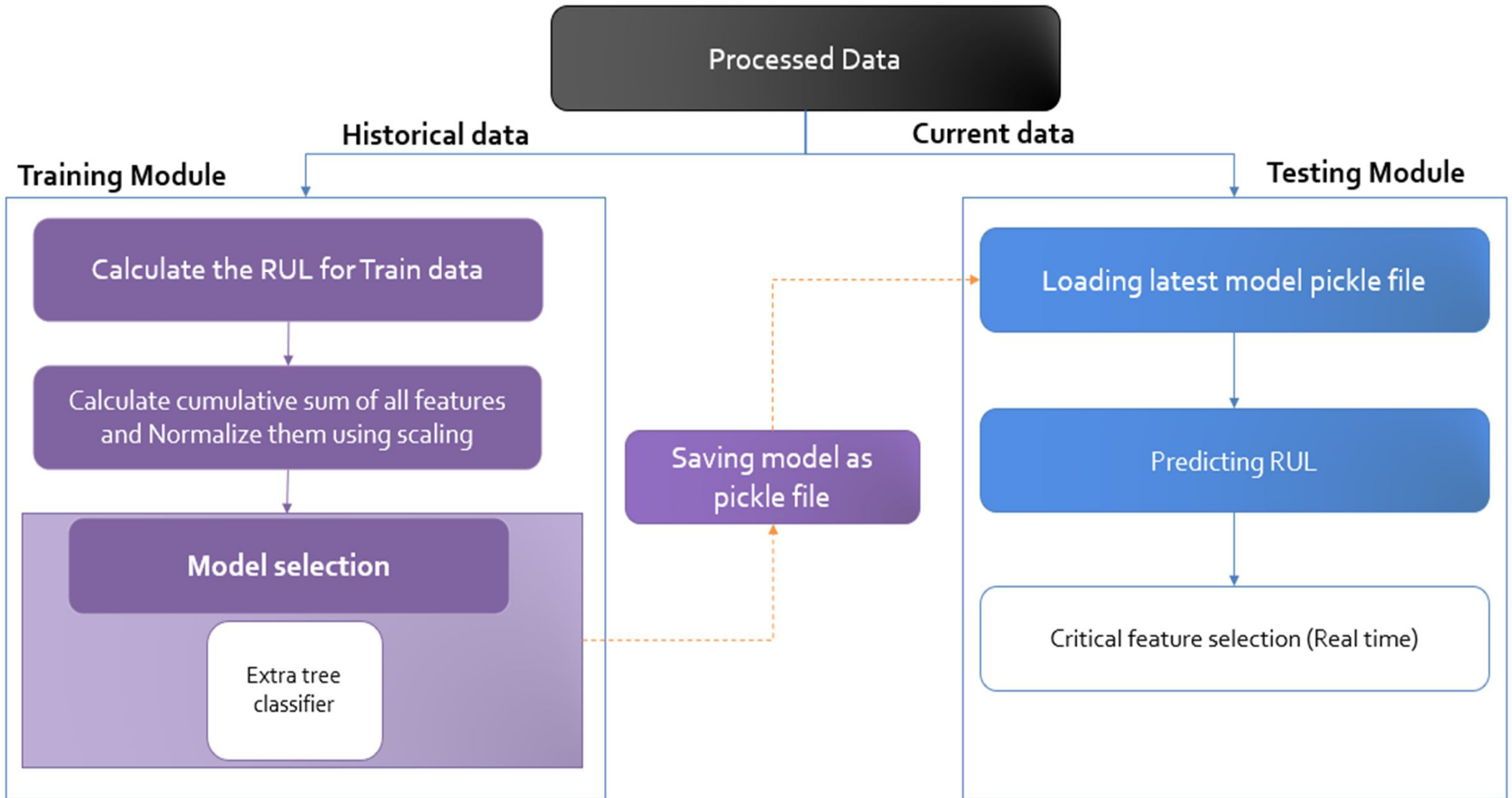
- Source - Daily Heat reports
- Considered Critical/Non-Critical parameters.
- Data classified into 5 main sections.



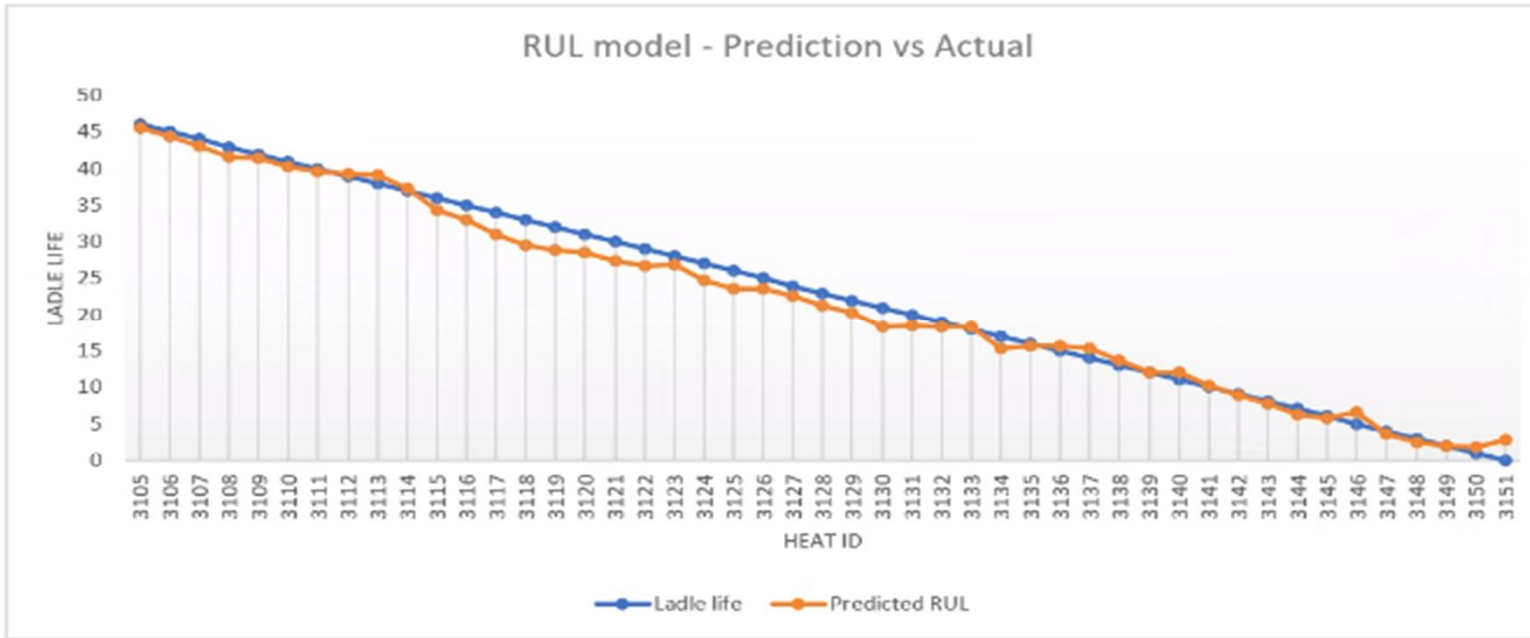
## Data Preprocessing

- Cleaning the data by correcting errors/ junk data
- Identifying incomplete slag zone life and removing it
- Formatting the model data
- Data Quality Module was used to ensure the correct and relevant data to used for analysis and modeling.

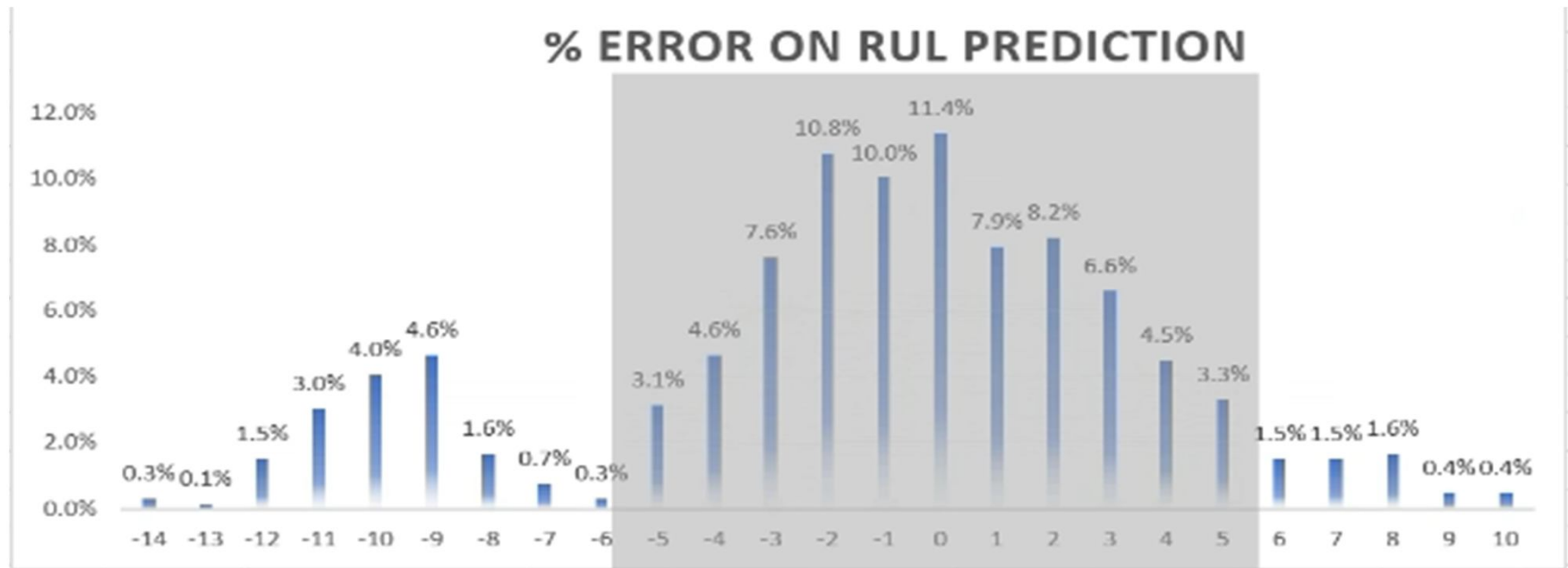
# Remaining useful life prediction



# RUL – Prediction results



90% of data covered in - 5 to + 5 error interval

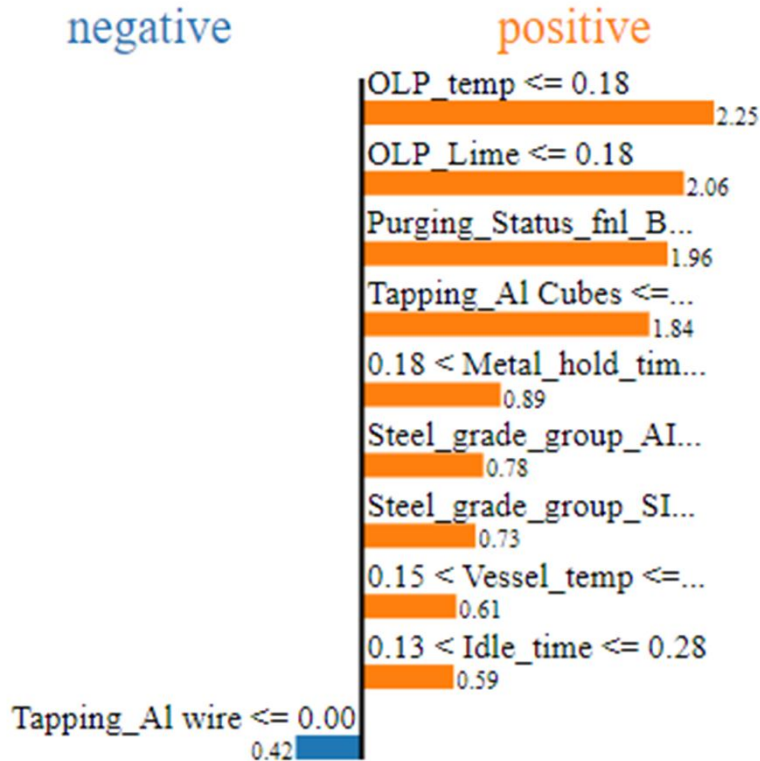


# RUL – Critical features (Real Time)

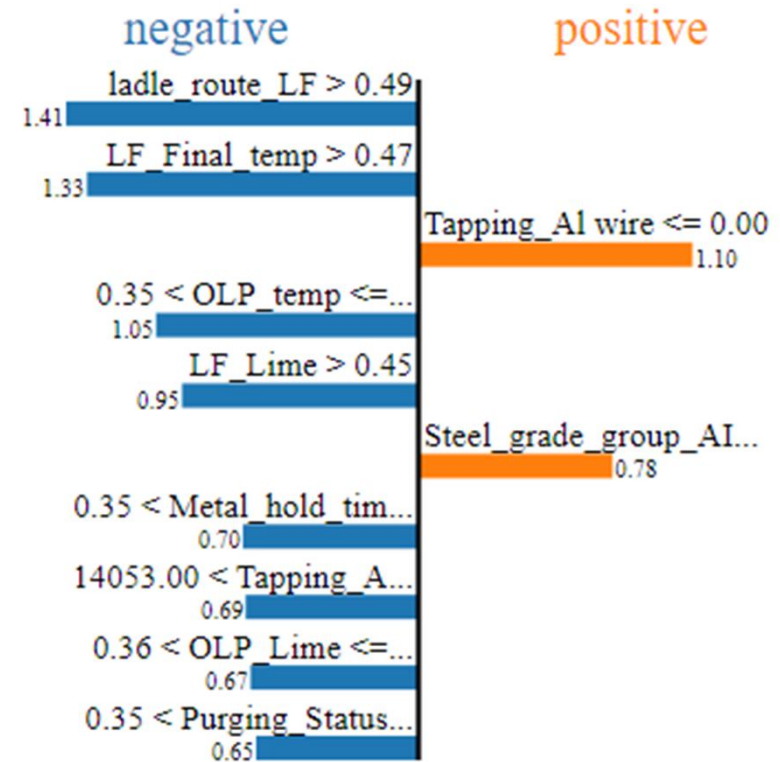


Critical Feature's impact (on good prediction)

Critical Feature's impact (on bad prediction)



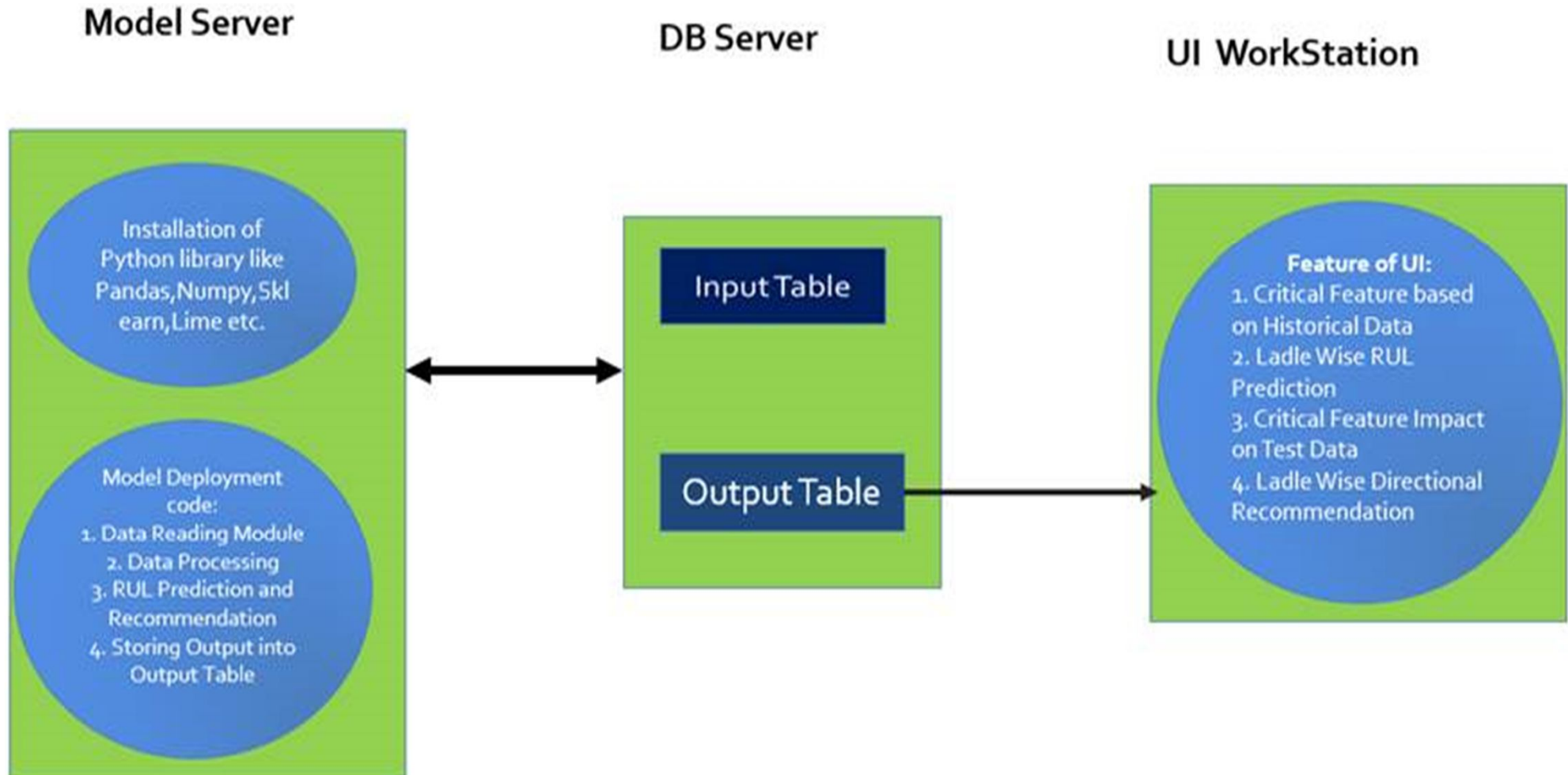
Actual value : 33  
Predicted value : 31.96



Actual value : 7  
Predicted value : 16

*Model accuracy is within an accuracy range 90 ± 5 % with a ladle life > 25 heats.*

# Architecture Diagram





Home

## Ladle Refractory Visualization

SELECTED LADLE NO: 14

FEATURE LIST:

Metal\_hold\_time

Display Chart

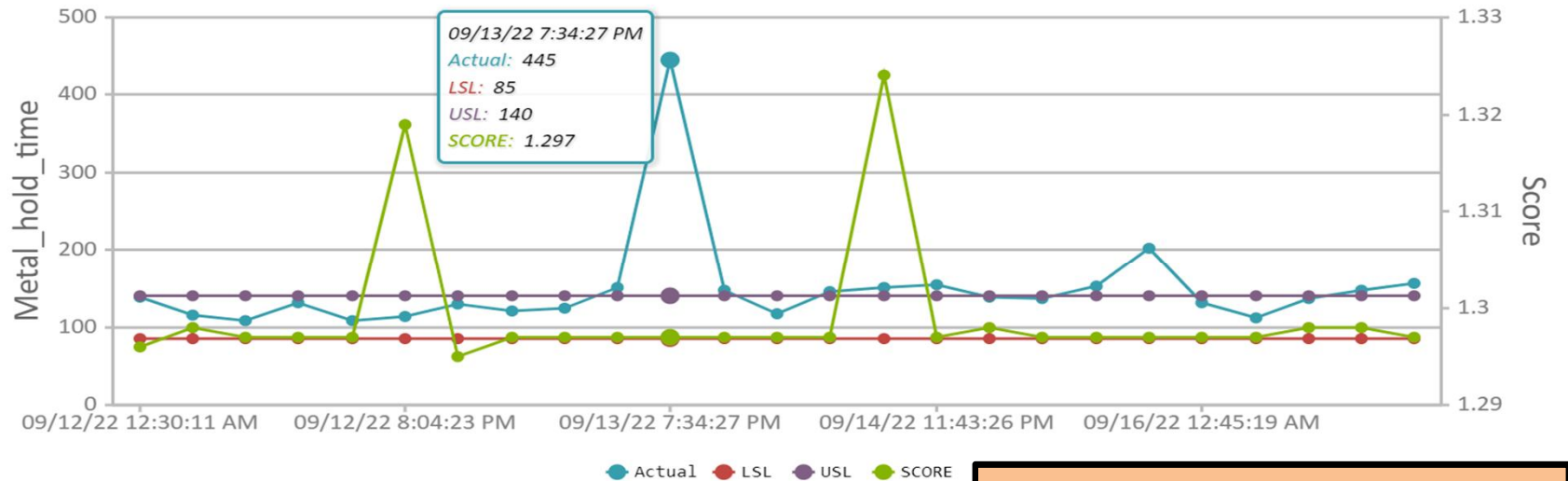
Export Data

LADLE NO      PREDICTED\_RUL

1	8
2	10
3	9
4	25
5	7
6	11
7	22
8	12
9	12
10	9
11	32
12	30
13	12
14	22

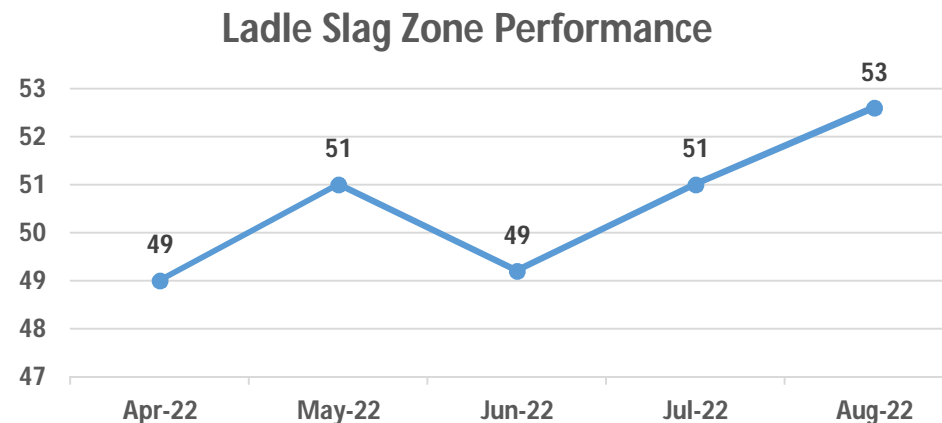
OLP_temp	OLP_Lime	ladle_route_LF	LF_Final_temp	LF_TreatmentTime	LF_Lime
Tapping_Turnaround_mins	Metal_hold_time	Idle_time	LF_Total arcing time	Vessel_temp	LF_SPAR
Steel_grade_group_AI_Killed	Steel_grade_group_SI_Killed	ladle_route_CASOB	CASOB_Final_temp	Steel_grade_group_AI_SI_Killed	OLP_SPAR
CASOB_TreatmentTime	OLP_TreatmentTime	ladle_route_CASOB and LF	CASOB_SPAR	Steel_grade_group_Others	ladle_route_Direct

FEATURE	RECOMMENDATION
Tapping_Turnaround_mins	decrease
Metal_hold_time	decrease
OLP_temp	decrease
LF_Lime	increase
OLP_TreatmentTime	decrease



- Negative parameters (red/yellow color)
- Positive parameters (green color)

- *Accurate life prediction*
- *Gives idea of affecting parameters*
- *Visual representation of parameters & alarming triggering /pop-up of the same to the operator.*
- *Enhanced ladle management i.e., Installation, ladle preheating & preparation for circulation.*
- *Ladle slag zone life enhanced by 4 heats.*





Thank You