Better Everyday

JSW Steel Limited, Salem Works

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AS 9100 Rev D

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BRITISH SAFETY COUNCIL

Sword of Honour 2022 Winner

International Conference on GREEN & SUSTAINABLE IRON MAKING

17,18 January, 2024

Project topic:

Blast Furnace process optimization for sustainable Iron Making”

JSW Steel Limited Salem Works

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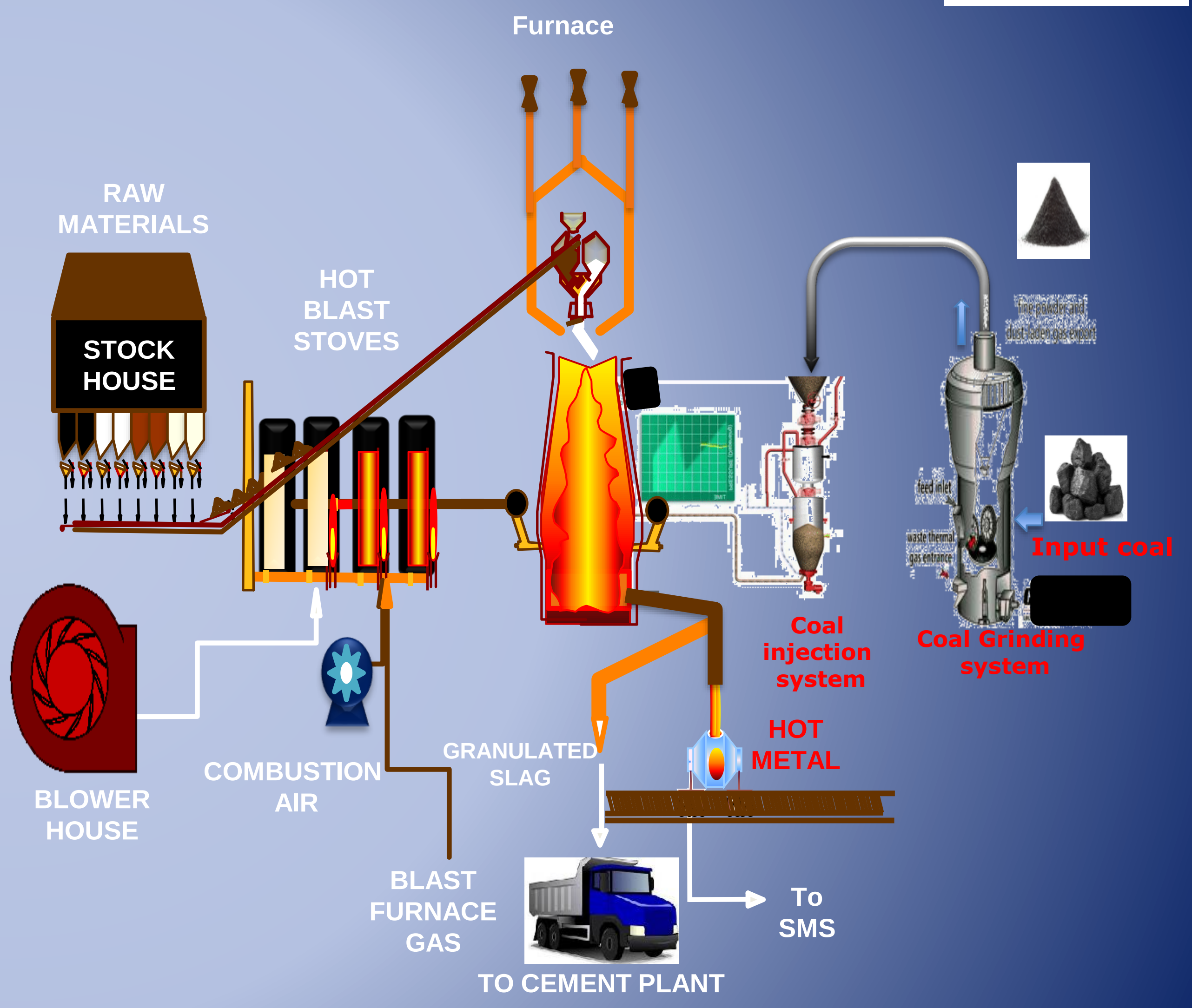


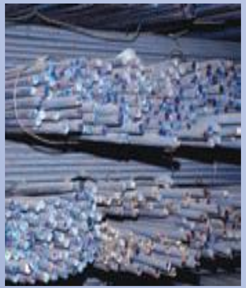
JSW Steel Ltd, Salem works, Tamilnadu

JSW Salem , part of 23 Billion USD JSW Group, is **India's largest integrated special steel plant** located in Salem, Tamilnadu with installed capacity of 1.15 Million Tonnes Per Annum (MTPA).

*Our organization won the prestigious **DEMING AWARD** for TQM in 2019.*

*JSW Salem is recognized with **5 Star Rating and Sword of Honour** by BSC for its OHS excellence in 2022.*

Product Portfolio in JSW Salem

AS Cast Product	Rolled Product (RP) – BRM		RP – BLM
Rounds – 180 mm to 310 mm	*Flats - 60 x 7 to 101 x 38 mm*	*Round Bars - 20.5 to 60 mm*	*Round Blooms -60 to 200 mm Dia*
			
Billets/Blooms - 250, 280x370mm, 340x400 mm sq.	*Coils - 5.5 to 32 mm*	*Hexagon - 20.5 and 32.5 mm*	**RCS - 55 to 240 mm Square*
			

Major Customers – JSW Salem

Direct Users

Bharat Forge, MM Forgings, Bill Forge – Your Proactive Partner, Ramkrishna Forgings Limited, Echjay Industries

LUK, INA, FAG – Schaeffler Group, Timken – Where You Turn, Koyo, JTEKT

TVS Sundram Fasteners Limited, STL Fasteners, Caparo

Mahalakshmi Bright Steel Industries Pvt. Ltd., G S, HFAIPL, Premier Steel Complex Pvt. Ltd – Adding Glow to the Steel

Jamna Auto Industries Ltd., Joneja Bright Steels Pvt. Ltd.

End Users

Honda, Komatsu, Ashok Leyland, Tata, TVS, Meritor, Hyundai

John Deere, BharatBenz, BHEL, CAT, Mahindra

JSW Salem holds number one position in the Special steel long products market in India

Awards & Recognitions

JSW Salem works received various awards on Quality , Safety, CSR (Corporate Social Responsibility) and also from Customers and Government bodies. Some of them are presented below:

Awarded Year	Award	Awarded Title
2020	Best IMC Partner Award	First Prize
2021	National Safety Council Awards	Award of Honor
2021, 2022, 2023	IIM Sustainability Award-Alloy Steel Category	First Prize
2022	ICC National OH&S Awards	Platinum Award
2022	Green Tech Award for Environment Protection	Winner
2023	Golden Peacock OH&S Award	Winner

National / International level awards (Nos.)

FY	NCQC	ICQCC
2015-16	2	1
2016-17	10	1
2017-18	14	2
2018 -19	8	3
2019-20	7	3
2020-21	16	7
2021-22	13	10
2022-23	8	10
2023-24	-	3

M/s. Kalyani

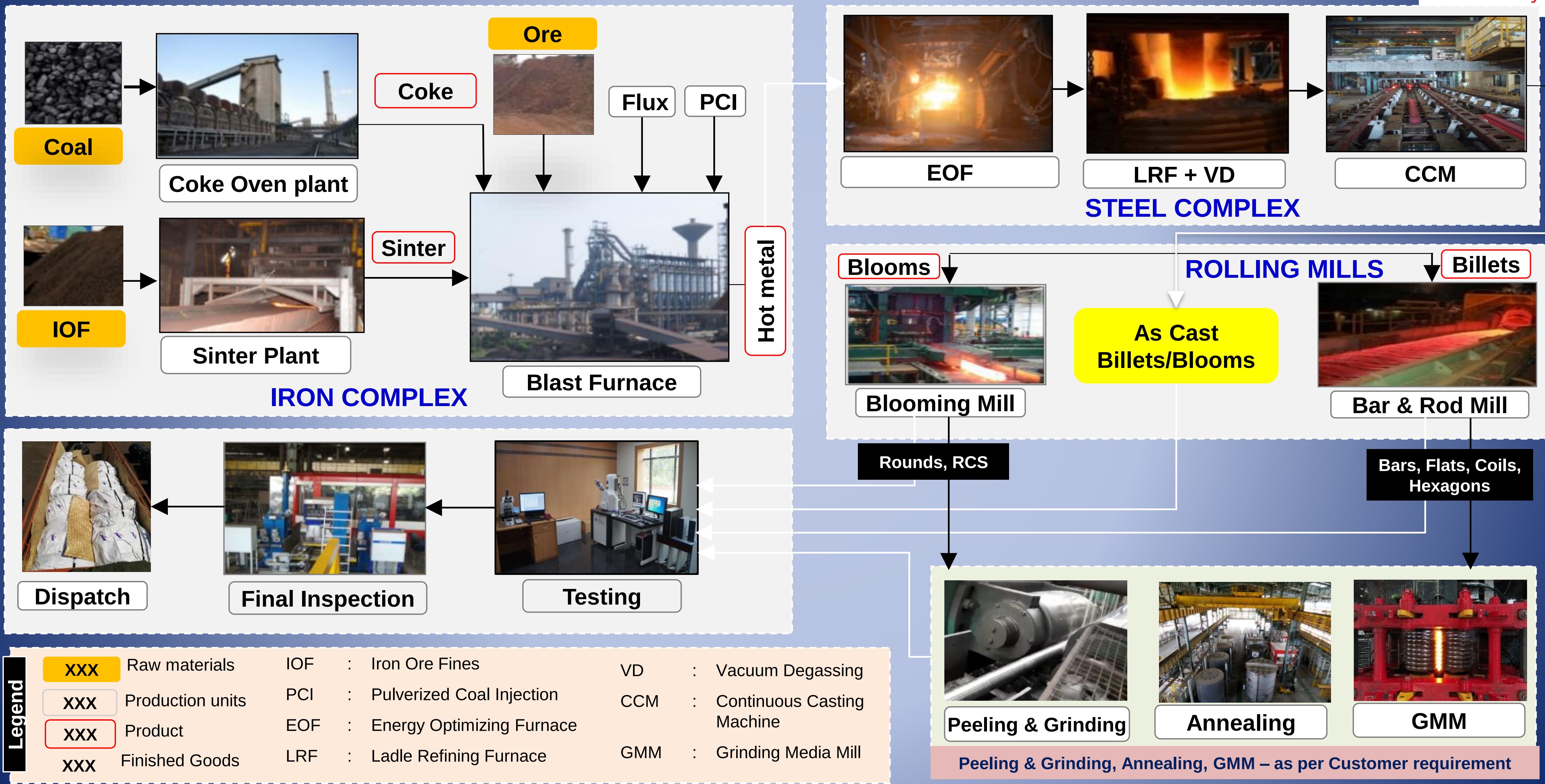
M/s. Brakes India

Some of the customer awards received in recent years are shown below

Year	Customer	Awarded Details
FY19	FAG Schaffler	Best Development Support
FY19	Automotive Axles	Best in Agility
FY19	Kalyani Techno Forge	Best Quality Services
FY20	Timken	Alliance & Strategic Partner
FY20	Brakes India Ltd.	Performance Award
FY23	Timken	Alliance & Strategic Partner

NCQC – National Convention on Quality Concepts *ICQCC – International Convention on Quality Control Circle*

Manufacturing Process



JSW Steel Decarbonisation Roadmap

48% of JSW Carbon reduction journey

SEED Sustainable Energy Environment and Decarbonization

Decarbonization Strategy

	FY05 BASEYEAR	FY23 30% REDUCTION	FY30 48% REDUCTION	Path towards Net Zero
Fuel Switch/ reduction		• Solid fuel reduction in BF	 Fuel rate optimization through • Burden-mix optimization • Fe improvement through beneficiation	 Fuel rate optimization through • Green H2 in BF-BOF • Syngas in BF • Green H2 in DRI
Energy recovery		• Heat recovery systems in Sinter Plant • Gas flaring reduction	• Heat recovery across all shops 	 • Top gas recovery in BF • Solid slag heat recovery
Energy & Tech transition		• Gas based DRI commissioning; • BF upgradation; • EAF commissioning	• RE Power (~10 GW) • Continued BF upgradation 	 • Technology transition of end campaign BF • Implementation of CCUS
Circularity			 • Scrap addition in SMS • COG/plastic/biofuel use in BF	 • Scrap based EAF

JSW SALEM

- JSW Steel Ltd., Salem works is an integrated special alloy steel plant with the capacity of 1.15 MTPA, located in Salem, Tamilnadu.
- JSW Salem has two mini blast furnaces (BFs) viz **Blast Furnace #1** and **Blast Furnace #2**

Description	UoM	BF-I	BF-II
Useful volume	m^3	402	640
Working volume	m^3	345	550
Technology		CERI,China	SINO steel,China
Wind volume	Nm3/Hr	60000	95000
Hot blast pressure	Kg/cm^2	1.90	2.80
Top pressure	Kg/cm^2	1.0	1.50
Tuyeres	No's	14	16
No.of Tapholes	No's	Single	Single
Hearth Diameter	mtr	5.1	6.15
Working height	mtr	16.27	17.67
Hot blast temperature	Deg C	1180	1180
Oxygen enrichment	%	Max 5	Max 5
No of stoves	Nos	3	4
Stoves	Type	Top Combustion	Top combustion
Gas cleaning system	Type	Wet type	Dry type
Charging system	Type	Skip	Skip
Top charging	Type	Bell Less Top	Bell Less Top
Hearth refractory	Type	Carbon hearth	Carbon hearth
Furnace cooling system	Type	Cast iron stave coolers	Cast iron stave coolers
Hearth Bottom cooling	Type	Natural draft	Water cooling
Hearth cooling	Type	Shower cooling	Stave coolers
Main Runner	Type	Pool with ramming mass	Pool with ramming mass

IBM Burden Mix: Sinter 60% and IOL 40%.

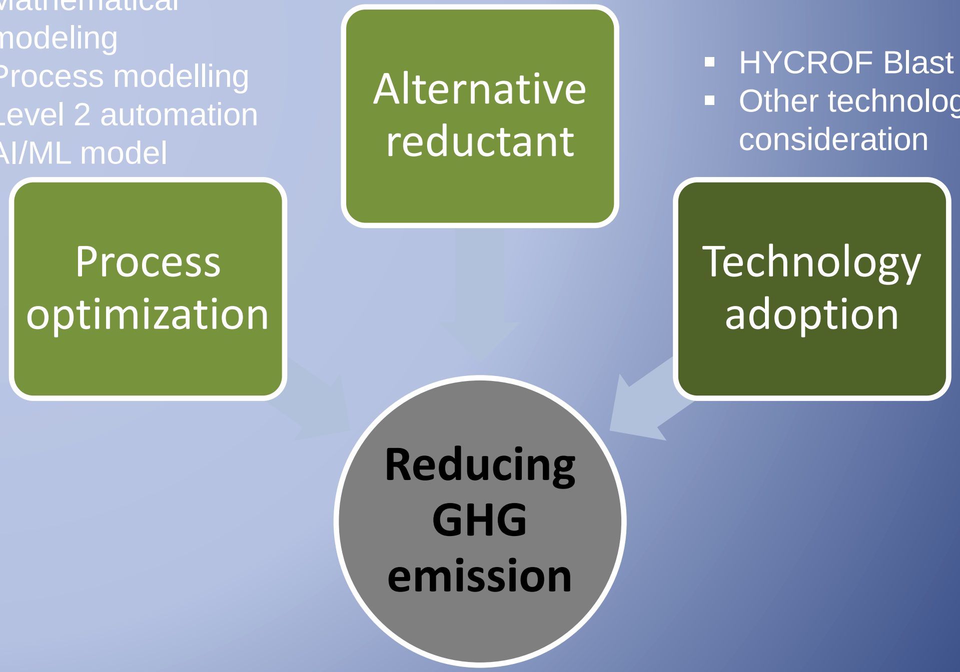
JSW Salem pathway towards

"Green and sustainable Iron Making".

- Burden distribution,
- Burden preparation
- Blast parameter control
- Mathematical modeling
- Process modelling
- Level 2 automation
- AI/ML model

- Green H2 injection
- Natural gas and Syngas injection
- Waste plastic injection
- Higher O2 injection
- Use of Biomass reductant

- HYCROF Blast Furnace
- Other technology consideration



Process optimization in JSW Salem

GREEN HOUSE GAS EMISSION

Scope-1
Fuel consumption
(Coke, Nut coke and coal)

Scope-2
Electricity / steam energy

Scope-3
Upstream and Downstream

Scope-1 (Fuel rate) Emission reduction through BF process optimization

BF
Quantitative data

BF
Qualitative data

Advanced Statistical Tools

- **Regression Analysis**
- **Hypothesis Testing**
- **Design of Experiments**
- **Other statical tools**

Significant enablers for reducing the Fuel rate

- Improving burden distribution.
- Burden preparation
- Metal/slag chemistry optimization
- Casting practice management
- Effective Preventive maintenance
- Reliability improvement practices

Process optimization in JSW Salem

1. Improving Burden distribution.

1 a. Mathematical burden distribution model development.

- Burden distribution - determines the **distribution of raw material**, **the particle segregation degree** and the **ore-to-coke ratio**
- Burden distribution affects the distribution of gas flow, quality and production of pig iron and the consumption of energy.

Mathematical Approach

Three distinct zones can be identified along the path of material movement.

- Material decent from charging bucket (hopper) to rotating chute
- Material movement in the rotating chute
- Material fall from chute tip to stock (burden) level

Mathematical model

Blast Furnace II BLT Trajectory mathematical simulation

Ring No	Chute Angle (α)	Dumping level in m	Chute rotation speed in r/se	Final Trajectory width in furnace radius in mm
1	6.88	2	0.1562	650
2	13.93	2	0.1562	1168
3	17.65	2	0.1562	1507
4	20.38	2	0.1562	1740
5	22.66	2	0.1562	1924
6	24.64	2	0.1562	2075
7	26.40	2	0.1562	2202
8	31.50	2	0.1562	2533
Enter in gray shaded cells only				Calculated value don't enter

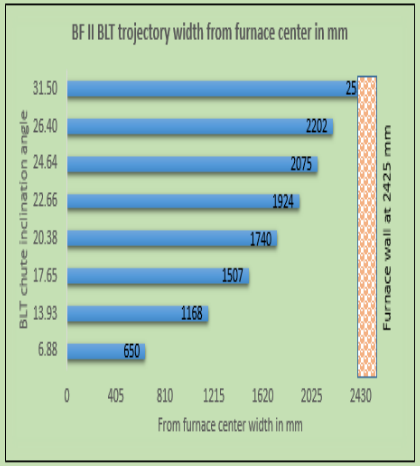
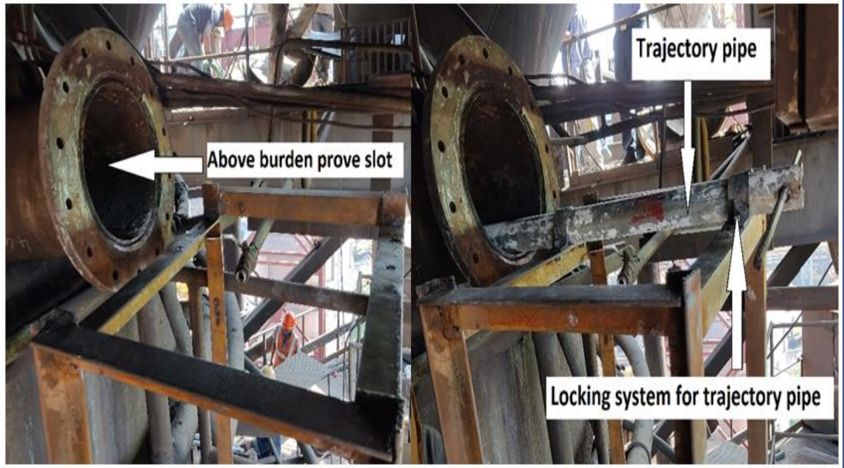


Figure: BLT trajectory model developed in excel format, by entering required chute angle, dumping level and rotation speed, the model enables to show the final trajectory width (material fall in stock line from furnace center) in mm. As calculation is inbuilt in the excel sheet:

Model validation



- Model validation done through physical trajectory test by using chalk line probe.
- The hallow trajectory pipe length was of 28.2 m, outer diameter 60 mm, inner diameter 52 mm, and the thickness of 28 mm as shown in fig.5.
- The trajectory pipe was inserted from above burden probe slot and a locking system was arranged for holding the pipe as shown in the figure 5.
- The trajectory pipe was painted with liquid chalk and dried up so that after the coke or ore charge the impressions made by the materials will be clearly visible.
- After charging measurement were taken to identify the material falling point and the band width

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By using the mathematical model, the chute angle and band width are modified to improve the burden distribution in BF-1 and BF-2

BLAST FURNACE-2

Before

Ring No	Chute angle	Distance from furnace center in m
1	5.57	0.65
2	13.57	1.06
3	17.74	1.42
4	20.78	1.66
5	23.3	1.86
6	25.48	2.01
7	27.39	2.14

- 7 rings used for distribution.
- Maximum chute angle is 27.39 °

After

Ring No	Chute angle	Distance from furnace center in m
1	7.57	0.72
2	15.57	1.241
3	19.74	1.588
4	22.78	1.823
5	25.3	2.004
6	27.48	2.150
7	29.39	2.270
8	**31.1**	**2.371**

- 8th rings used for distribution.
- Maximum chute angle increased to 31.1°

Benefits:

- Self slips reduced from 25 nos/month to <2/month
- Fuel rate reduced by ~5 kg/thm
- Extra coke consumption reduced by 50%.
- Process stabilized and abnormality reduced.
- Productivity increased

1 b. Burden distribution pattern optimization by Design of Experiment

- After studying the historical data and bench marking of various similar capacity blast furnaces, four (4 for coke and 4 for IBM) best burden distribution patterns are identified.

BLT Distribution pattern		Selected BLT Pattern							Burden weight % discharge							Total number of rings	Logic for selection
		R1	R2	R3	R4	R5	R6	R7	R1	R2	R3	R4	R5	R6	R7		
Coke Pattern	A	1	0	0	1	1	1	2	17	0	0	17	17	17	33	6	Material distribution centre:17 %, Intermediate:51% ,Periphery 33%
	B	1	0	0	1	1	1	3	14	0	0	14	14	14	43	7	Material distribution of center 14 %, Intermediate 42% and Periphery 43%
	C	1	0	0	1	1	2	2	14	0	0	14	14	29	29	7	Material distribution of center 14 %, Intermediate 57% and Periphery 29%
	D	1	0	0	1	2	1	2	14	0	0	14	29	14	29	7	Material distribution of center 14 %, Intermediate 57% and Periphery 29%
Ore Pattern	A	0	0	1	2	2	2	0	0	0	14	29	29	29	0	7	Higher in intermediate (IBM 72%)
	B	0	0	1	1	2	3	0	0	0	14	14	29	43	0	7	Higher in center (IBM 58%)
	C	0	0	1	2	2	2	0	0	0	14	29	29	29	0	7	**Even distribution (Bell type)**
	D	0	0	1	2	2	3	0	0	0	13	25	25	38	0	8	Higher in center (IBM 63%)

Design of Experiments

Factor code	Factors	UOM	L1	L2	L3	L4
A	Centre coke	Pattern	Coke Pattern A	Coke Pattern B	Coke Pattern C	Coke Pattern D
B	Periphery coke	Pattern	IBM Pattern A	IBM Pattern B	IBM Pattern C	IBM Pattern D

Optimum burden distribution pattern derived through DoE

Process optimization in JSW Salem

By using the mathematical model, the chute angle and band width are modified to improve the burden distribution in BF-1 and BF-2

BLAST FURNACE -1

Before

BLT Chute angles						
Dumping Level (m)	RING No. 1	2	3	4	5	6
0.6	7.39	17.38	22.20	25.82	28.78	31.29
0.7	7.39	17.38	22.20	25.82	28.78	31.29
0.8	7.39	17.38	22.20	25.82	28.78	31.29
0.9	6.73	15.91	20.39	23.78	26.57	28.96
1.0	6.73	15.91	20.39	23.78	26.57	28.96
1.1	6.73	15.91	20.39	23.78	26.57	28.96
1.2	6.19	14.66	18.84	22.03	24.66	26.94
1.5	5.72	13.60	17.50	20.50	23.00	25.16
1.8	5.72	13.60	17.50	20.50	23.00	25.16
2.0	5.72	13.60	17.50	20.50	23.00	25.16

6 rings used for burden distribution.
maximum chute angle in 31.29°

After

BLT Chute angles							
Dumping Level (m)	RING No. 1	2	3	4	5	6	7
0.8	5.10	15.10	19.75	23.15	25.85	28.10	30.00
1.0	5.32	14.50	18.85	22.05	24.75	27.00	29.00
1.2	5.72	14.19	18.32	21.46	24.05	26.28	28.20
1.5	5.72	13.60	17.50	20.50	23.00	25.16	27.04
1.8	4.79	12.97	16.82	19.74	22.17	24.28	26.10
2.0	4.61	12.49	16.29	19.21	21.63	23.71	25.50

7 rings used for burden distribution.
maximum chute angle optimized to in 30°

1 b. Burden distribution pattern optimization by Design of Experiment

- After studying the historical data and bench marking of various similar capacity blast furnaces, four (4 for coke and 4 for IBM) best burden distribution patterns are identified.

BLT Distribution pattern		Selected BLT Pattern R1	R2	R3	R4	R5	R6	R7	Burden weight % discharge R1	R2	R3	R4	R5	R6	R7	Total number of rings	Logic for selection
Coke Pattern	A	1	0	0	1	1	1	2	17	0	0	17	17	17	33	6	Material distribution centre:17 %, Intermediate:51% ,Periphery 33%
	B	1	0	0	1	1	1	3	14	0	0	14	14	14	43	7	Material distribution of center 14 %, Intermediate 42% and Periphery 43%
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Ore Pattern	A	0	0	1	2	2	2	0	0	0	14	29	29	29	0	7	Higher in intermediate (IBM 72%)
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	D	0	0	1	2	2	3	0	0	0	13	25	25	38	0	8	Higher in center (IBM 63%)

Design of Experiments

Factor code	Factors	UOM	L1	L2	L3	L4
A	Coke	Pattern	Coke Pattern A	Coke Pattern B	Coke Pattern C	Coke Pattern D
B	IBM	Pattern	IBM Pattern A	IBM Pattern B	IBM Pattern C	IBM Pattern D

Benefits:

- Fuel rate reduced by ~3 kg/thm
- Extra coke consumption reduced by 50%.
- Process stabilized and abnormality reduced.
- Productivity increased

Process optimization in JSW Salem

1c. a) LMG (Lower material gate) flow rate model development)

Diamond opening

Bell Curve opening

Johanson equation (discharge rate through outlet for coarse particles)

$$\text{Equation-1: } \dot{m} = \rho_b * A * \sqrt{\frac{B * g}{2 * (1 - m) * \tan\theta}}$$

Equation : Johanson equation (discharge rate through outlet for coarse particles)

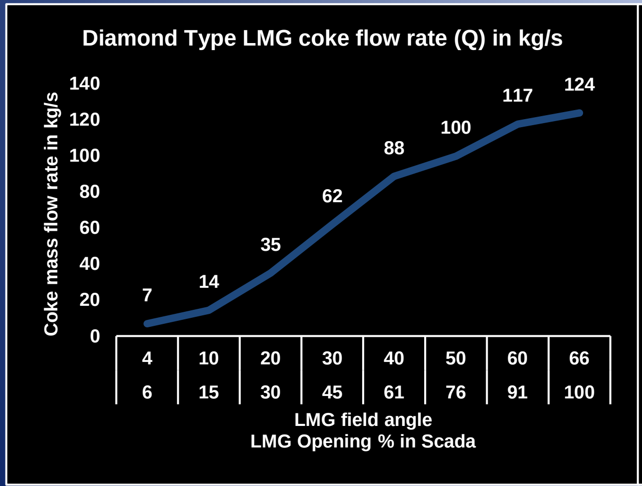
M _ discharge discharge rate in kg/s

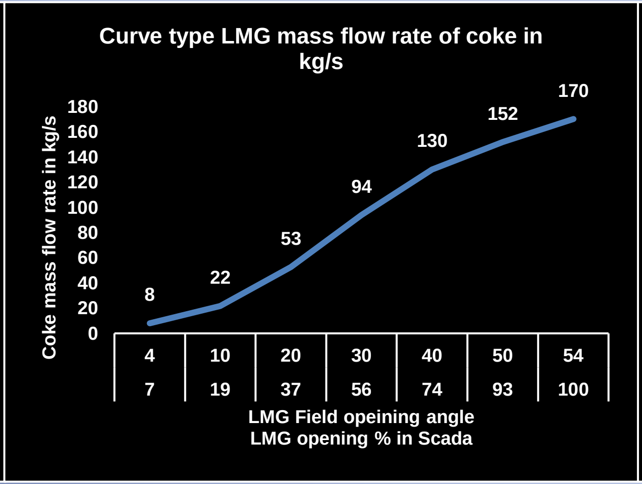
θ angle of hopper deg

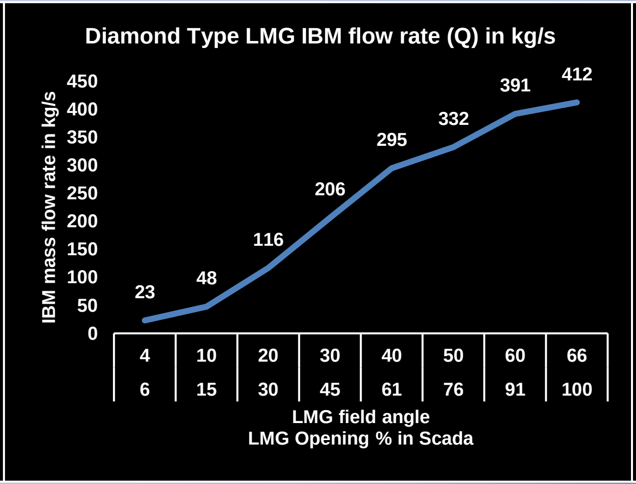
ρ_b bulk density in kg/m3

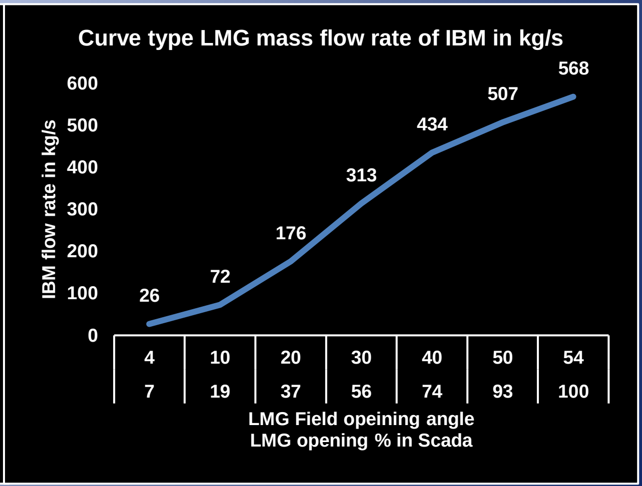
g is the acceleration of gravity 9.81 ms-2

Flow rate model is developed for different type of LMG and flow rate curve derived from the model. Based on the flow rate curve LMG opening adjusted.









Benefits: Controlled flow rate of burden.
: Standardization of material flow rate
: Standardization of LMG type.

- ❖ Model validated with physical measurement during shutdown.

Process optimization in JSW Salem

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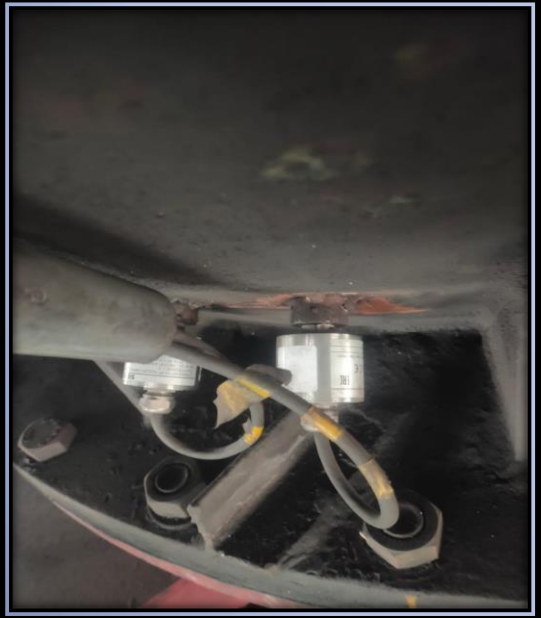
1c. b) Acoustic sensor installation in burden tank.

- Planned discharge time is calculated based on the BLT chute rotation encoder and display shown in the SCADA
- Actual material discharge time is derived from Radar signal or by acoustic sensor of the burden tank.
- Time based LMG auto correction logic developed in house by using acoustic sensor readings and flow rate curves

Acoustic sensor installation in Burden tank



BLT Discharge monitoring

Benefits: Effective burden distribution
: Fuel rate reduction by 3 kg/thm
: Process stabilized and abnormality reduced.

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1d. Installation of Furnace top thermal image camera

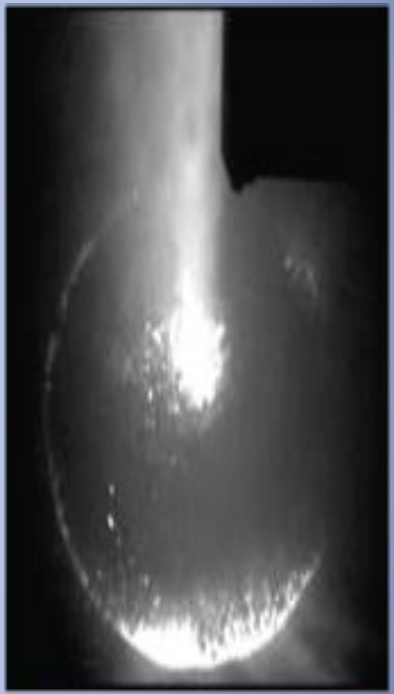
- Gas flow inside the furnace and proper burden (Raw material) distribution are major base parameters for maintaining the safety, process efficiency and other techno economics of the operation

Solution approach

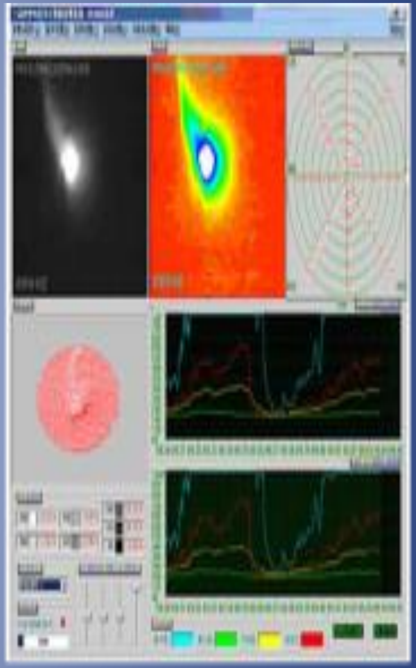
Solution identified: Provision of infrared camera at blast furnace

- Installation of infrared camera at furnace top for BLT monitoring
- Visualizing and analyzing gas distribution, Equipment condition & water seepage from camera image
- Using the information to optimize furnace burden distribution and PCI rate

Visual inspection during Shutdown



Proper visibility of gas flow



Gas flow with temperature trend

Benefits: Effective burden distribution
: Process stabilized and abnormality reduced.
: Anomaly detection
: Increased PCI rate by 5 kg/thm

Process optimization in JSW Salem

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2. Burden preparation.

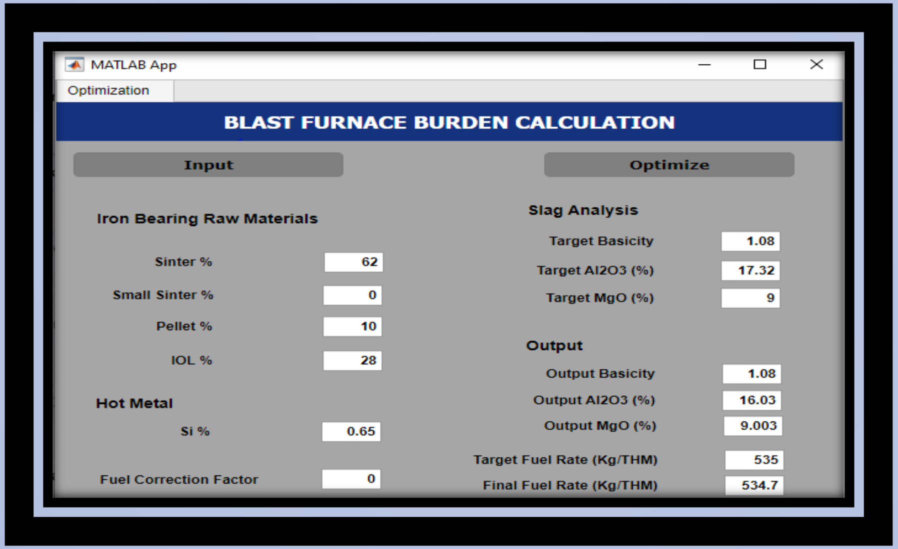
a) External screening of Iron Ore Lumps and Fluxes to reduced fines input in the furnace.

b) Burden calculation model development by using MATLAB

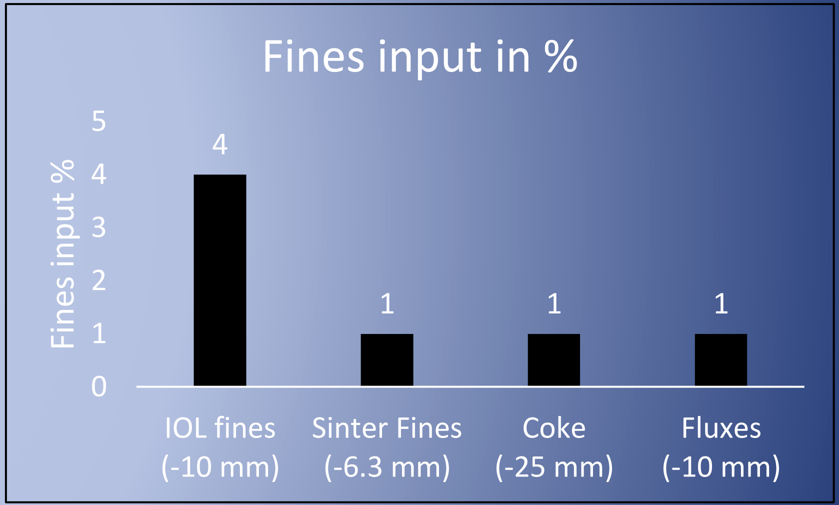
b) Increasing the SH screen screening area for effective screening of BF raw material

c) Improved Yard management practices to ensure proper blending of Iron Ore lumps

External screening of IOL and Fluxes



Burden calculation model by using MATLAB



The average 70% of feed IOL is being Externally screened.
Planned to increase 100% IOL external screening to achieve IOL fines input <1%

Benefits: Fines input reduction
: Eta CO improved by 1%.
: Fuel rate reduction by 5 kg/thm
: Process stabilized and abnormality reduced.
: Effective burden control

Process optimization in JSW Salem

3.Metal/slag chemistry optimization.

a) Development of Hot Metal Silicon prediction model

In house development of Hot metal silicon prediction model developed

- **Model Developed by using MLR (Multiple regression) and NN (Neural network)**
- **Data Processing done by using P test, F test and other statistical tools.**

GUI (Graphical user interface) made by using VB.Net Plat form.

Benefits:

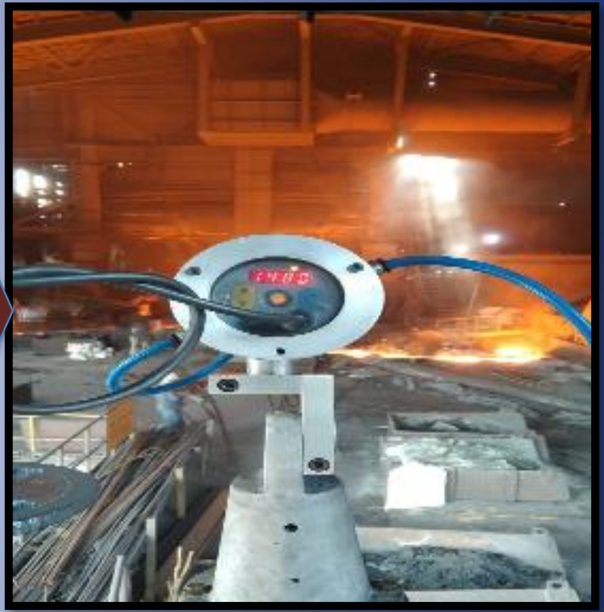
1. **HM silicon prediction before 2 hours.**
2. **HM Silicon deviation reduced from 0.16 to 0.10**
3. **Fuel rate reduced by 2 kg/thm**

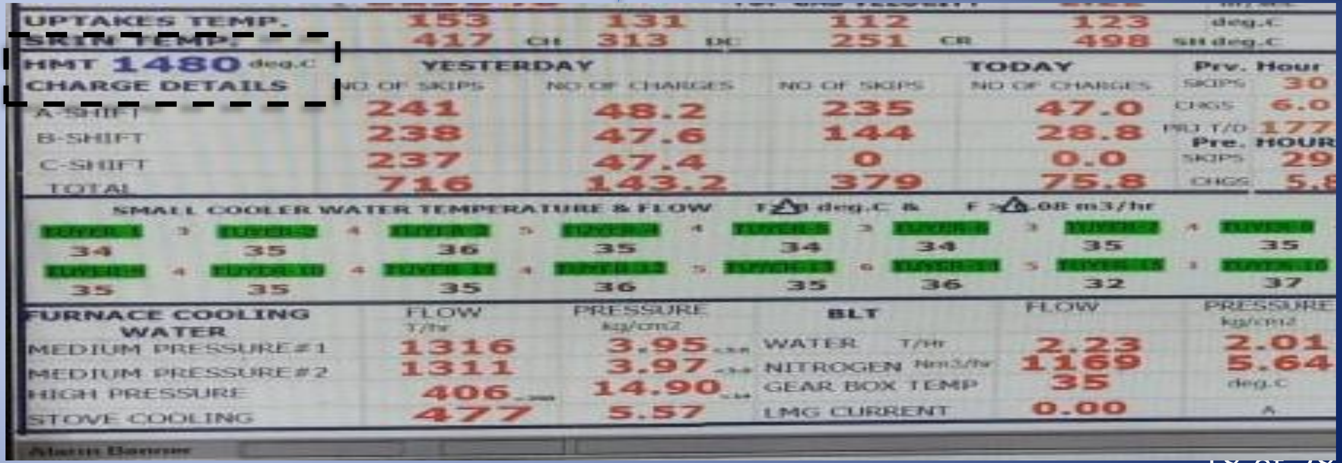
Process optimization in JSW Salem

b) Implementation of online Hot metal temperature measurement.

Solution identified: Installation of Hot Metal temperature measurement

- Installation of online pyrometer at cast house to measure online hot metal temperature during casting
- Integration of Hot metal temperature in L1 PLC system
- Exporting Hot metal temperature to L2 automation system for analysis





Benefits:

1. **Continues Hot metal temperature monitoring.**
2. **HM temperature standard deviation reduced.**
3. **Abnormality reduction**

Process optimization in JSW Salem

3c. Other optimization in metal and slag chemistry

a) Optimization of Hot metal Mn% (0.25 to 0.40%) for effective coke/coal char gasification in the BF hearth.

Mn-containing materials expands the possibilities of carbon gasification in the lower part of hearth where is experiencing a deficiency of bound oxygen for reaction with crashed particles of coke (coke debris) and PCI unburnt char:

$MnO + C = Mn + CO - 288.29$ MJ, (5) therefore, due to arrival of additional oxygen in form of (MnO), washing effect is enhanced.

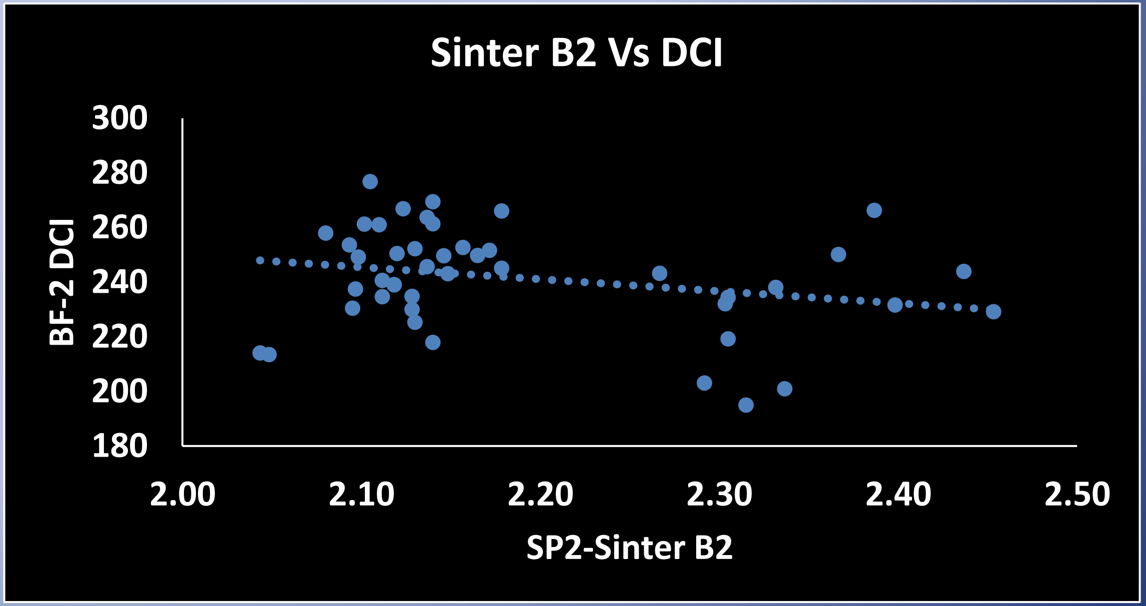
b) Slag MgO and Al_2O_3 optimization (Slag MgO optimized to 7.5 to 9.5 based on Al_2O_3% (<20%) By studying the slag characteristics.

c) Monitoring the Mn partition, taking necessary action based on data to improve the thermal stability of BF hearth.

d) Monitoring the deadman cleanliness index (DCI), taking necessary action based on data to improve the thermal stability of BF hearth

e) Alkali and ZnO flushing management with 100% flushing.

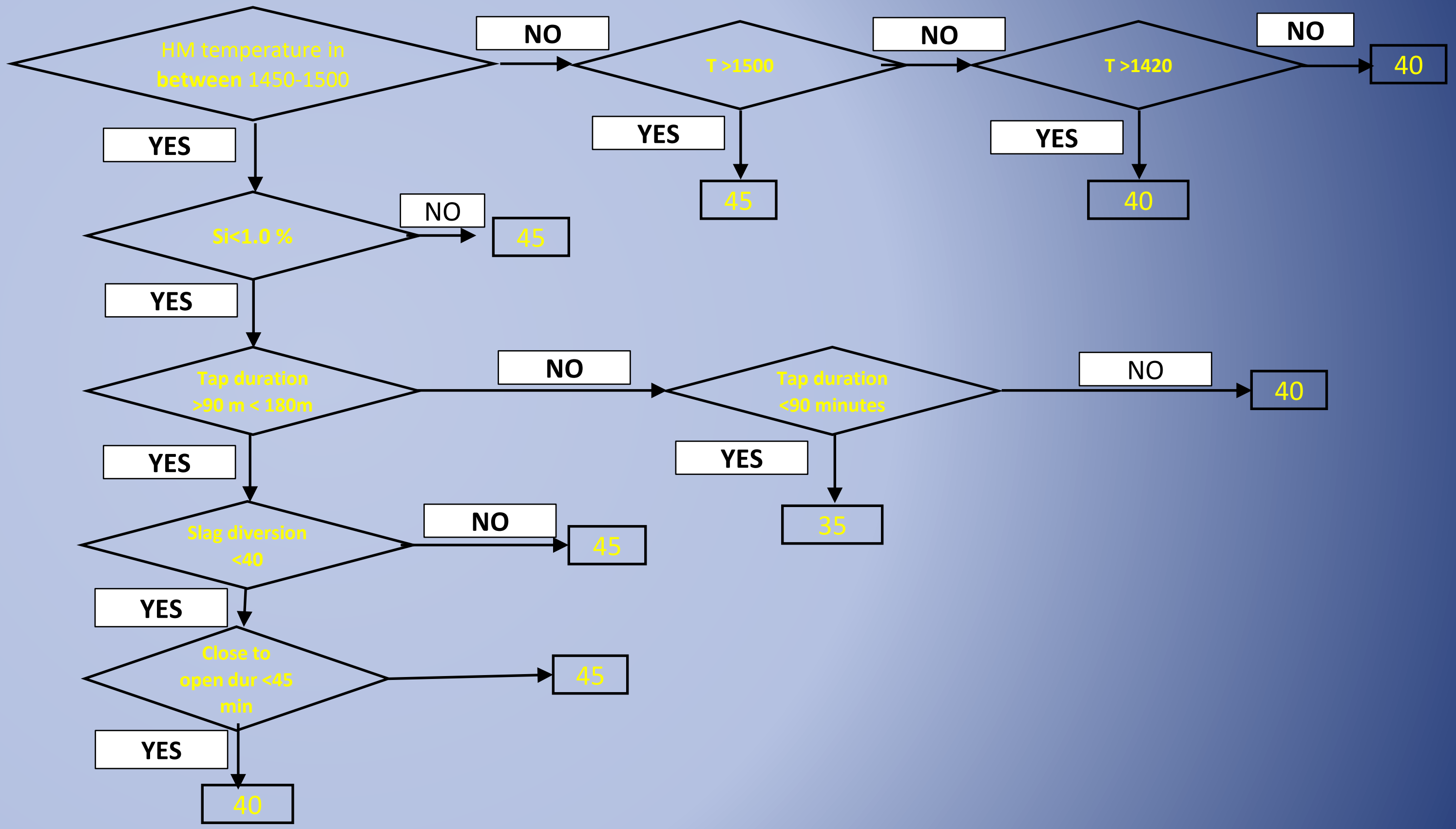
f) Sinter Basicity optimized to improve the process stability



Process optimization in JSW Salem

4.Casting practice management.

DECISION TREE: Tapping guidelines for BF II STANDARD DRILL BIT DIAMETER 40 MM



Tapping practice improvement by

- Optimizing the Tap hole clay quality.
- Various trails conducting for improvement of tap hole clay
- Zero non dry cast by improving the hot metal handling capability.
- Drill bit Design optimization of improve smooth drilling of tap hole.
- Reduction in close to open time.
- Selecting suitable drill bit size based on the condition.
- Titanium and carbon paste application to improve the tap hole refractoriness.
- Effective runner maintenance to reduce casting delay

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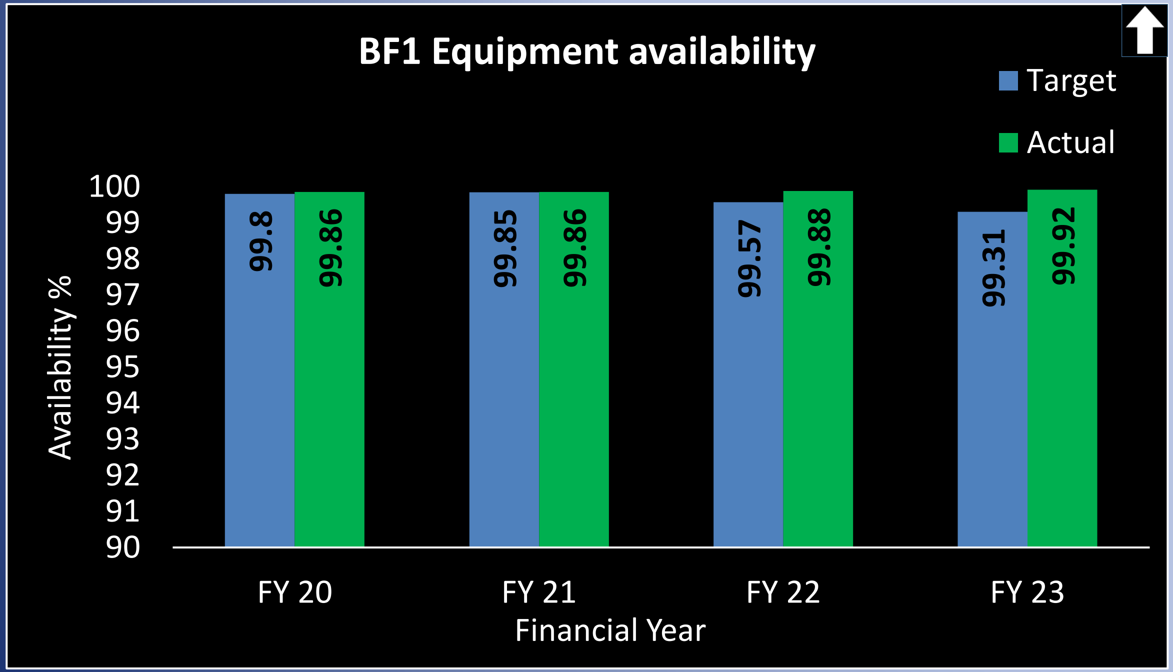
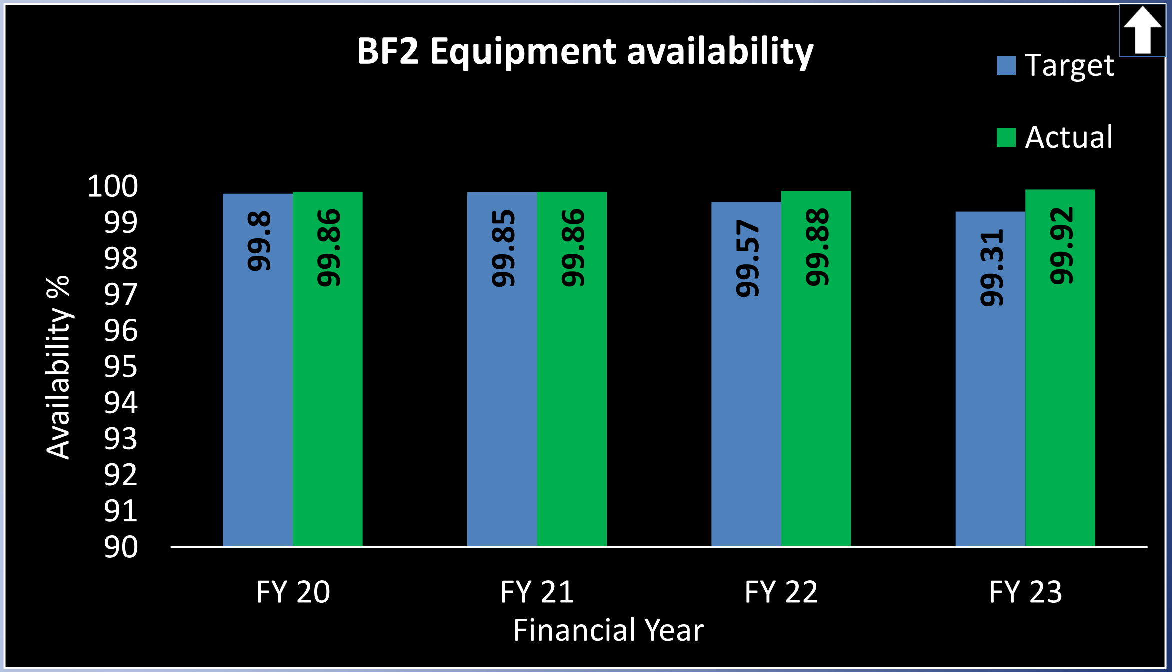
5.Effective Preventive maintenance and Reliability improvement practices

Objectives – BF Maintenance

Maintenance Objective:

- To minimize the impact of unplanned events on safety, the environment, and business profitability
- Higher Equipment availability at optimum maintenance cost





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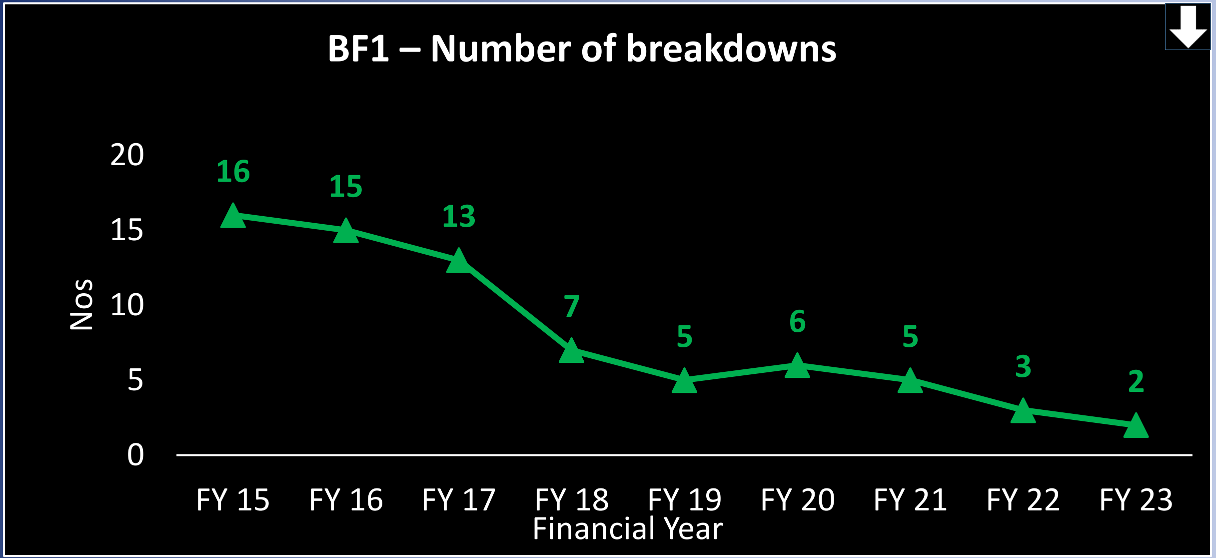
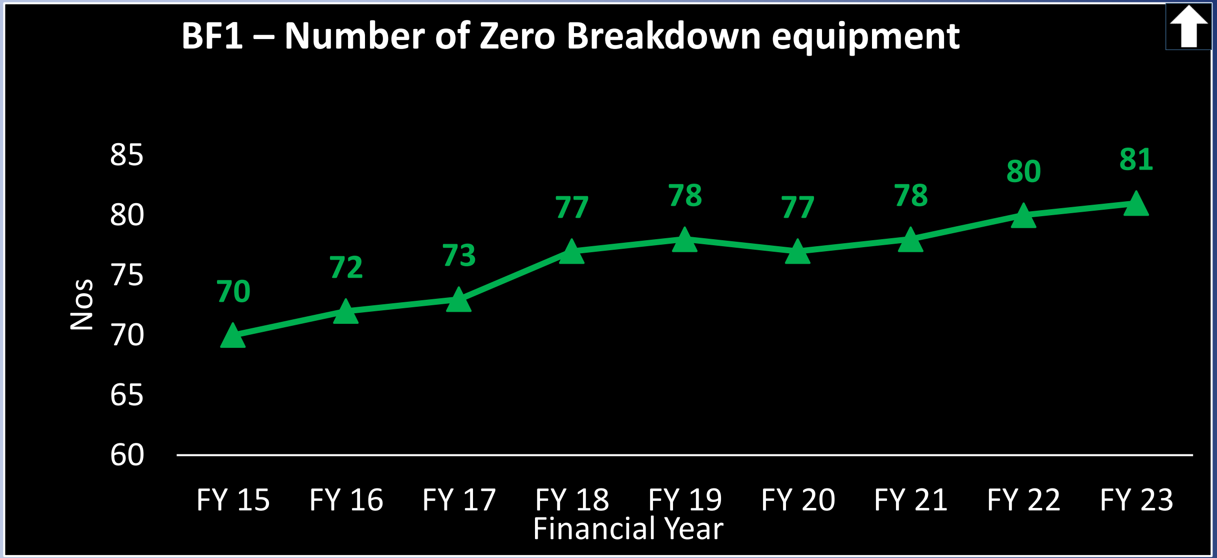
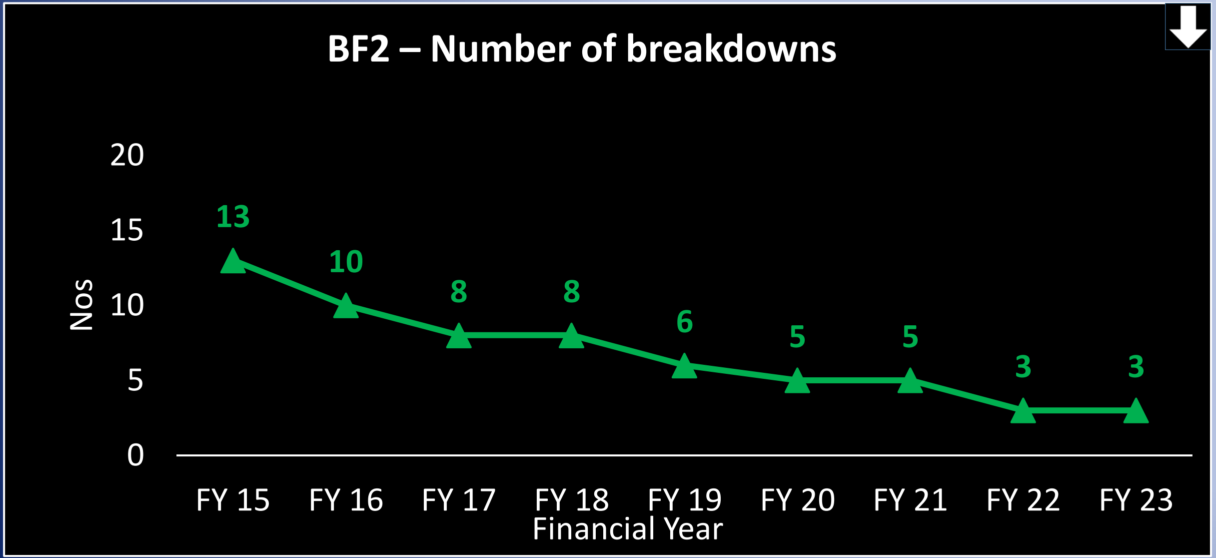
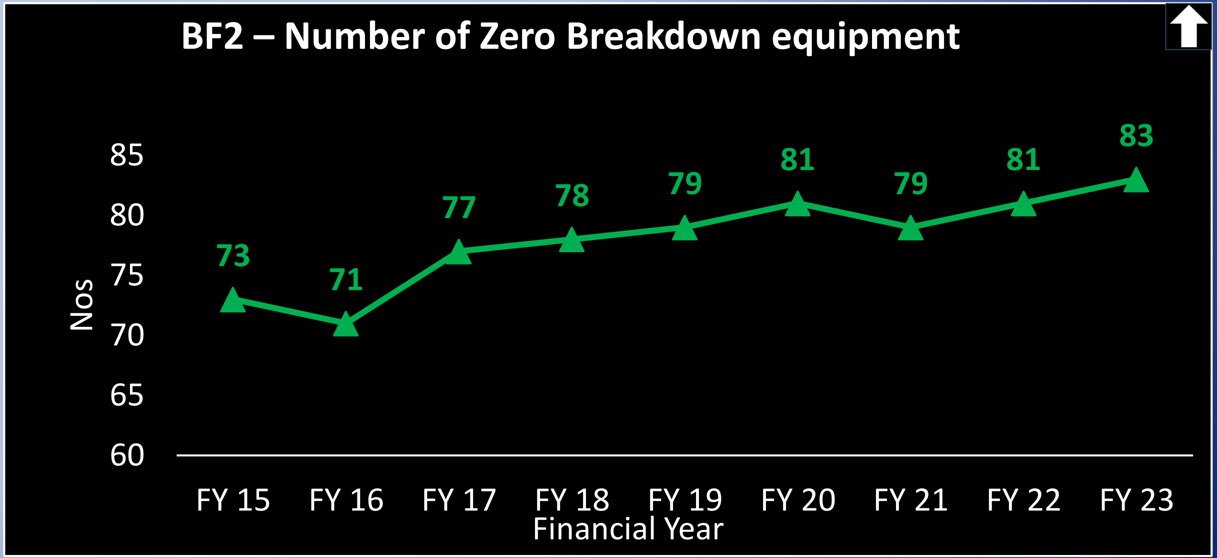
Improving Equipment reliability – BF Maintenance









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Enablers of Improving Equipment reliability in BF Maintenance

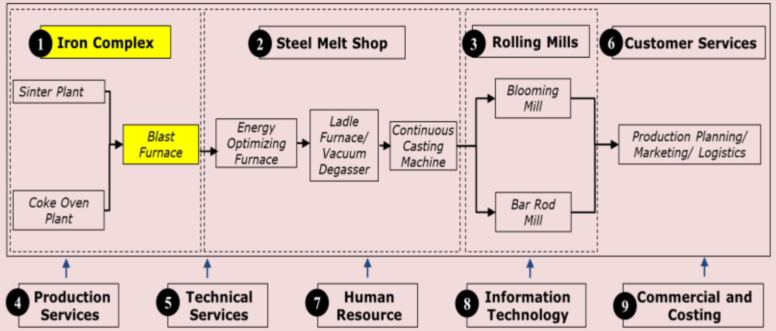
SL No	Initiation	Actions taken
1	Zero breakdown strategy	# All A,B & C category equipment are mapped for zero breakdowns for a period of 36 months back from the point of analysis # Projects are taken based on the compliance of critical equipment in to Zero breakdown category
2	Adaption of Criticality assessment	# Based on criticality assessment, prioritizing of poor performing critical equipment is done # Projects are taken based on the necessity of improvement in MTTR / MTBF to reduce the impact and frequency of equipment failures # The impact scale of our criticality assessment has been narrowed down by 10 times since FY 2015 # The frequency scale of our criticality assessment has been narrowed down by 4 times since FY 2015
3	Adaption of Equipment Failure Mode Effect Analysis (EFMEA)	# Failure modes are mapped against all levels of Main equipment, Sub equipment and BOM of critical equipment # RPN for Each failure modes are weighed by product of weightages of Severity X Occurrence X Detectability # Projects are taken on failure modes having Top 3 RPN values at any time for critical equipment
4	Adaption of Trouble shooting tools	# FTA (Fault Tree Analysis) has been adapted for critical equipment # Fault finding made quicker to ensure better MTTR # Improvements and revisions are made periodically and against failures
5	Daily trainings / Interactions for worker level manpower	# Daily trainings / Interactions are made with worker level associates / employess for the sake of their improvement in maintenance on the following 1. Technical aspects of critical equipment 2. Safety aspects of area/equipment specific maintenance activities 3. Trouble shooting of critical equipment failure 4. Root cause analysis of failures in critical equipment

Process optimization in JSW Salem

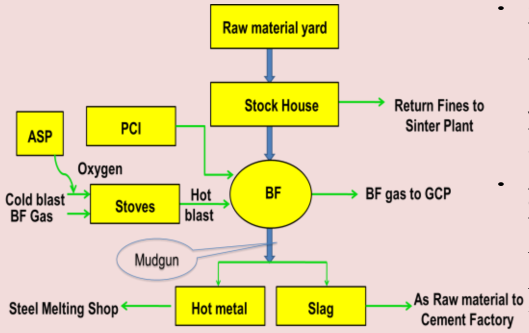
Better Everyday

Date : 01.02.2023	ACHIEVING ZERO BREAKDOWN IN BF1 MUDGUN	Better Everyday

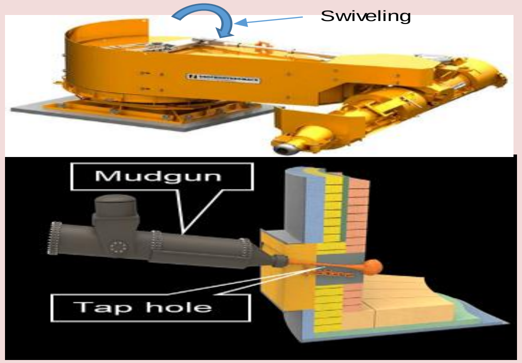
Introduction



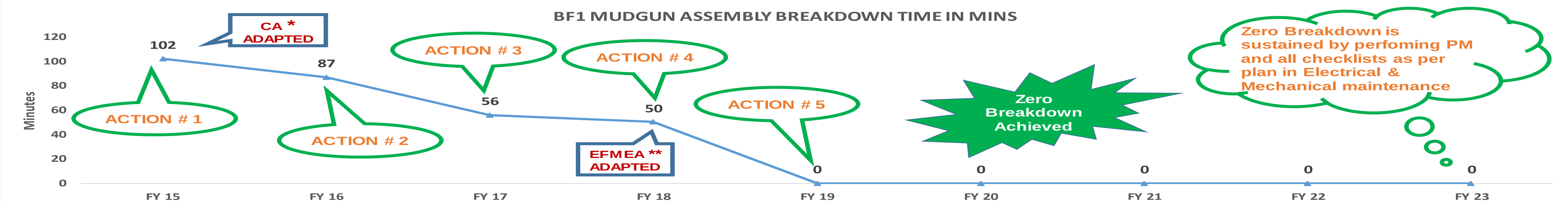
- Blast furnace is the plant facility that produces hot metal and supplies to Steel Melting Shop (SMS)
- To meet the internal customer demand of HM, BF1 needs to operate at a stretched production level. So, it was necessary to ensure the availability of equipment in BF1. In FY15, delays (36.5 hours) accounted to hot metal production loss of around 1600 MT in BF1
- Mudgun is an A category critical equipment in Blast furnce



- Casting is the process of tapping hot metal from Blast furnace by opening the tap hole through driller unit and closing the tap hole with mudgun unit in which swiveling is a part to rotate mudgun towards and away from tap hole
- As Swiveling System is crucial part of mudgun, its failure will be resulting in non- Closing of tap hole that leads to throttling of production in blast furnace. Mudgun swiveling system is driven by electric motor



Improvement

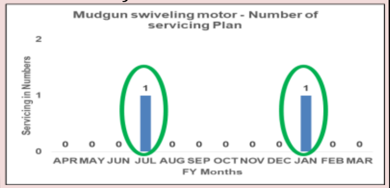


* CA - Criticality Assessment ** EFMEA - Equipment Failure Mode and Effects Analysis

Action # 1 (FY15)
Equipment : Mudgun
Problem : Mudgun Swivel Motor Failure
Action Taken : Sealing Compound provided for motor terminal box .
Tools Used : Why Why Analysis & Selection matrix

Sealing compound provided for motor terminal box

Action # 2 (FY16)
Equipment: Mudgun
Problem :Swivel Motor Failure
Action Taken : Motor Service frequency increased
Tools Used : Histogram , Cause & Effect Analysis



Motor Service frequency increased from once/year to twice/year

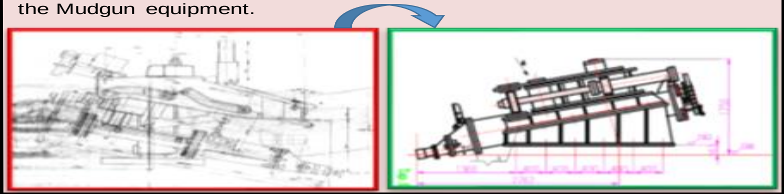
Action # 3 (FY17)
Equipment : Mudgun
Problem : Tilting cylinder failure
Root Cause: Poor tensile strength of cylinder piston
Action Taken : Piston material changed and piston diameter increased
Tools Used : Cause & Effect Analysis

Piston at thread portion diameter increased from 48 to 60mm

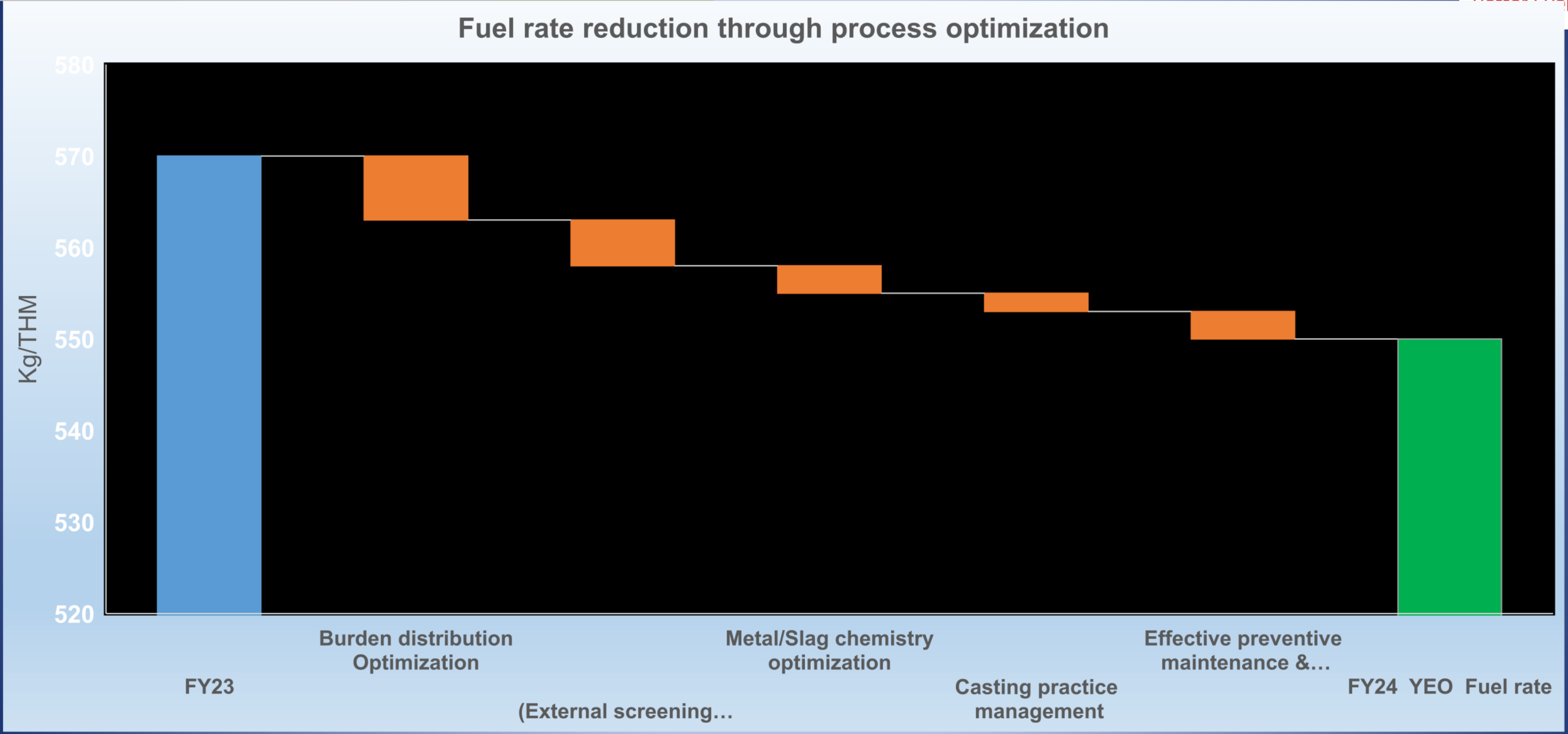
Action # 4 (FY18)
Equipment : Mudgun
Problem : Anchor hook rope failure
Root Cause: Rope surface exposed to high workplace temperature
Action Taken : Fibre glass sleeve provided for wire rope
Tools Used : Why Why Analysis

Wire rope covered with glass fibre sleeve

Action # 5 (FY19)
Collaborative approach with supplier
Equipment : Mudgun
Continual Improvement:
Introduction of Fully Hydraulic Operated Mudgun inplace of Electrohydraulic Mudgun.
Tools Used : Configuration Management
Outstanding Activity
Result:
a)Entire mudgun system has been updated to the best fit configuration
b) After implementation of the actions ZERO BREAKDOWN acheived for the Mudgun equipment.



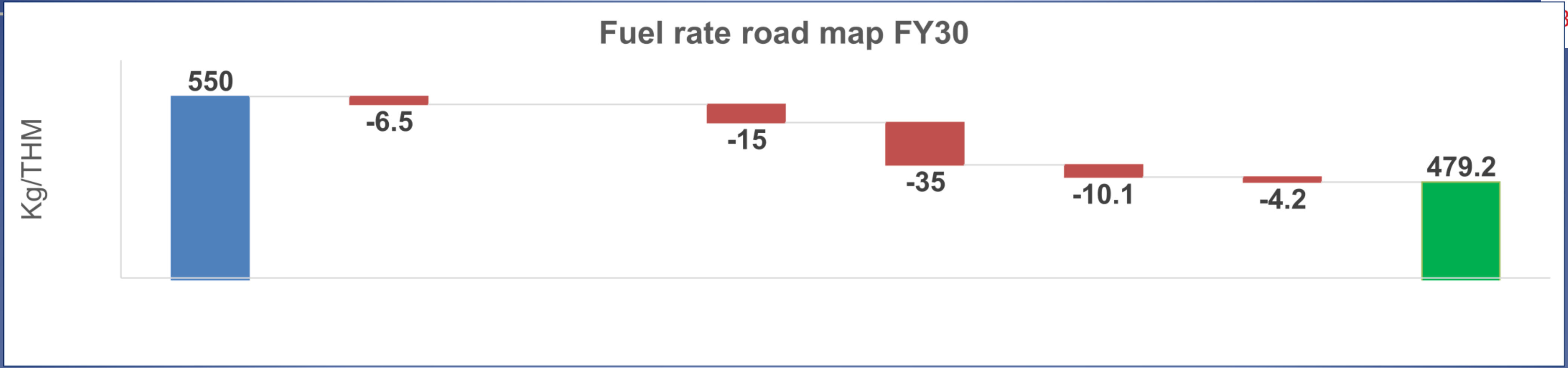
Fuel rate reduction through Various Process control activities



** Through process optimization, fuel rate was reduced from 570 to 550 Kg/THM (Reduction : 20 Kg/THM)*

** Productivity was increased from 3.4 to 3.6 t/m3/day and process stability improved*

JSW Salem Fuel Rate| Roadmap for BF



1 Level 2 Automation (Contd)	-2.5						-2.5
2 Hot metal Si Prediction model (Contd)	-2						-2
3 Online heat flux monitoring (Contd)	-2						-2
4 Increase in HBT from 1180- 1250 deg C			-4.2	-2.8			-7
5 Natural gas injection			-10.8	-7.2			-18
6 Higher agglomerated burden				-14			-14
7 Slag volume reduction (360 -340 Kg/THM)				-5			-5
8 Steam reduction (30-20 gm/Nm3)				-6			-6
9 Green H2 introduction (15 Kg/THM)					-10.1		-10.1
10 Coke dry Quenching						-4.2	-4.2
Total Reduction							**71**

JOURNEY TOWARDS NET ZERO EMISSION

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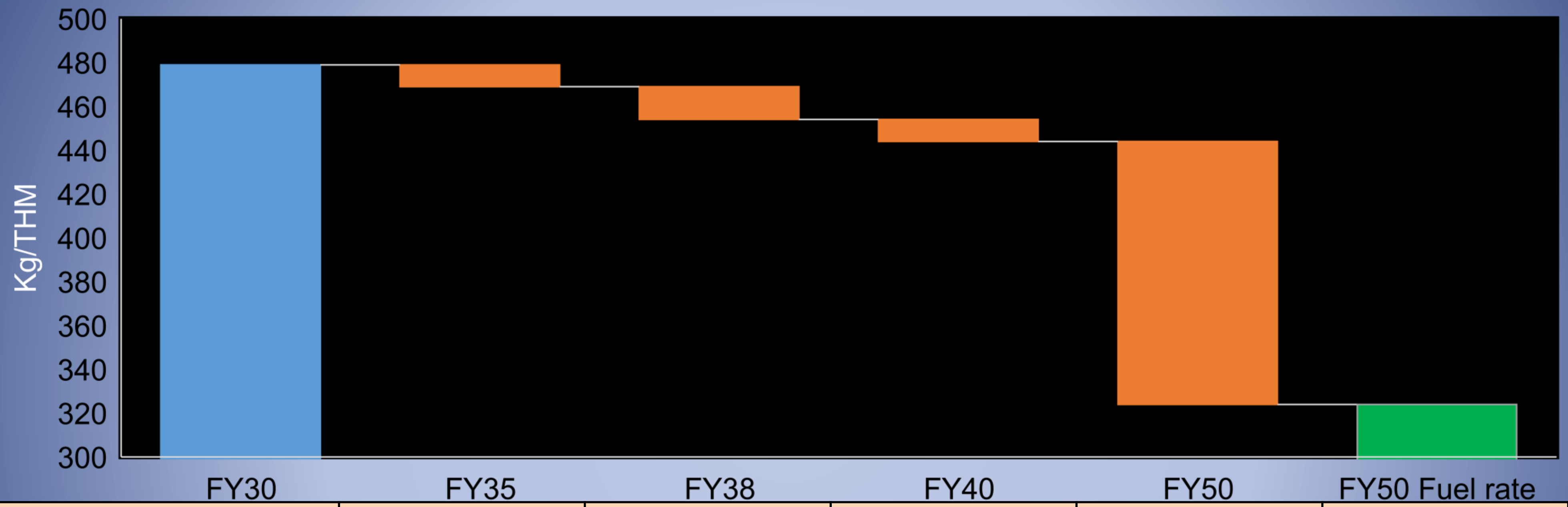
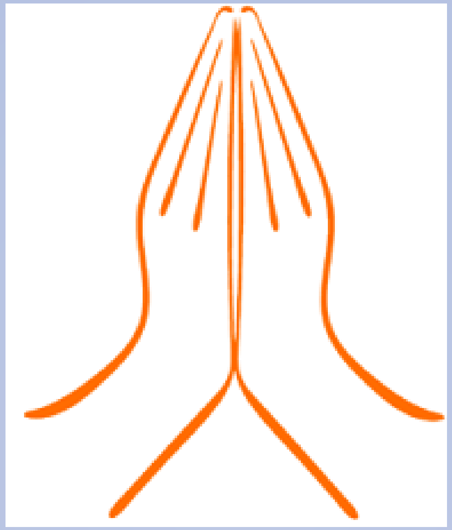
Fuel rate reduction FY50 - Net Zero



Increase in Green H2 from 15 Kg/THM to 30 Kg/THM	**-10**				**-10**
Increase in Green H2 from 30 Kg/THM to 50 Kg/THM		**-15**			**-15**
Blast Furnace Top gas recycling by carbon capture and utilization (CCU)			**-10**		**-10**
Adoption of New Technology like HyCROF (Hydrogen-enriched carbon cycle and oxygen furnace),,Blue BF,Syngas etc..,				**-120**	**-120**
Total Reduction					**-155**



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