National Seminar on

“Recent Advances in Blast Furnace Operation"

Bokaro Steel City

30 November 2013

PC Series chute transmission gearboxes

Why a new generation of chute transmission gear ?

Provide a “no-worries” package…

… Sturdier

- Resist toughest operational conditions
- Designed for large and largest size of blast furnaces

… Further reduced maintenance

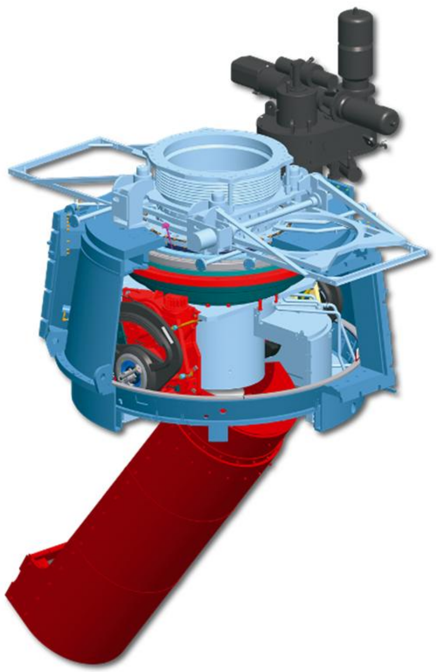
- Longer lifetime of chute tilting and planetary gear
- No maintenance on cooling elements

… Higher process flexibility

- 12 RPM rotation leading “finer” charging patterns
- Flow rates of up to $1.1 m^3/s$

While remaining interchangeable with existing chute transmission gears

The CTG G3 - Overview



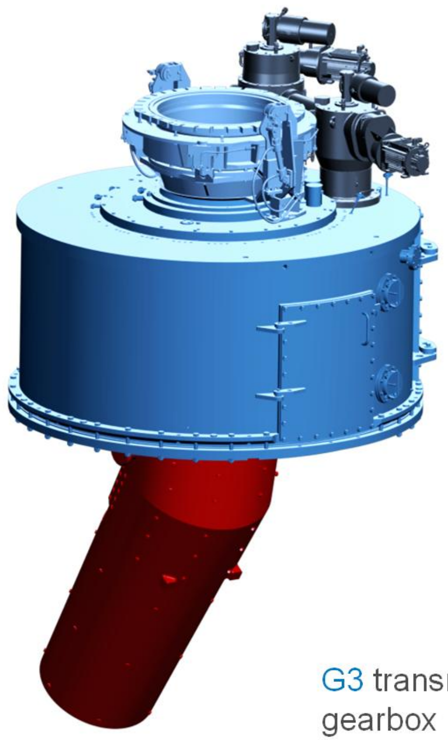
REINFORCED water cooled transmission gearbox

20 years after the introduction of the REINFORCED gearbox…

Better in any aspect

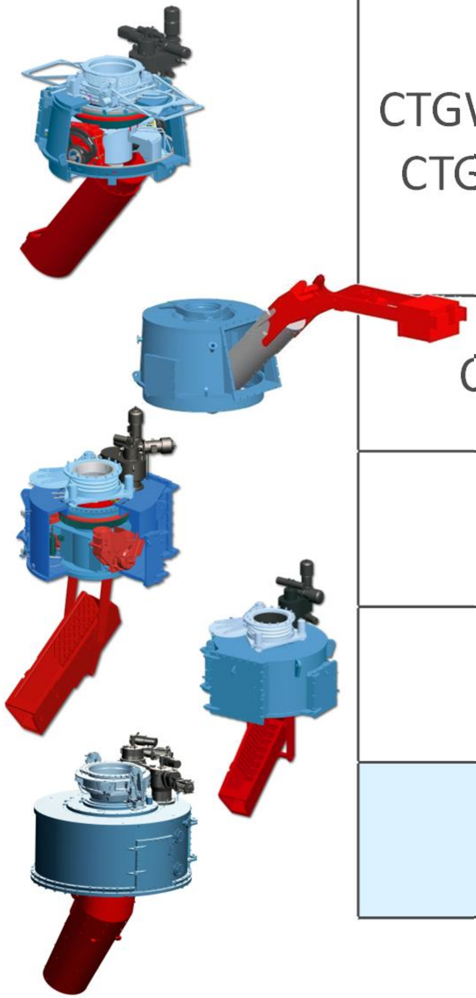
Improvements:

- High performance cooling: Closed cooling system & high efficiency cooling panels
- Enhanced greasing for distribution chute tilting gearbox



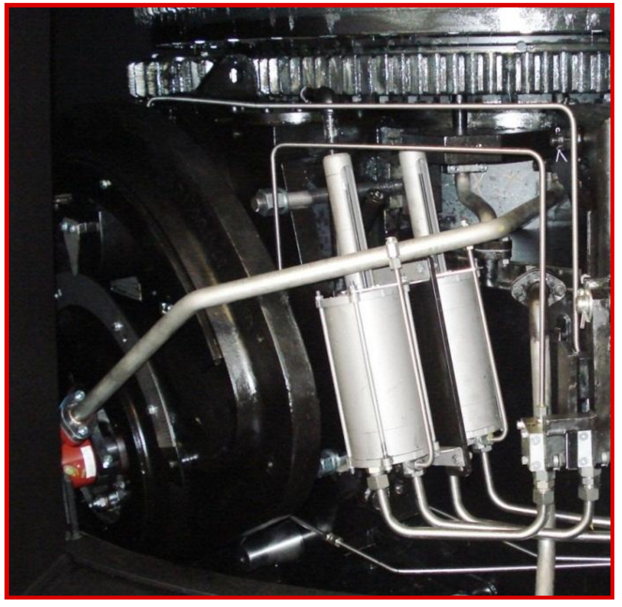
G3 transmission gearbox

The CTG G3 - Designed for roughest process conditions



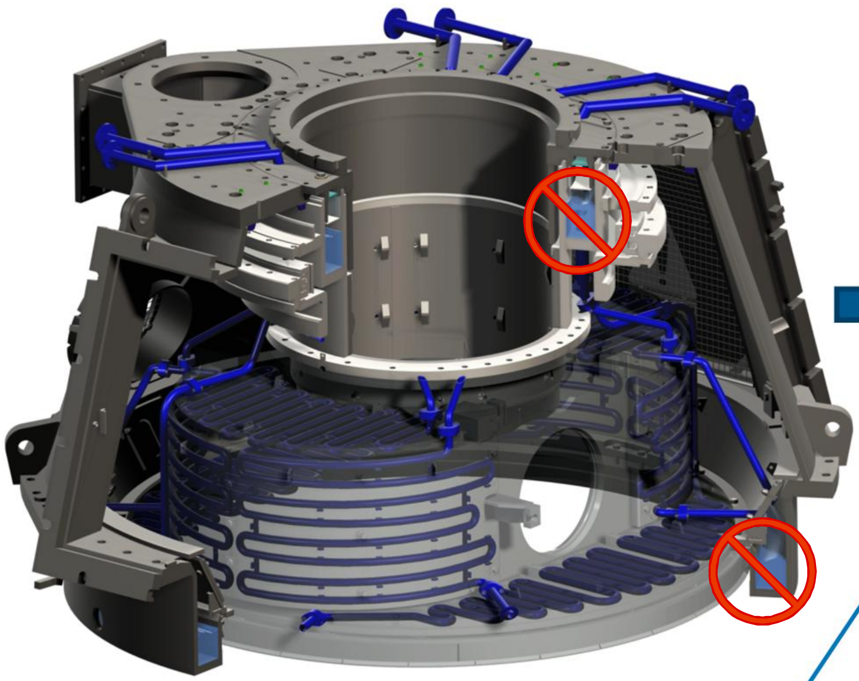
		Centre Top Temperature		
		Continuous	20x/year for 30’	20x/year for 10’
CTGWS & CTGWR	standard	450°C	600°C	750°C
	with PC™ cooling	500°C	600°C	900°C
CTG Compact		450°C	600°C	750°C
CTG Midi		500°C	600°C	900°C
CTG Mini		500°C	600°C	900°C
CTG G3		700°C	750°C	1000°C

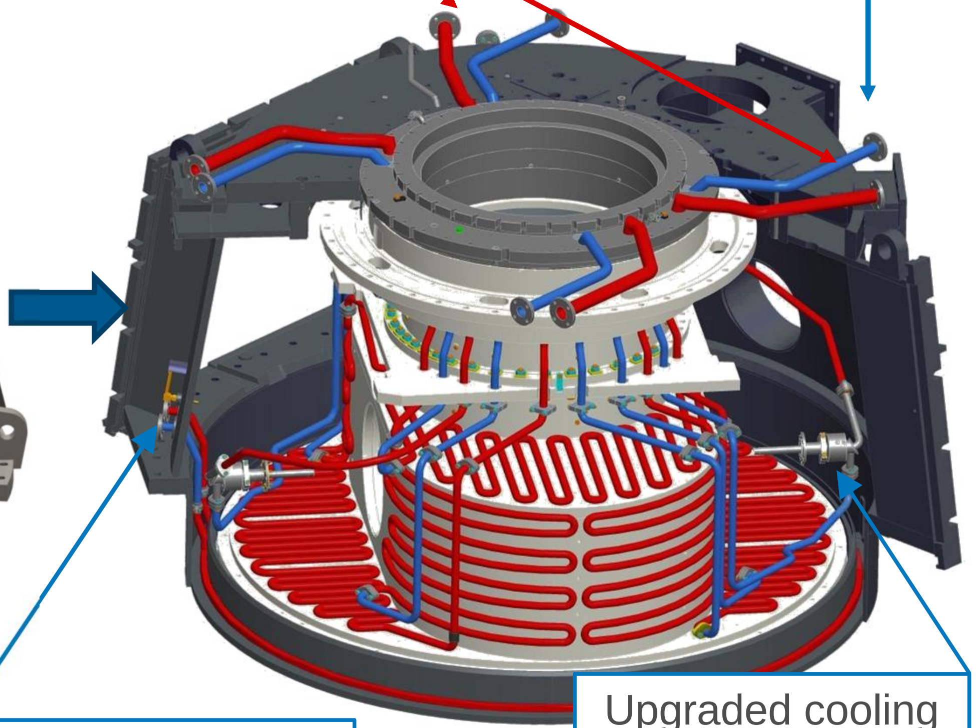
The CTG G3 - Greasing chute tilting gear

Classic greasing		G3 continuous greasing
		
Actuation after a given number of charging cycles 5 litres of grease 1 lubrication point per bush	**5X more grease** ⇨	Continuous greasing whenever chute is tilting upwards: least load acting on bushes 25 litres of grease Autonomy > 6months 4 lubrication points per bush

Conventional CTG cooling

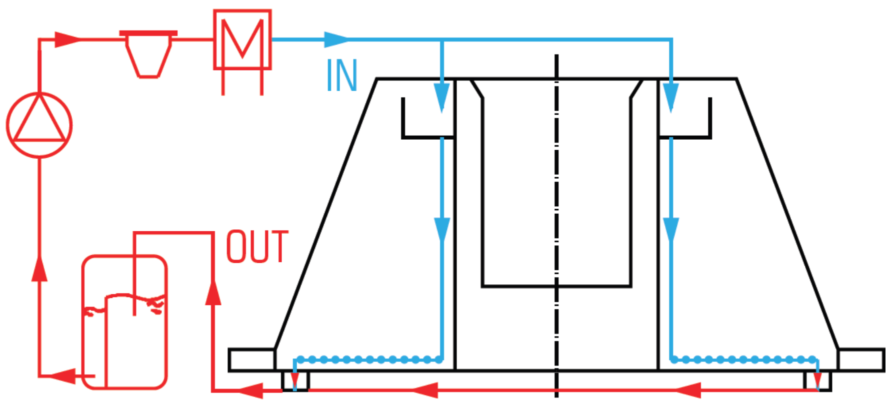
CTG-PC cooling closed loop cooling



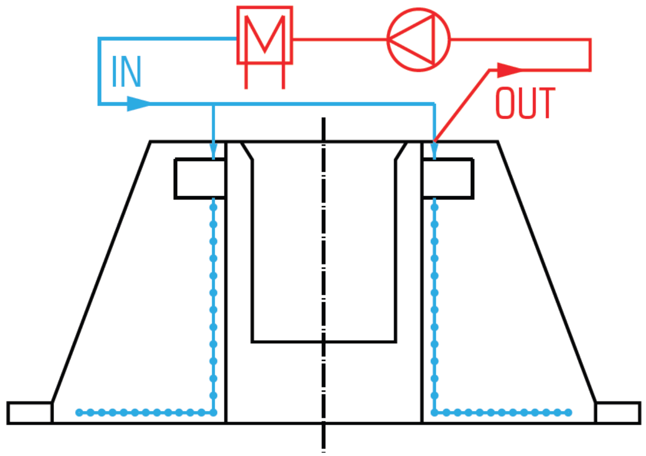


Pressurized cooling – Cooling flow rate

Semi-closed water-cooling



Pressurised water-cooling



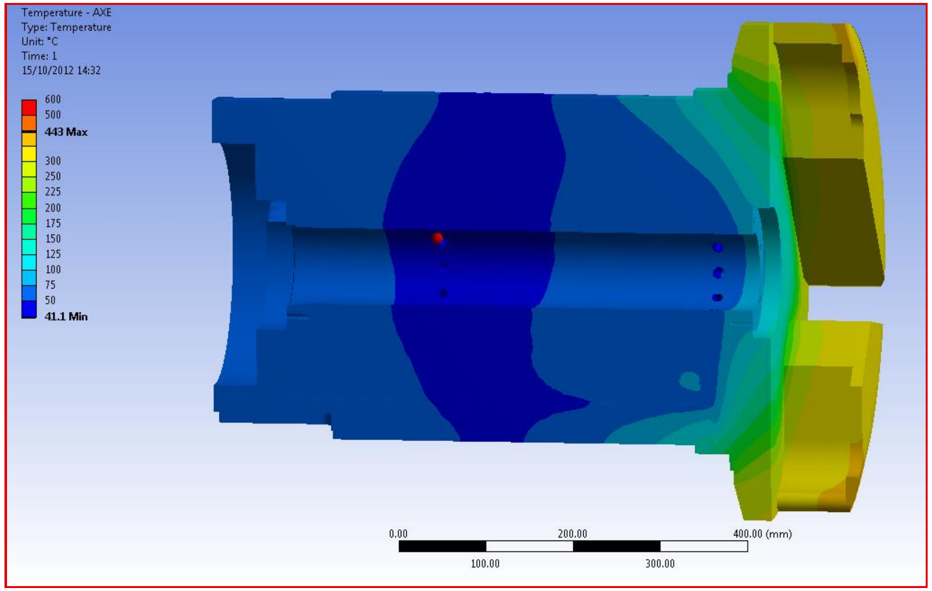
		CTG standard	CTG reinforced	CTG PC
Water	[m³/h]	20	25	70(*)
N_2	[Nm³/h]	200	200	200
P_{pump}	[kWh]	4-7,5	4-7,5	5

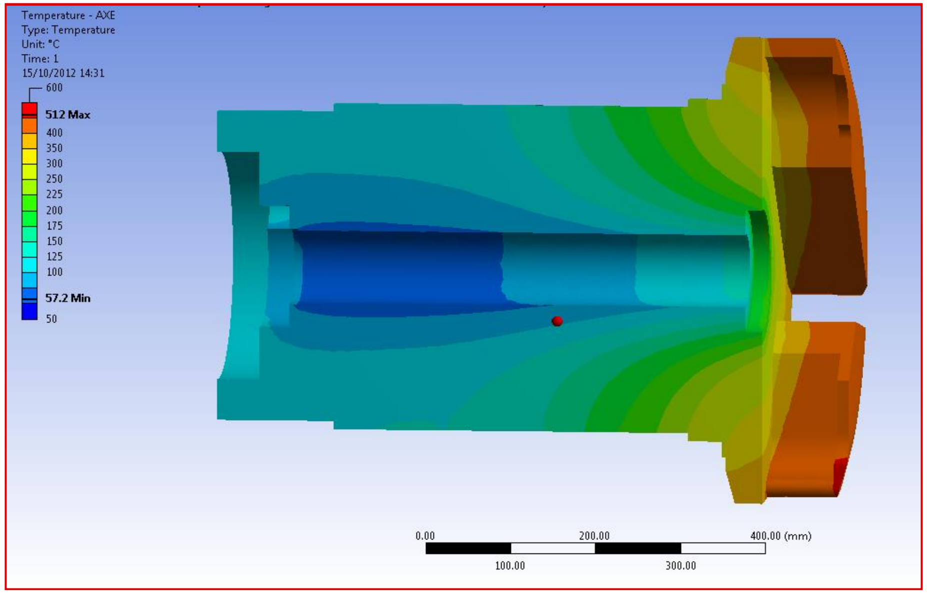
(*) S-cup: min 60m³/h, max 67m³/h
Lower trough: 3m³/h

Pressurized cooling – Chute tilting gear cooling

- New design of chute suspension axle
- Higher flow rate due to pressurized cooling provide

→ Optimal cooling of the shaft bushes leading to higher lifetime



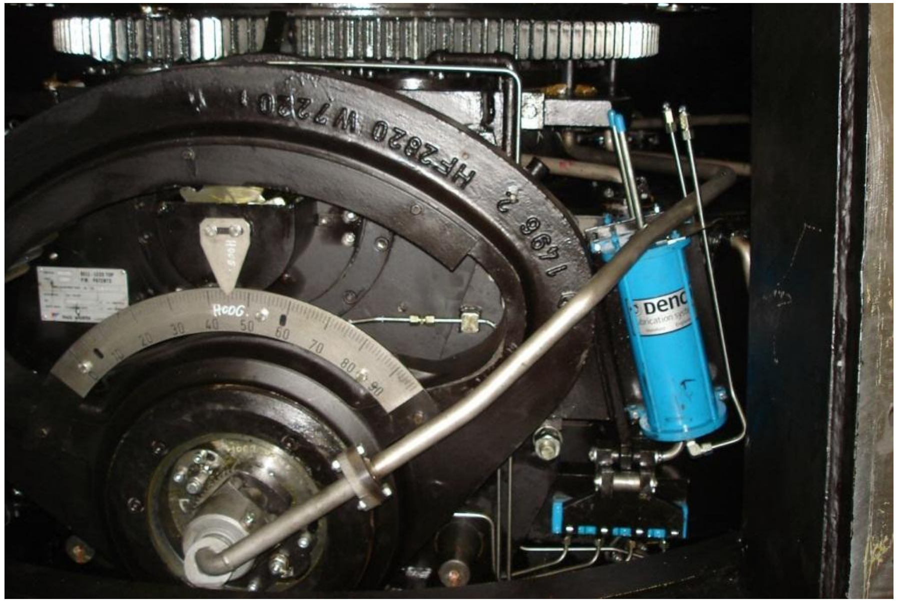


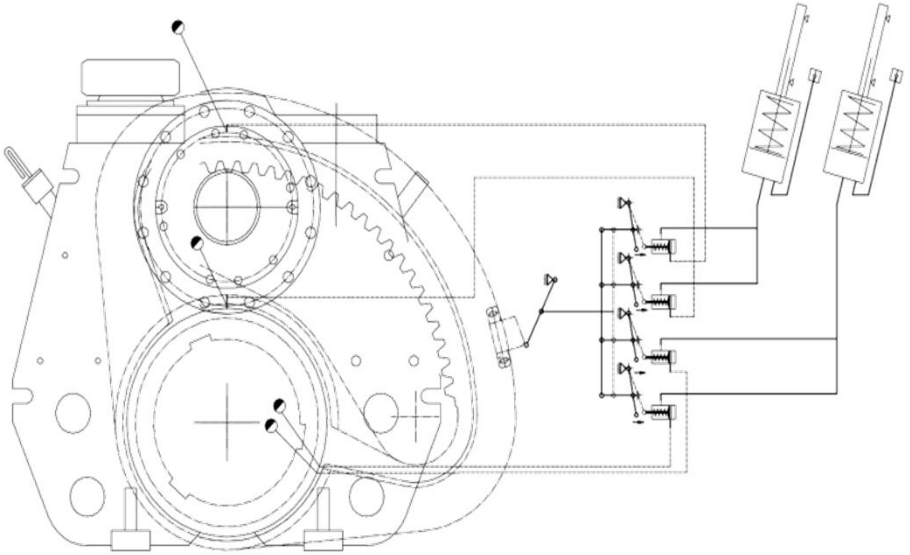
Pressurized cooling = Pump-driven closed loop

- No maintenance due to contamination of cooling water by blast furnace gas, dust or grease
- Reduced water consumption: 25 l/day vs. 1000l/day
- Longer lifetime of chute tilting gear
- Compact and simplified cooling circuit
- Existing gearboxes can be upgraded

→ **Minimized OPEX**

Continuous greasing – Old greasing system



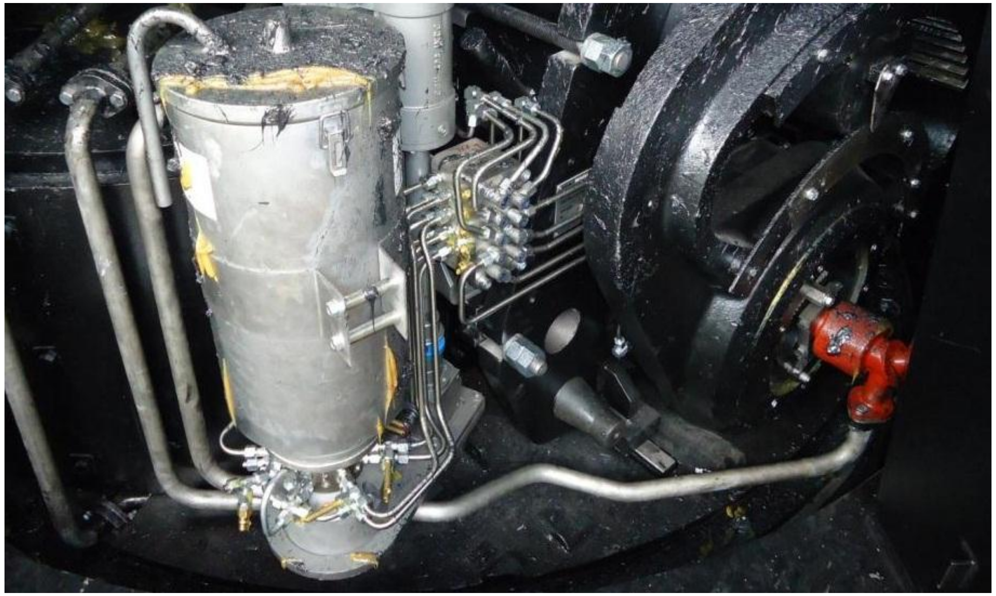


When the chute tilts to the greasing position (2°-3°), grease is sent to 4 lubrication points (2 on bushes)

Total grease tanks capacity is 5l for an autonomy of about 6months

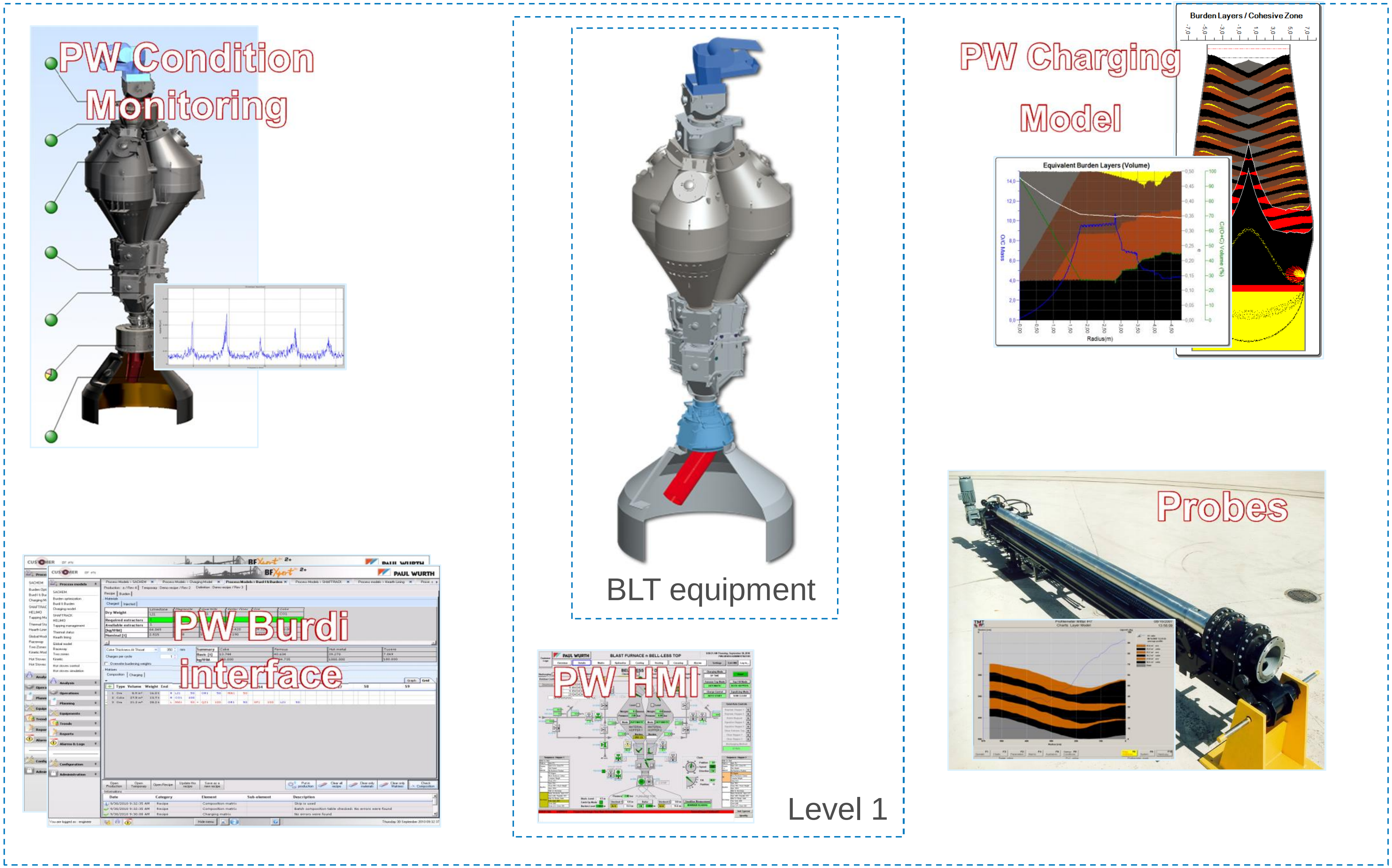
Grease tanks are not easily refilled

Continuous greasing – Continuous greasing system for CTG PC

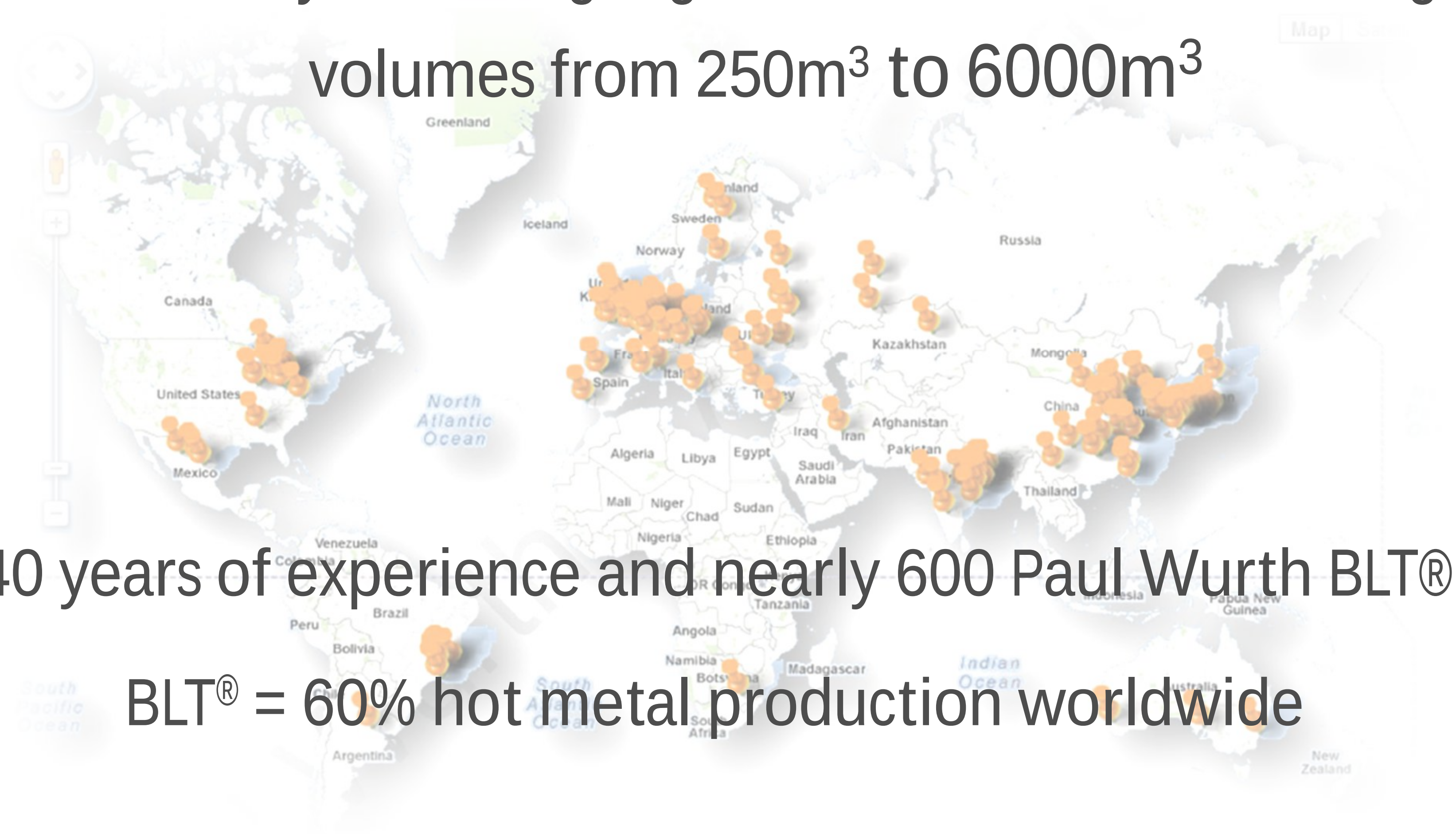


- Continuous greasing whenever chute is tilting upwards: least load acting on bushes
- grease is sent to 9 lubrication points (4+4 on bushes)
- Total grease tanks capacity is 25 (20) litres of grease for an autonomy of about 6 months

More than just hardware



“BLT® Family”, a strong argument for BFs with working volumes from 250m³ to 6000m³



40 years of experience and nearly 600 Paul Wurth BLT®

BLT® = 60% hot metal production worldwide

Thank you for your attention

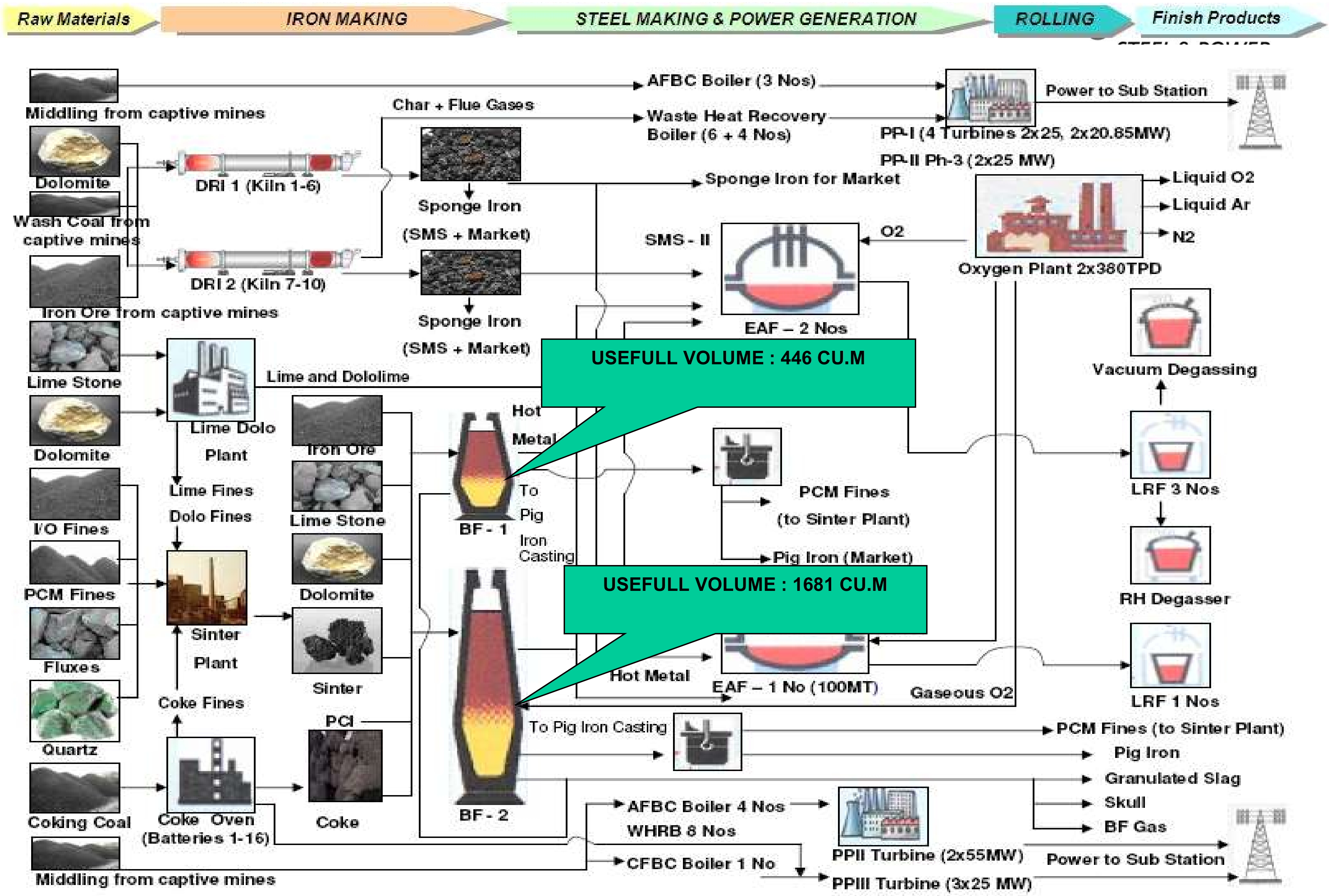
Danke für Ihre Aufmerksamkeit

Merci pour votre attention

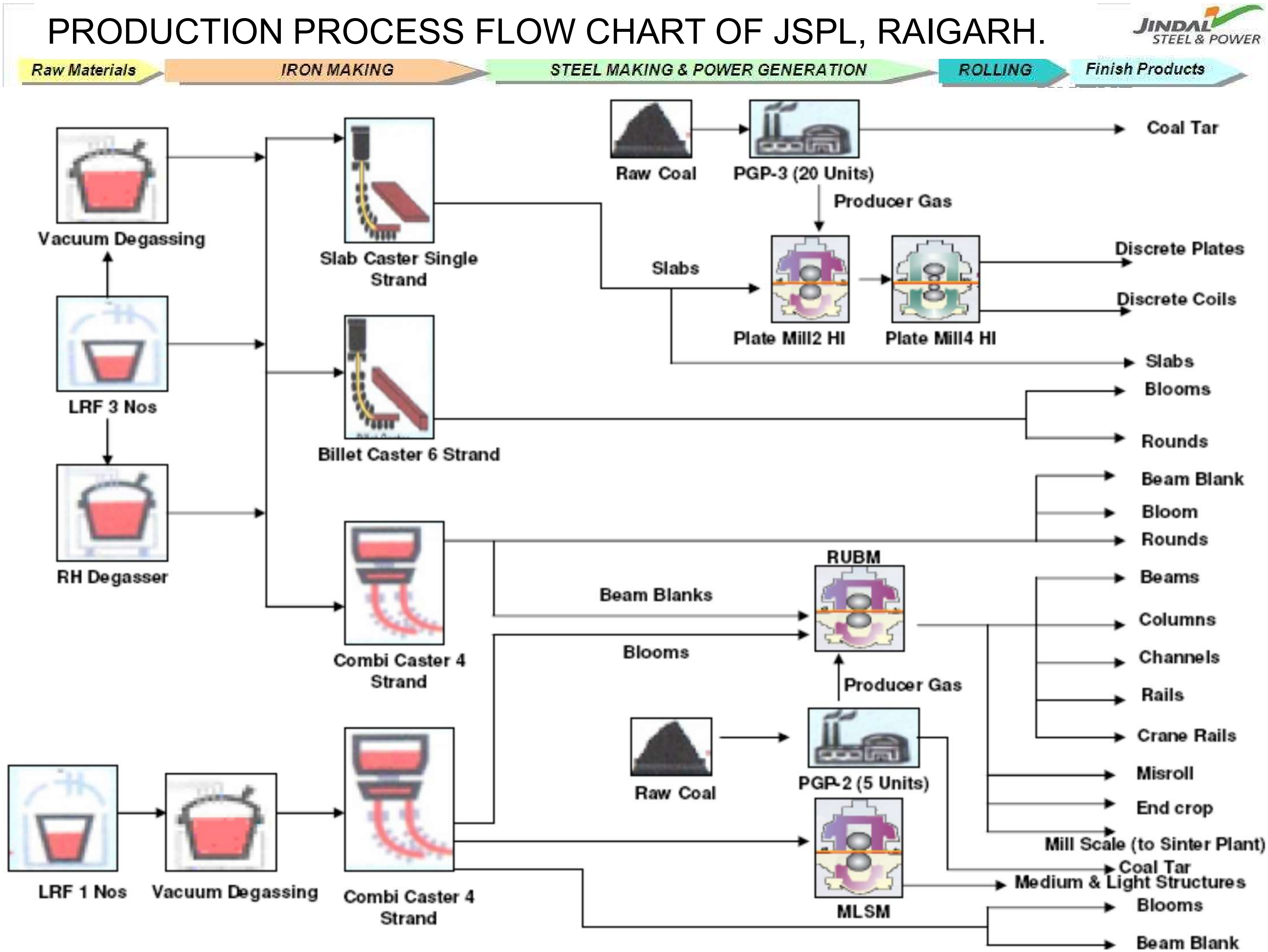
Process Optimization of Blast Furnace through Instrumentation & Control

Mr. A. K. Bhagat
Mr. A.S.Chauhan
Mr. J.K.Bhoi
Mr. Nitish Nevgi

PRODUCTION PROCESS FLOW CHART OF JSPL, RAIGARH.



PRODUCTION PROCESS FLOW CHART OF JSPL, RAIGARH.



Process Improvisation at Blast Furnace through Instrumentation & Control

1) Furnace proper and Furnace top equipment's .

- Escalation of RADAR for uninterrupted charging

2) Water Circuit

- Relocation of Magnetic Flow Meter transmitter to enhance monitoring
- Use of Wireless Technology for efficient monitoring of raw water.

3) Pulverized Coal Injection

- Uninterrupted pulverized coal injection by revamping flow meter of transport air line.

4) Stock House

- Precise coke control by using moisture gauge

1) Relocation of Magnetic Flow Meter transmitter to enhance monitoring

System Description

- 80 numbers of magnetic flow meter are used in high pressure and low pressure

- Installed in supply & return water line

- Installed above the tuyeres, tap holes, Bustle main and emergency dry slag pit

.

Defining the Problem

- Inappropriate function of Flow Meter

- Unable to detect the Tuyere Leakage

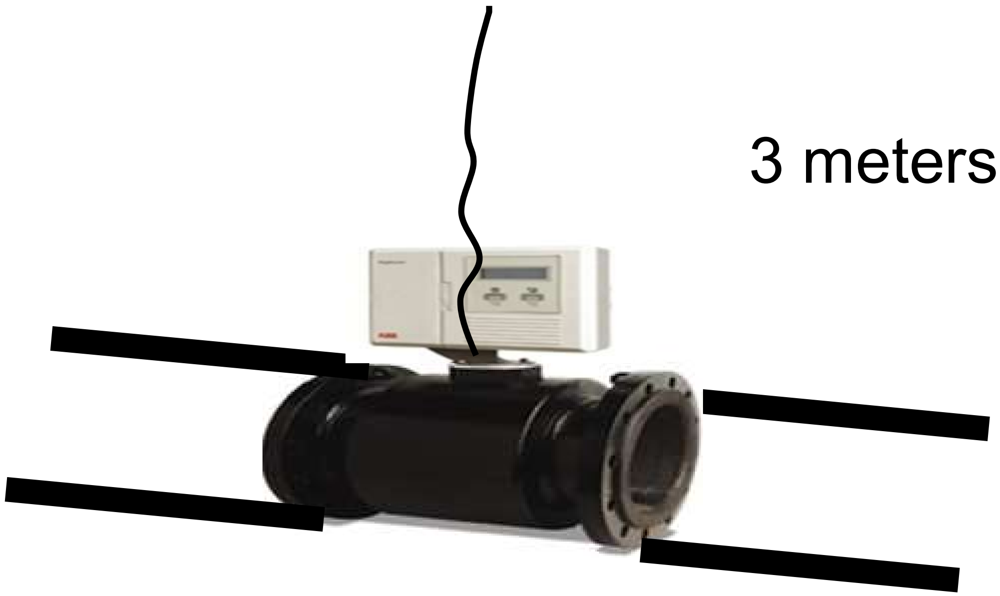
Analysis

- Transmitter malfunctions

- Located in High Heat zone

Solution…

- Covered with asbestos cloth
- Exhaust fan for cooling



Solution

- Sensor and Transmitter separated.
- Communication up to 3 m with instrument cable
- Communication up to 100 m with special communication cable
- Relocated to moderate heat area
- Relocated up to 30 m

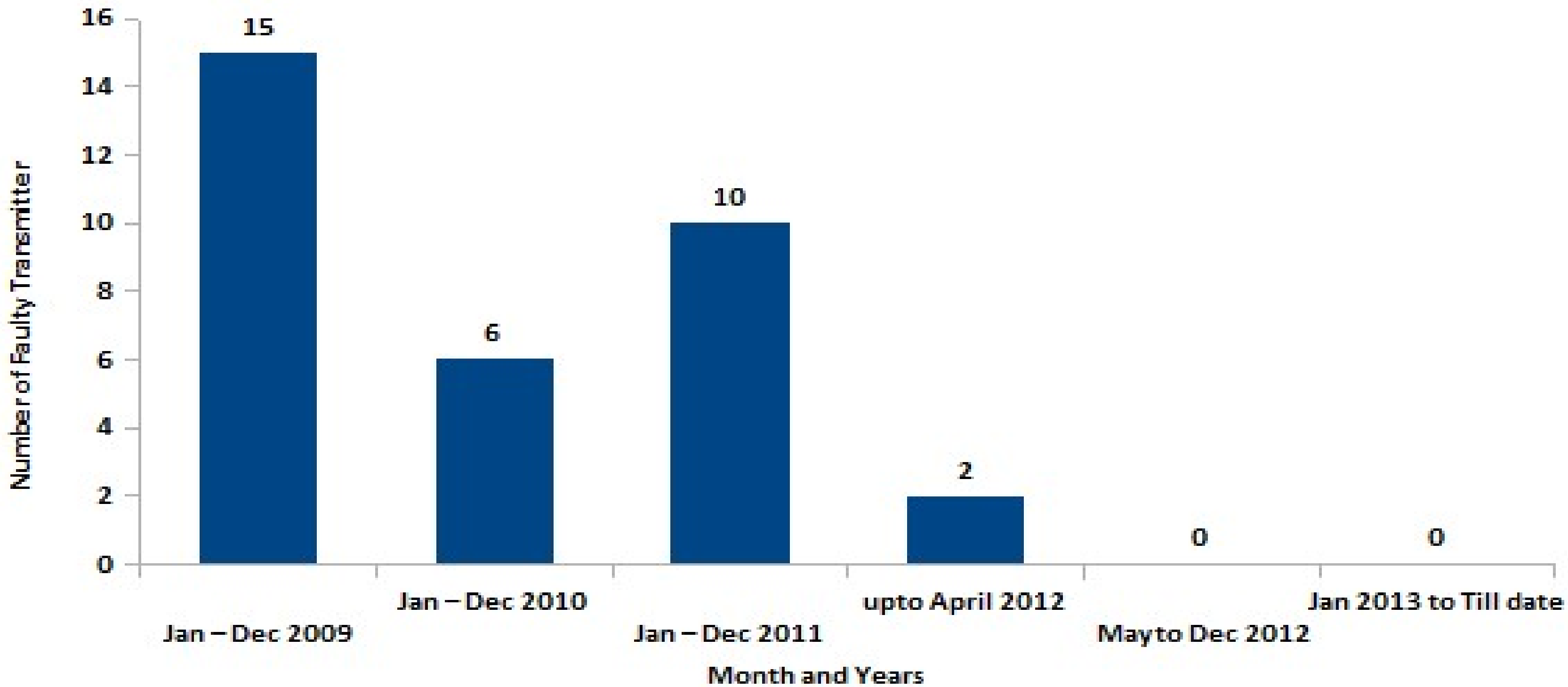
Before

After

Benefits

Failure rate reduced

Easily approachable



2) Escalation of RADAR for uninterrupted charging

Defining the Problem

- Radar showing incorrect level

- Nucleonic level gauges malfunction

- Delay in charging

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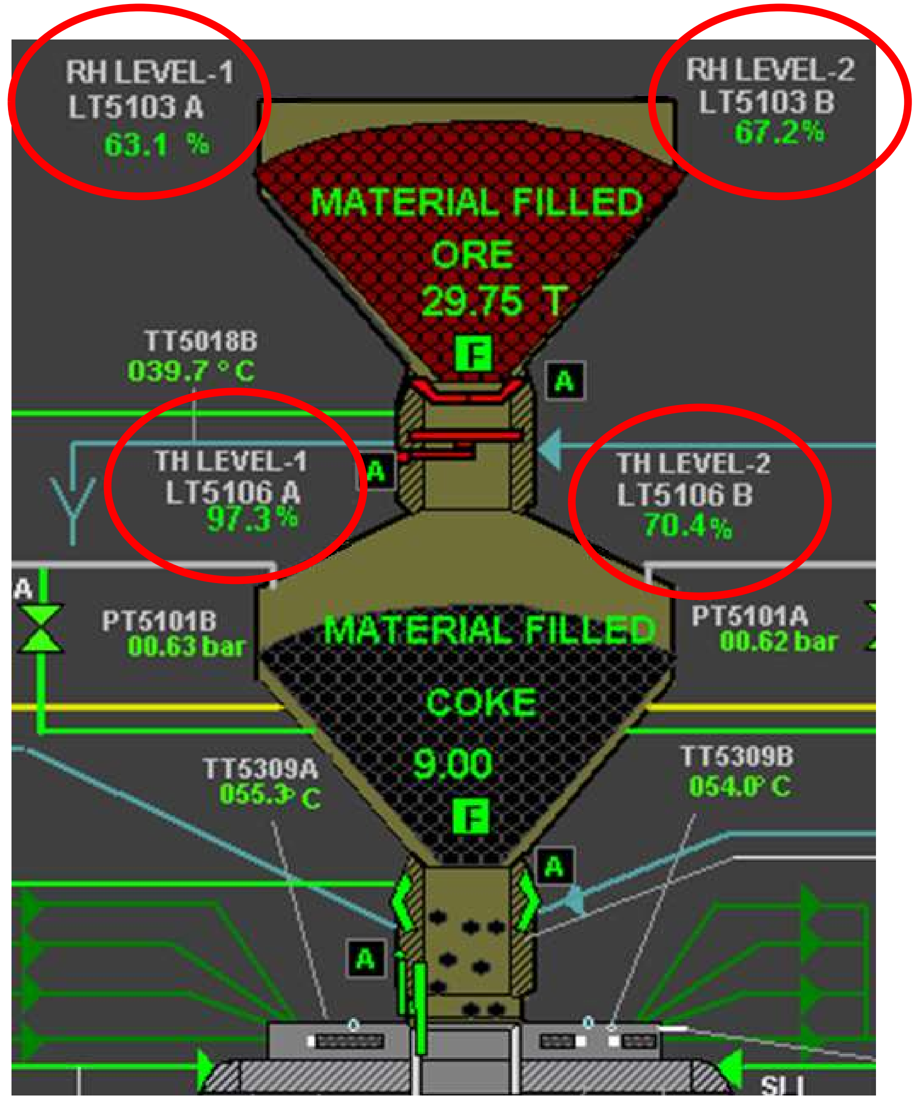

Analysis

- Dust deposition at Radar
- No provision for purging
- Low frequency (6 GHz) of Radar

Solution

- Radar of Higher Frequency 26 GHz

- Continuous air purging

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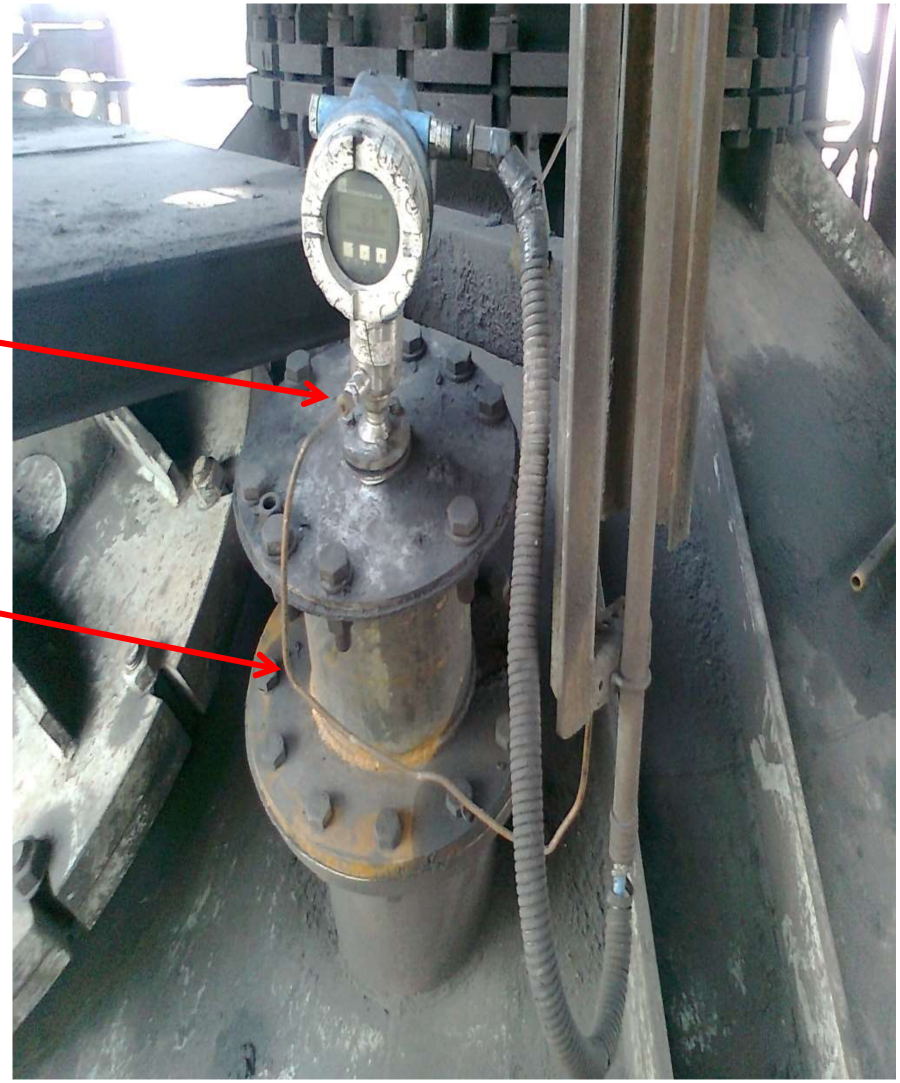
- Spool piece

- Development in logic



Results

- Smooth charging

- Continuous monitoring of Level of material in Hopper.

- Availability of “Nucleonic Level Switch” for maintenance

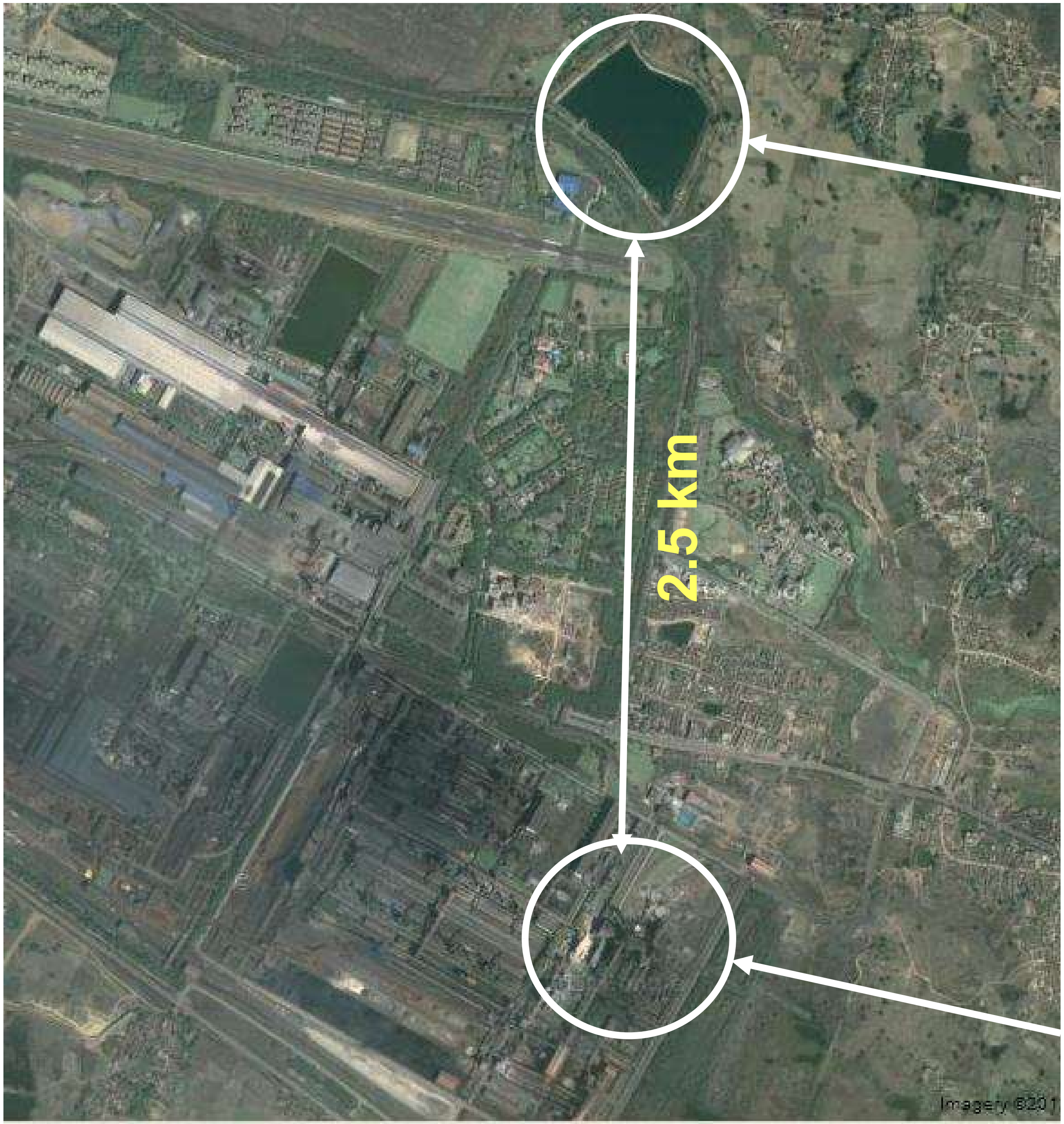
3) Use of Wireless Technology for efficient raw water monitoring

Problem Description

- No feedback of raw water flow at Blast Furnace

- Reservoir 3 Km away

- Flow monitored by operator



Reservoir

Blast Furnace

Solution

Installation of Flow measurement instrument at Maan Sarover pump house.

1) Orifice plate

2) Differential pressure transmitter

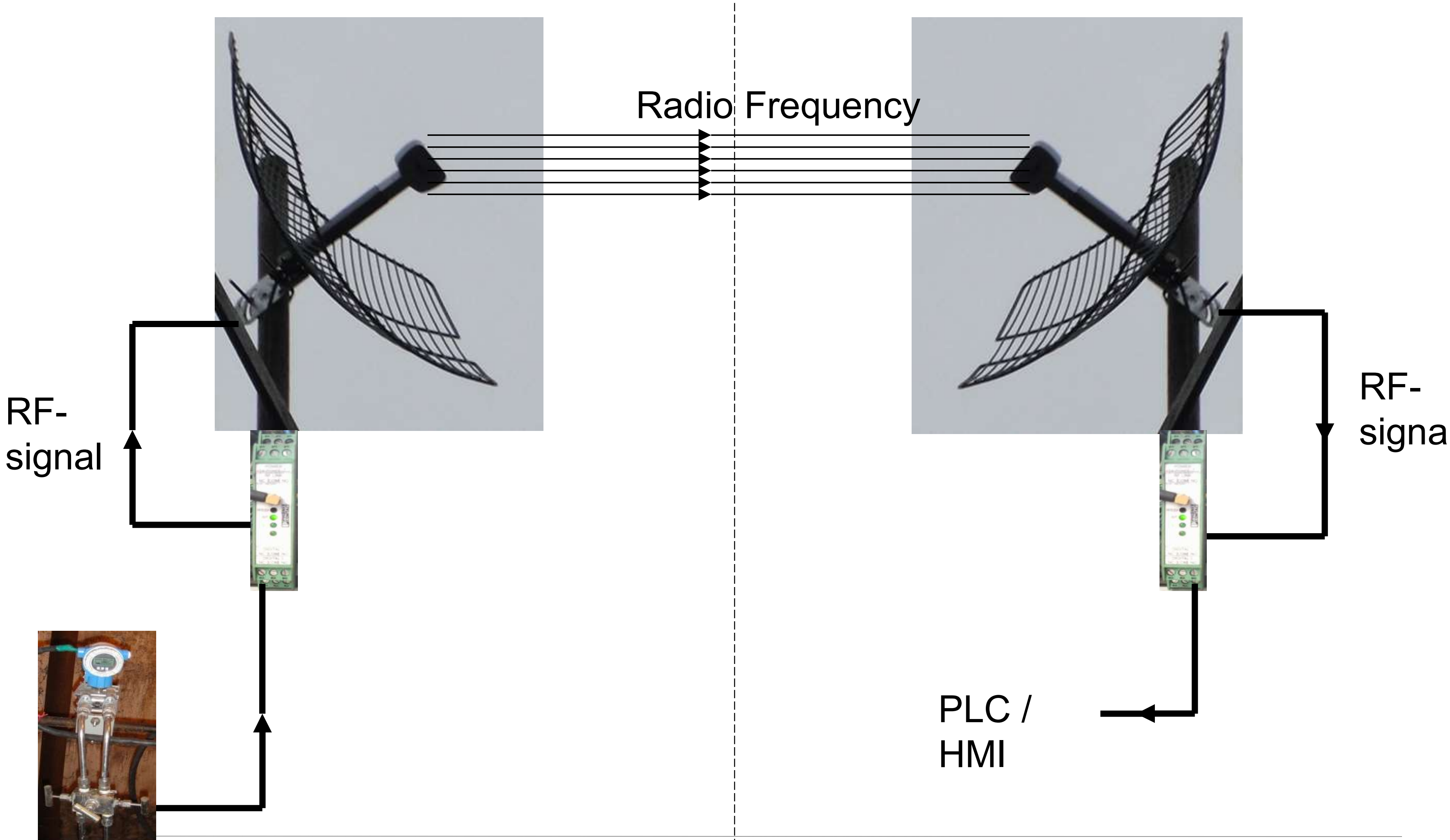
Flow Transmitter

Orifice Plate

Solution

- Unable to lay instrument cable
- Use of wireless (Radio Frequency) Technology for Data Transmission
- Installation of transmitting antenna at Maan Sarovar
- Installation of receiving antenna at Blast Furnace-2
- Installation of signal converters at both ends.

Reservoir end Transmitter | Blast Furnace-II end Receiver



Benefits

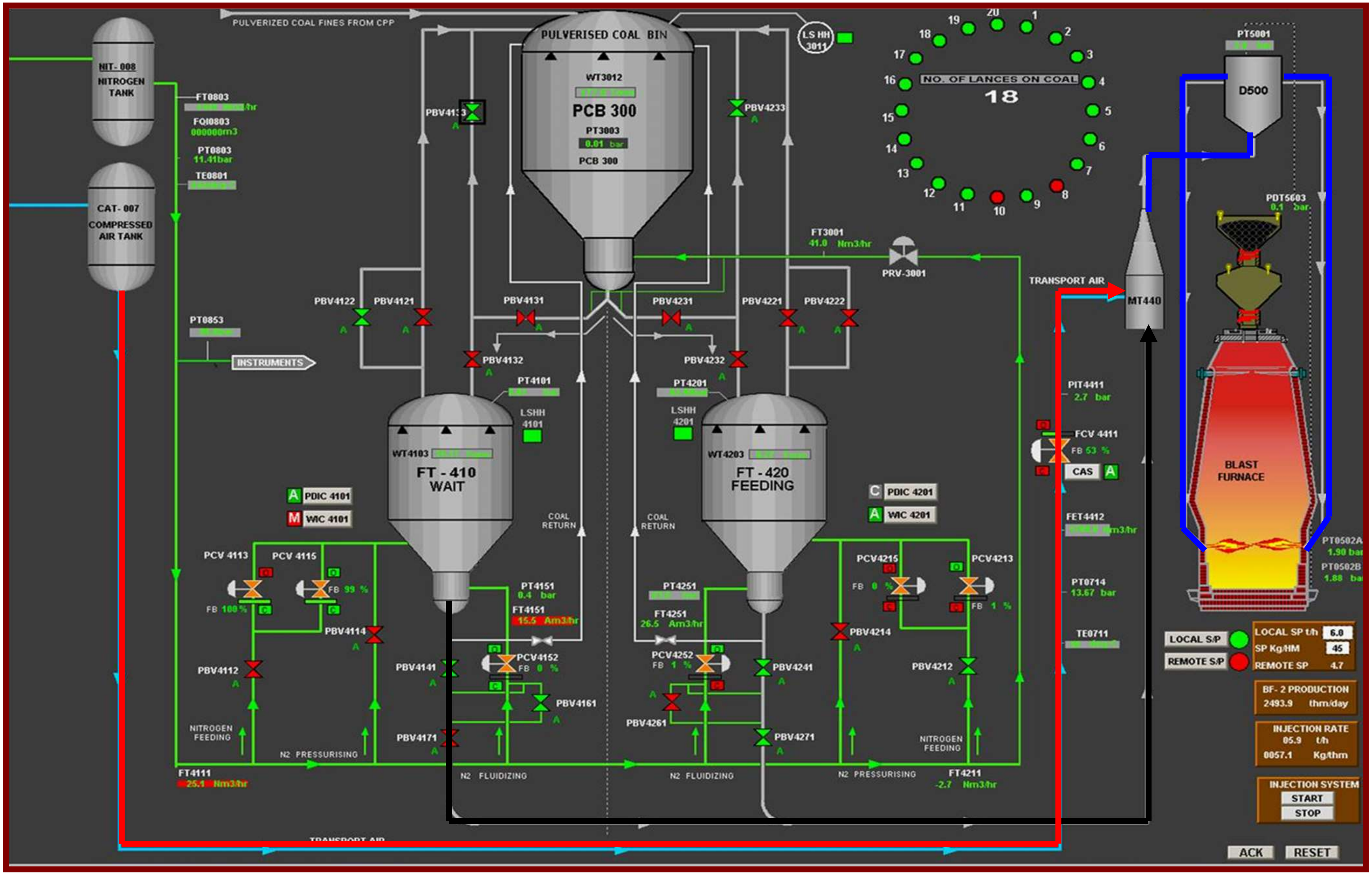
- Continuous monitoring of Raw Water flow.
- Reduces man power cost
- Running status of pump can be predicted.
- Easily detect the line leakage

4) Enhanced pulverized coal injection by revamping flow meter of transport air line.

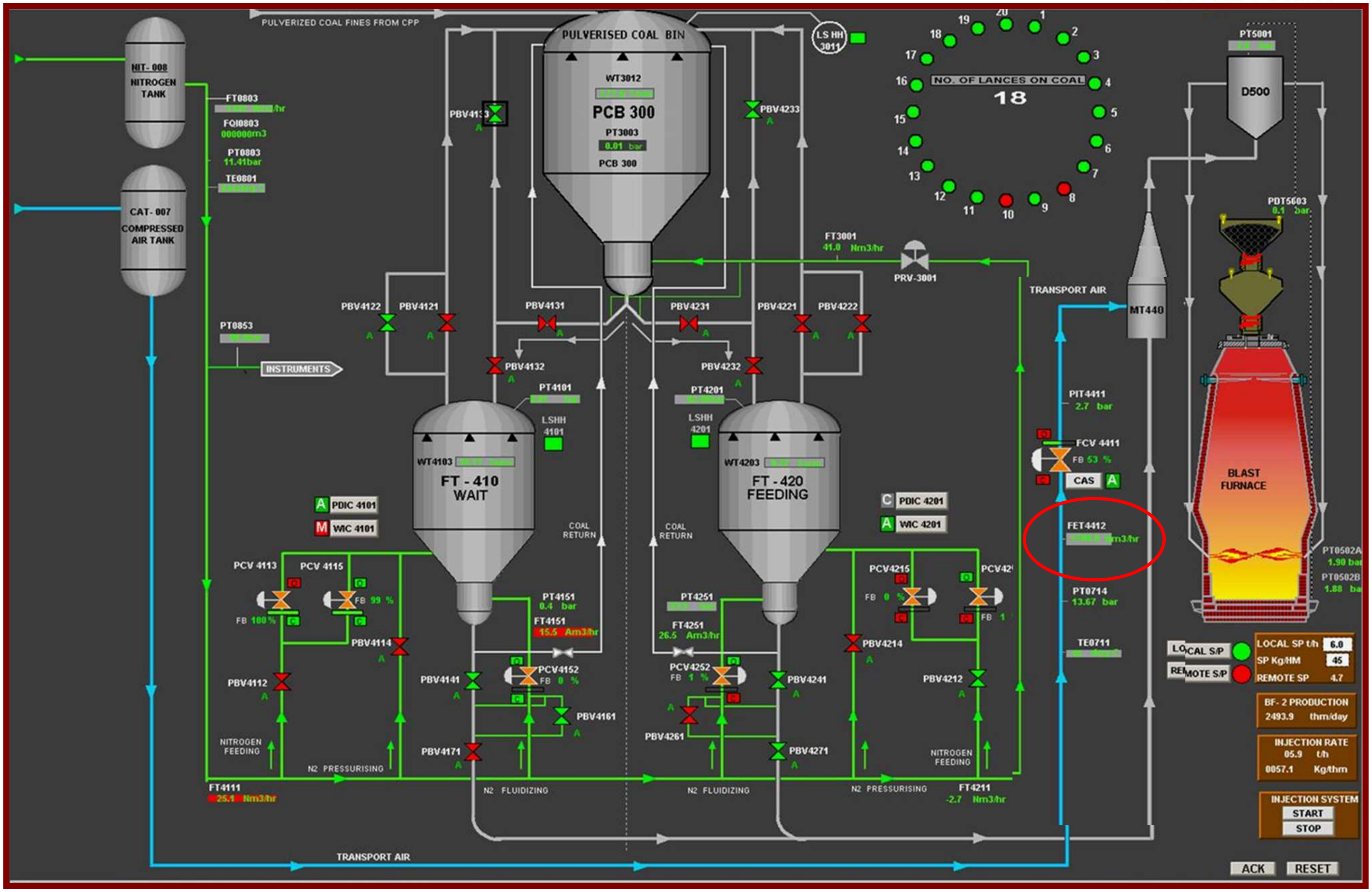
Defining the Problem

- Vortex flow meter was used in transport air line.
- Vortex flow meter showing inappropriate flow
- Disturbed pulverized coal injection
- Increase coke consumption

System Description



System Description



Analysis

- Sensor inappropriate behavior-
  a. Coal Dust
  b. Moisture
  c. Vibration

- Support is provided

- Drain point is provided at main pipe line

Solution

- Orifice plate as primary element.

- Differential pressure type flow meter as secondary element.

Results

- Break down minimized.

- Uninterrupted PCI injection

5) Moisture measurement for precise coke control

Defining the Problem

- Online monitoring moisture

- Variation in coke moisture reading

Neutron Moisture Gauge

Solution

- Material always present in front of sensor

- Partially Filled Weigh Hopper

- Relocated at Coke Bunker

Coke Bunker

Moisture Gauge

Benefits

- Moisture reading of each bunker

- Accurate coke compensation

BF-II Performance:2012-13

S. N.	Parameters	Unit	Period	Value
1	Highest Monthly Production	mt	Mar-13	128373
2	Highest Day Production	mt	25-Mar-13	4574
3	Highest Daily Production Rate	mt	Mar-13	4141.00
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5	Highest Yearly Productivity	$mt/m^3/d$	2012-13	2.76
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7	Lowest Yearly Coke Rate	kg/thm	2011-12	343.46
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11	Lowest Yearly Fuel Rate	Kg/thm	2012-13	510.86
12	Lowest Monthly Fuel Rate	kg/thm	Oct-11	496.53
13	Highest Monthly O_2 Enrichment	%	Mar-13	7.05

Thank You !!!!!!

Advance Performance Facilitators for 1681-m^3 Blast Furnace in Jindal Steel & Power Limited, Raigarh

Arvind Kumar Bhagat & B.K. Pandit

JINDAL STEEL & POWER

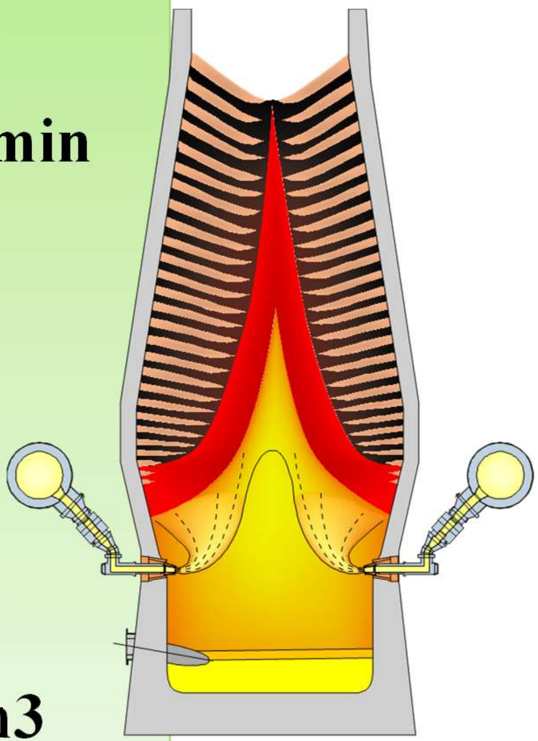
What Advancement?

Going ahead with Sustainable Value addition for

- **Enhanced Performance.**
- **Reduced Cost.**
- **Improved Quality parameters as desired.**
- **Ensuring Safety.**
- **Clean Environment.**
- **Alignment of all stakeholders.**

Furnace Features

• Working Volume	:	1462 m3
• Max Blast Flow	:	2660 Nm3/min
• Max Blast pressure	:	3.2 bar
• Max Blast temp	:	1250 0C
• Max top pressure	:	1.5 bar
• Rated production	:	3625 t/day
• Productivity	:	2.5 t /day/m3



Infrastructure Facilities

1. **Hoogoven stoves to provide hot blast temp up to 1200 0C.**
2. **Bell-less rotary charging unit (TOTEM) for effective burden distribution.**
3. **Coal preparation and injection system to inject PCI up to 250 kg/thm.**
4. **Close-loop cooling water circuit.**
5. **Waste heat recovery system to help increase hot blast temp.**
6. **Air-cooled cast house troughs.**

Bell-less Rotary Charging Unit

An un-conventional Charging Unit supplied by M/s. TOTEM Co. Ltd

1. The distribution of material is in flared manner through five flowered vanes.
2. Soft discharging of material that keeps revived the profile of preceding batch.
3. Better & uniform distribution of material throughout the cross section by varying speed of rotor.

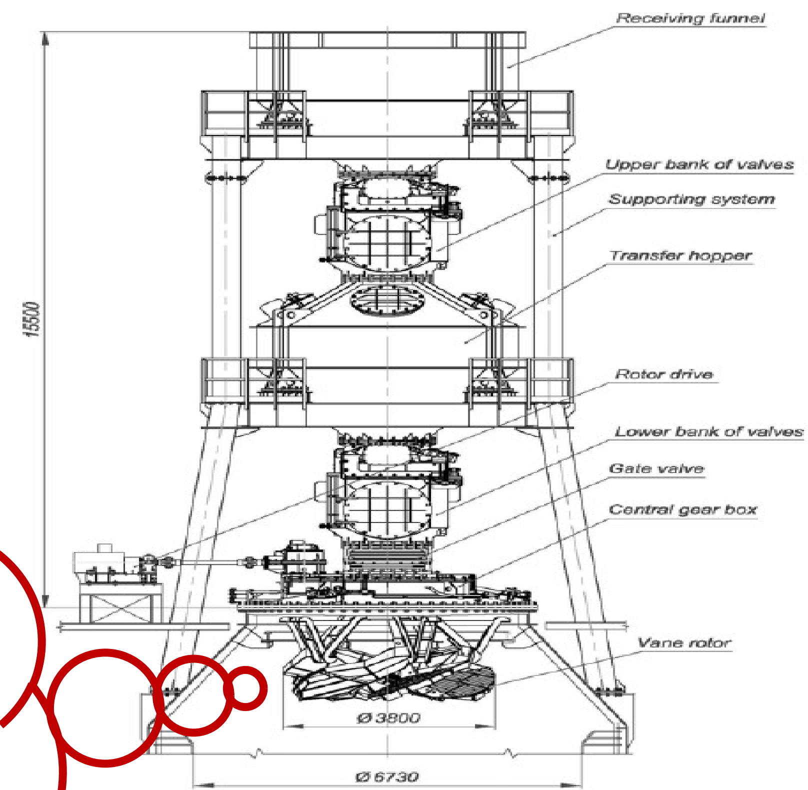
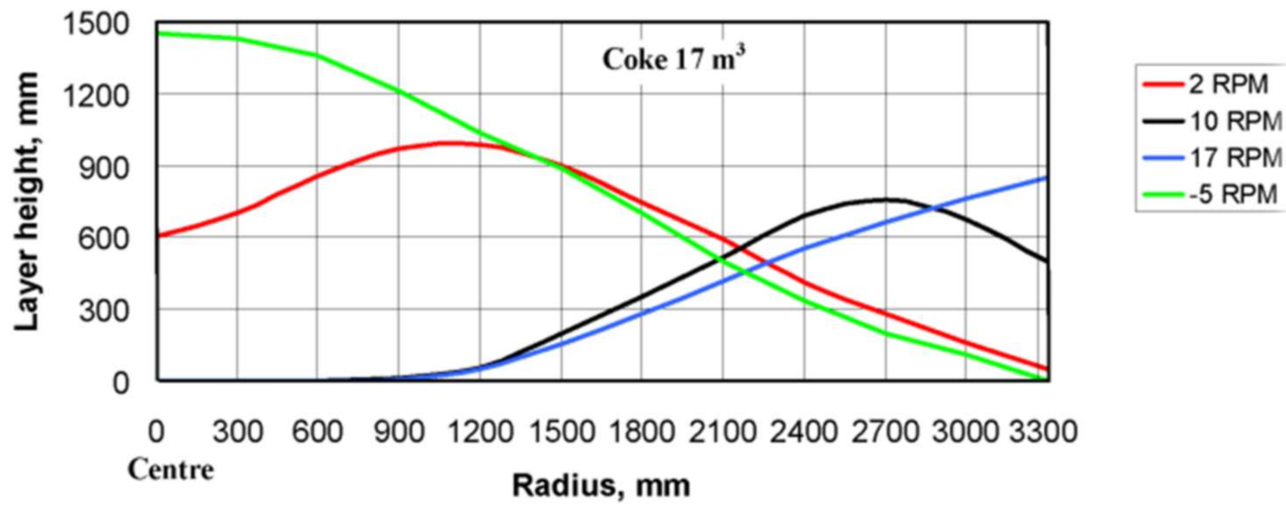


Figure 1 General view of BRCU

BRCU cont.....



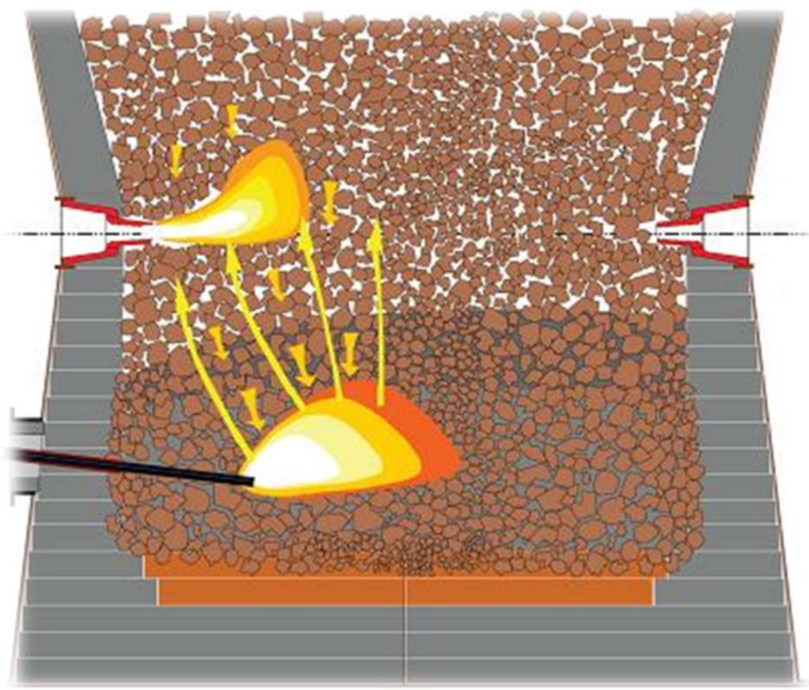
Material	R_1	R_2	R_3	R_4	R_5	R_6
C		100				
O				50	50	
C		40	30	20	10	
O				50	50	
C		40	30	20	10	
O				50	50	
C		40	30	20	10	
O				50	50	

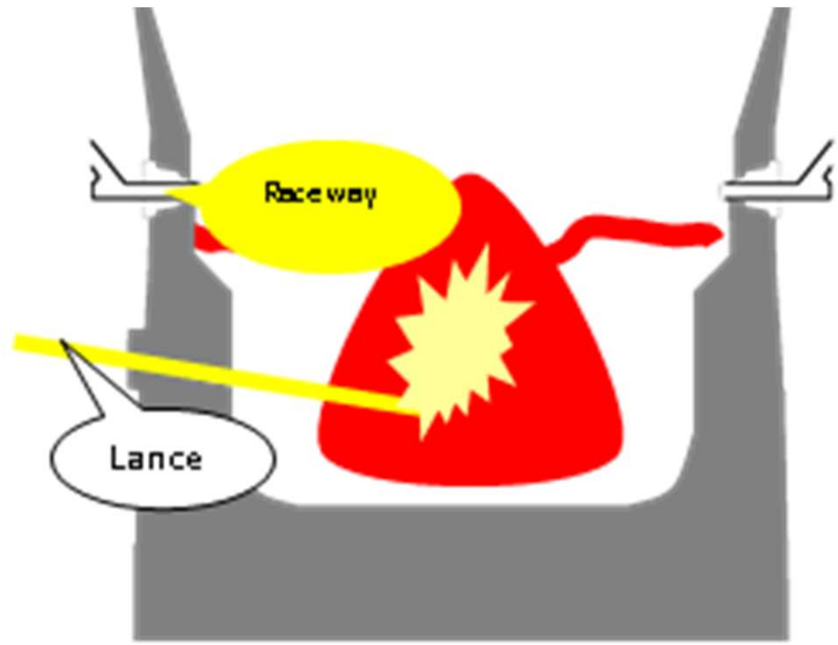
Segregating coke properties

1. Earlier JSPL coke ovens would produce single quality coke with CSR ~ 65 and CRI ~25.
2. As JSPL BF-I (446 m3) restarted after modernization need for different quality coke was envisaged for both the furnaces keeping following points in mind.
   a) Though there is no direct established relation between pulverized coal injection rate and CSR/CRI of coke, but considering the separate design and operational parameters , it was decided to fix higher coke strength for BF-II and bit lower but adequate strength for BF-I.
   b) Both the furnaces were being operated not only at different production level but also with different parameters such as oxygen enrichment, pulverized coal injection, hot blast temp.
3. Accordingly, in coke ovens, around 20% ovens were planned to produce coke for CSR- 62 and CRI- 28 whereas rest 80% were operated with target of CSR-66 & CRI- 24.
4. Above system has helped in maintaining good gas permeability and in enhancing pulverized coal injection.

Oxy-lance for furnace revival

In bigger furnaces, after getting chilled, the conventional process of lancing through tuyeres alone is not effective for revival. Thus an innovative idea, to access the most hot and permeable part of hearth i.e. the coke pile of dead man, is now adopted. The idea is to burn the dead man coke, by supplying O_2 directly there, to generate enough heat to melt the metal / slag in hearth to make passage for connection of tuyeres with tap hole.

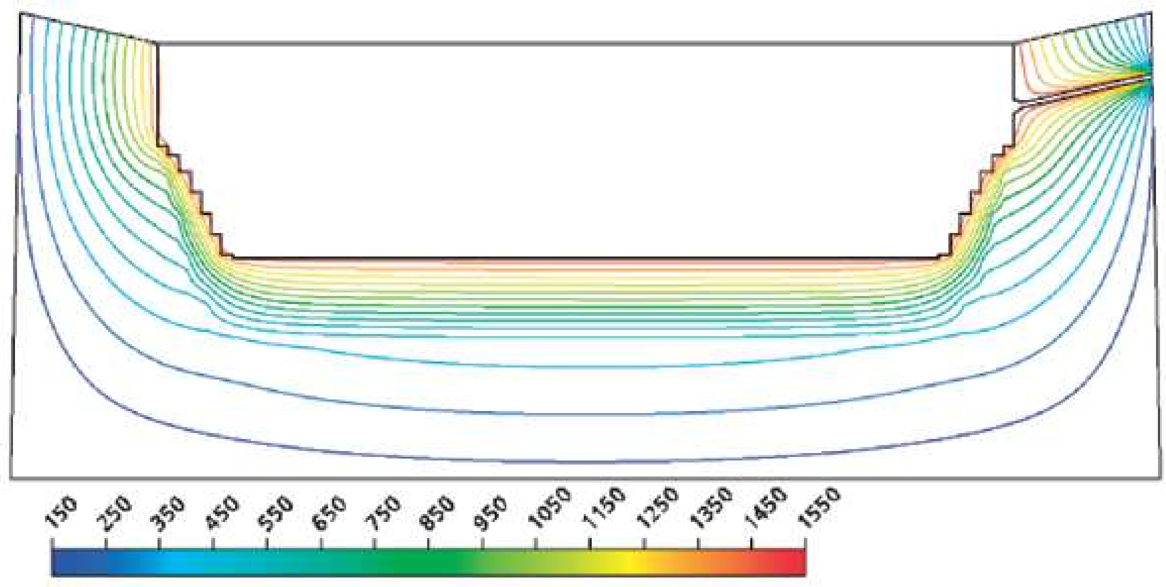




Hearth Monitoring System

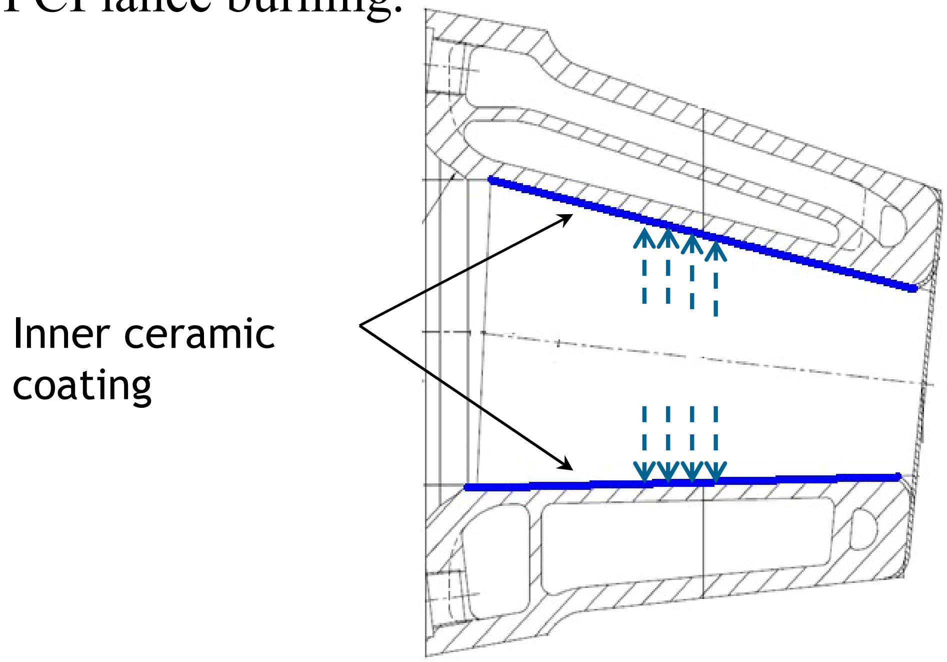
A computer simulation based on temperature data from hearth thermocouples and refractory properties, to monitor :

1. Temperature trends and heat flux.
2. Isotherm monitoring to understand wear-profile.
3. To understand formation of protective scab that may help for prolonged hearth life.



Refractory Coated Tuyeres

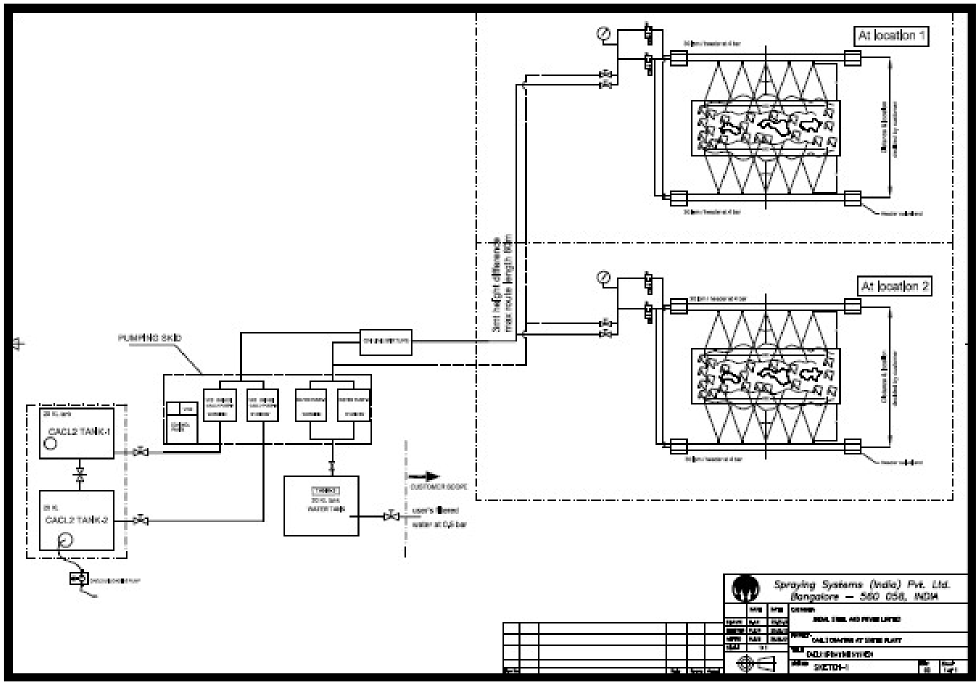
A 10 mm thick SiC coating is provided at the inner surface of tuyeres to reduce heat loss with water and thus to enhance hot blast temp just in front of the tuyere. Additionally it provides protection to tuyere from abrasion from displaced coal jet due to PCI lance burning.



Composition of the lining material					
Al_2O_3	CaO	Fe_2O_3	Na_2O	SiO_2	Others
95.5	3.6	0.2	0.2	0.1	0.4

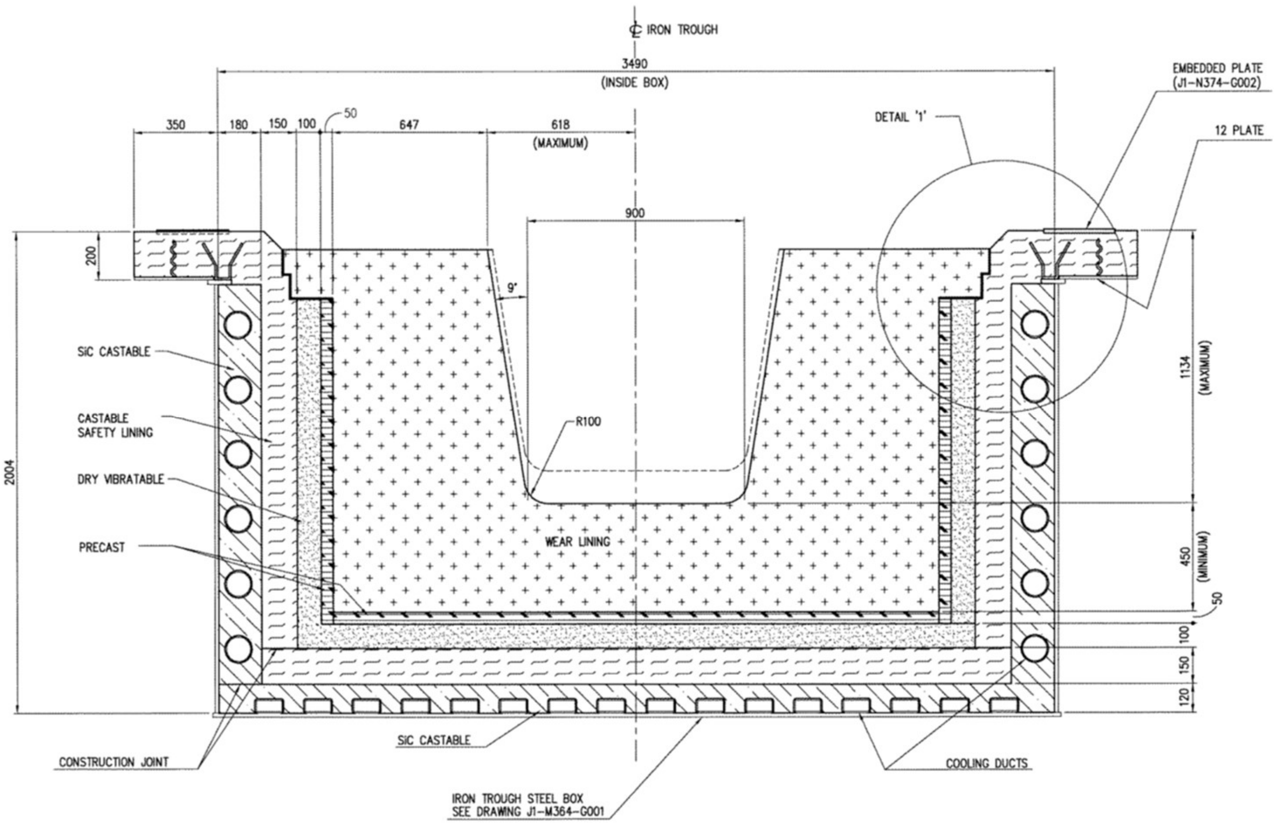
$CaCl_2$ spraying on sinter

A $CaCl_2$ spraying arrangement was installed in sinter plant. For $CaCl_2$ concentration of 30-35 gm /ton of sinter with water spray 30 ltr/min on the product sinter conveyor the average RDI reduced was to 23-26 from 35-40.



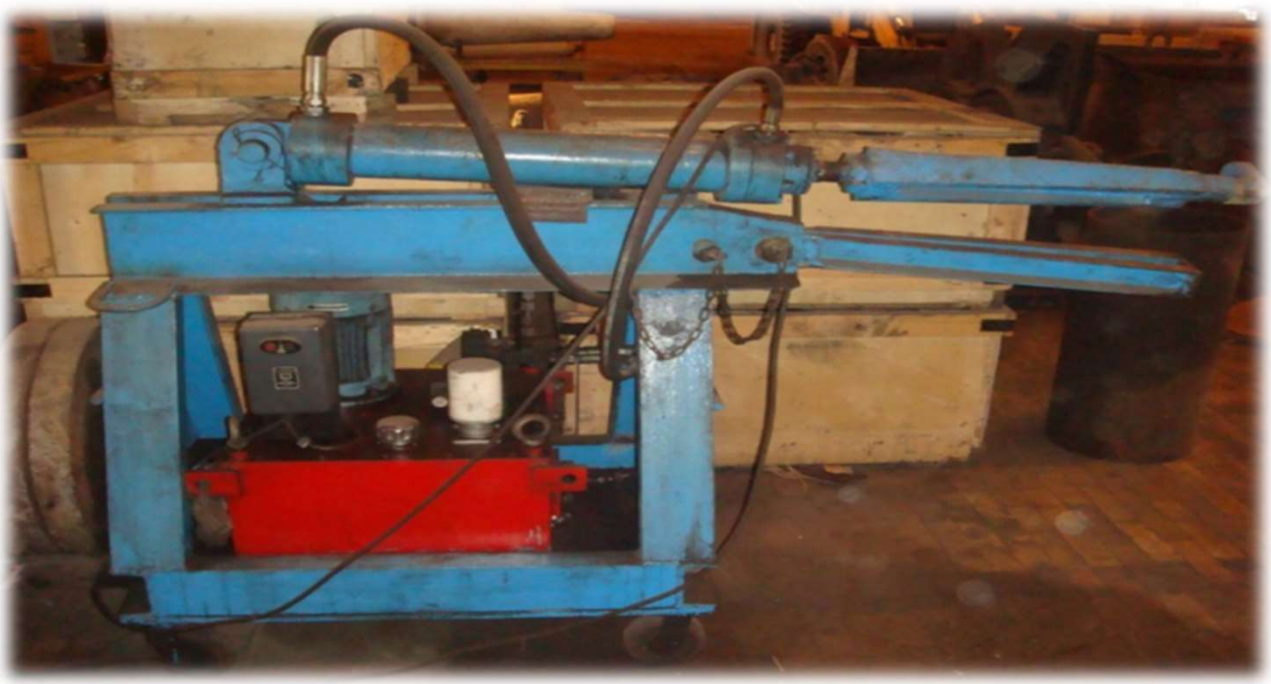
Cast House Runner Management

- Condition monitoring of air cooled runners.
- No intermittent repair and thus avoiding frequent drain out of hot metal.

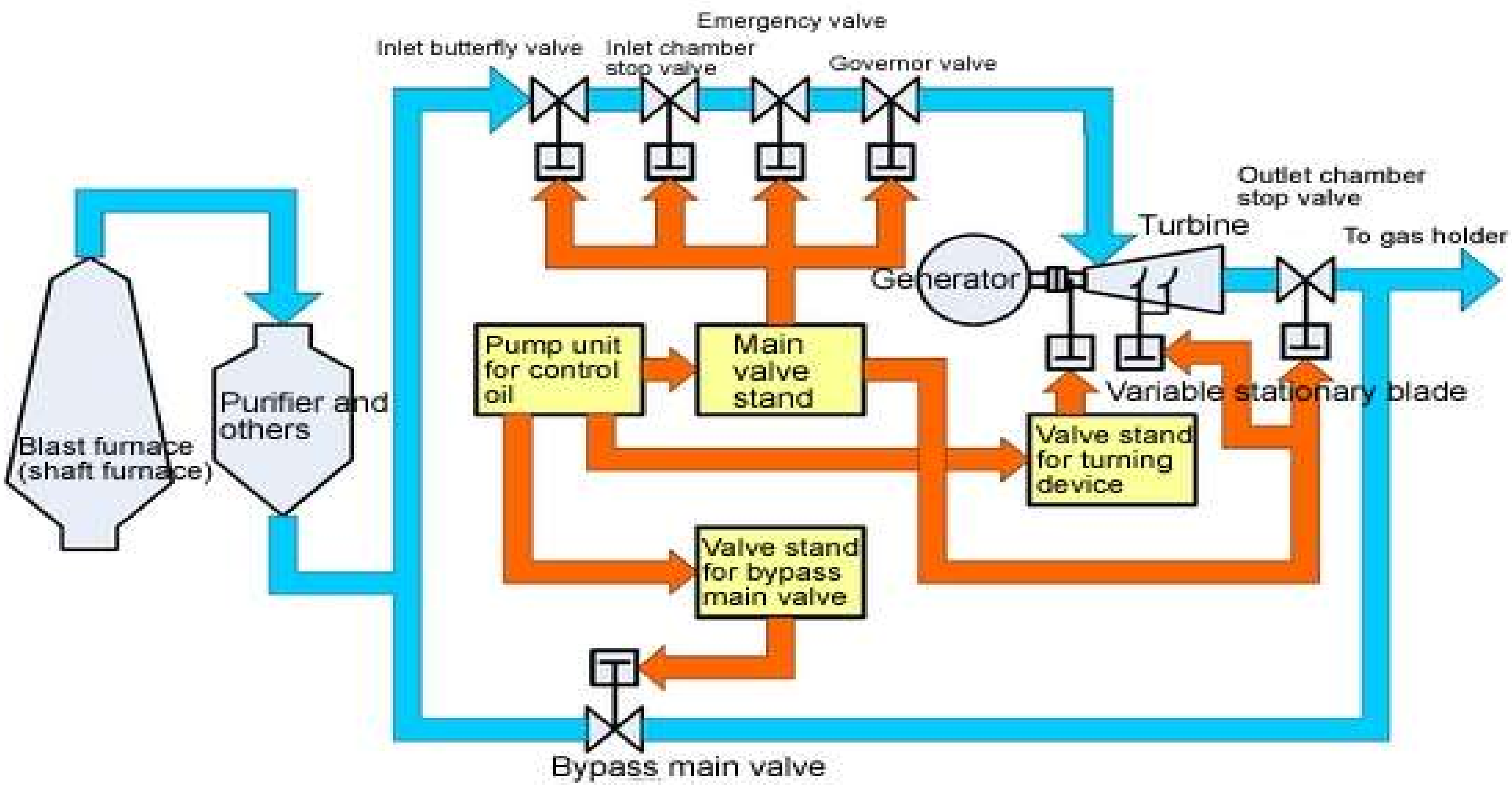


Tuyere Replacement Device

To reduce manual involvement to the extent minimum and to save time in tuyere changing, a unique tuyere changing device was manufactured in-house. The tuyere changing time has been saved by 20minutes as compared to earlier after using this device.



Top Recovery Turbine (TRT)



Blast Furnace Power Recovery Turbine (BPRT)

The principle of BPRT works on recovering thermal & pressure energy of Blast Furnace Gas for improving efficiency of blower to run on reduced energy consumption. The turbine and blower are arranged on a common shaft. By installation of BPRT 30-40% of power consumed by an electrical blower can be saved.

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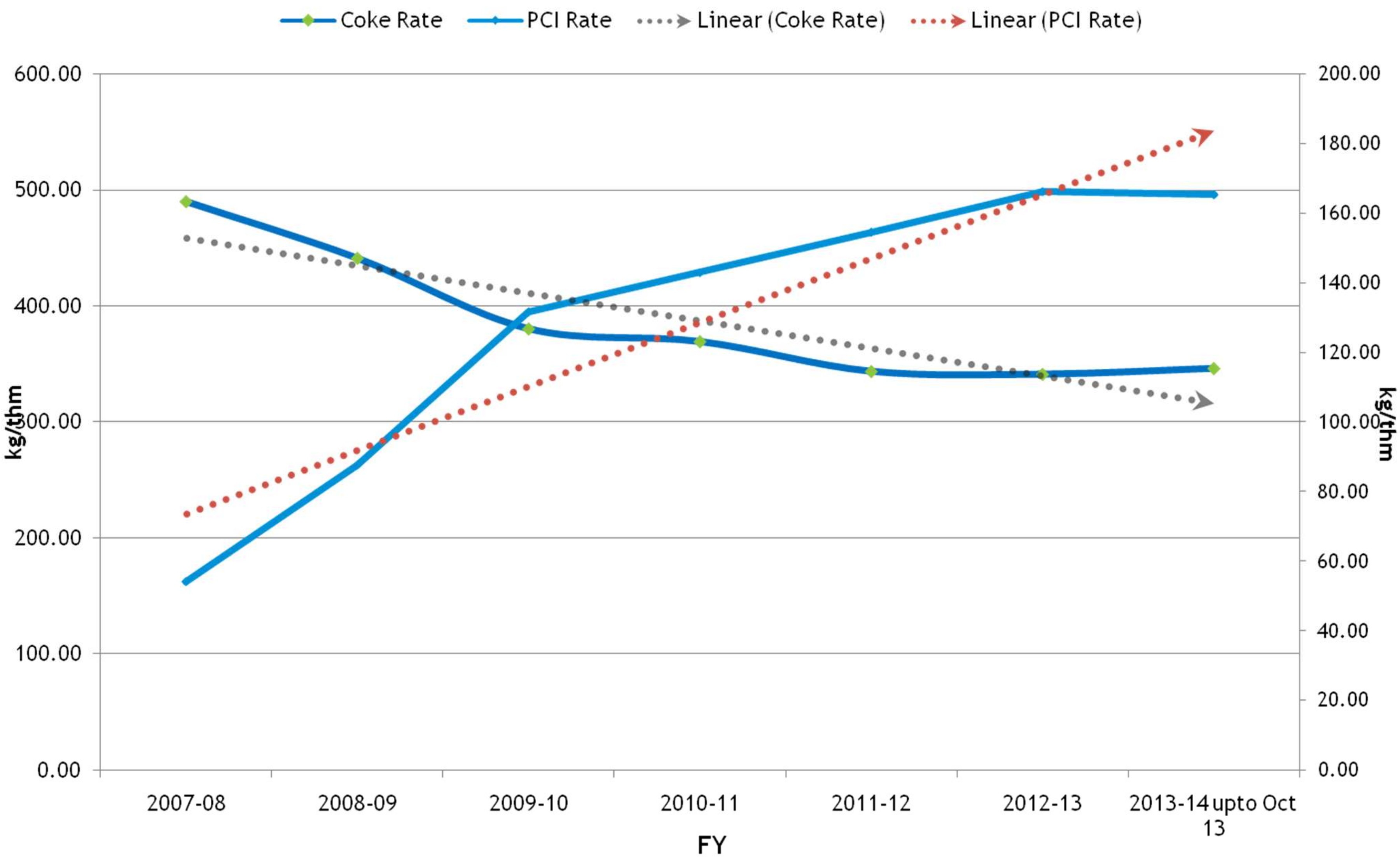
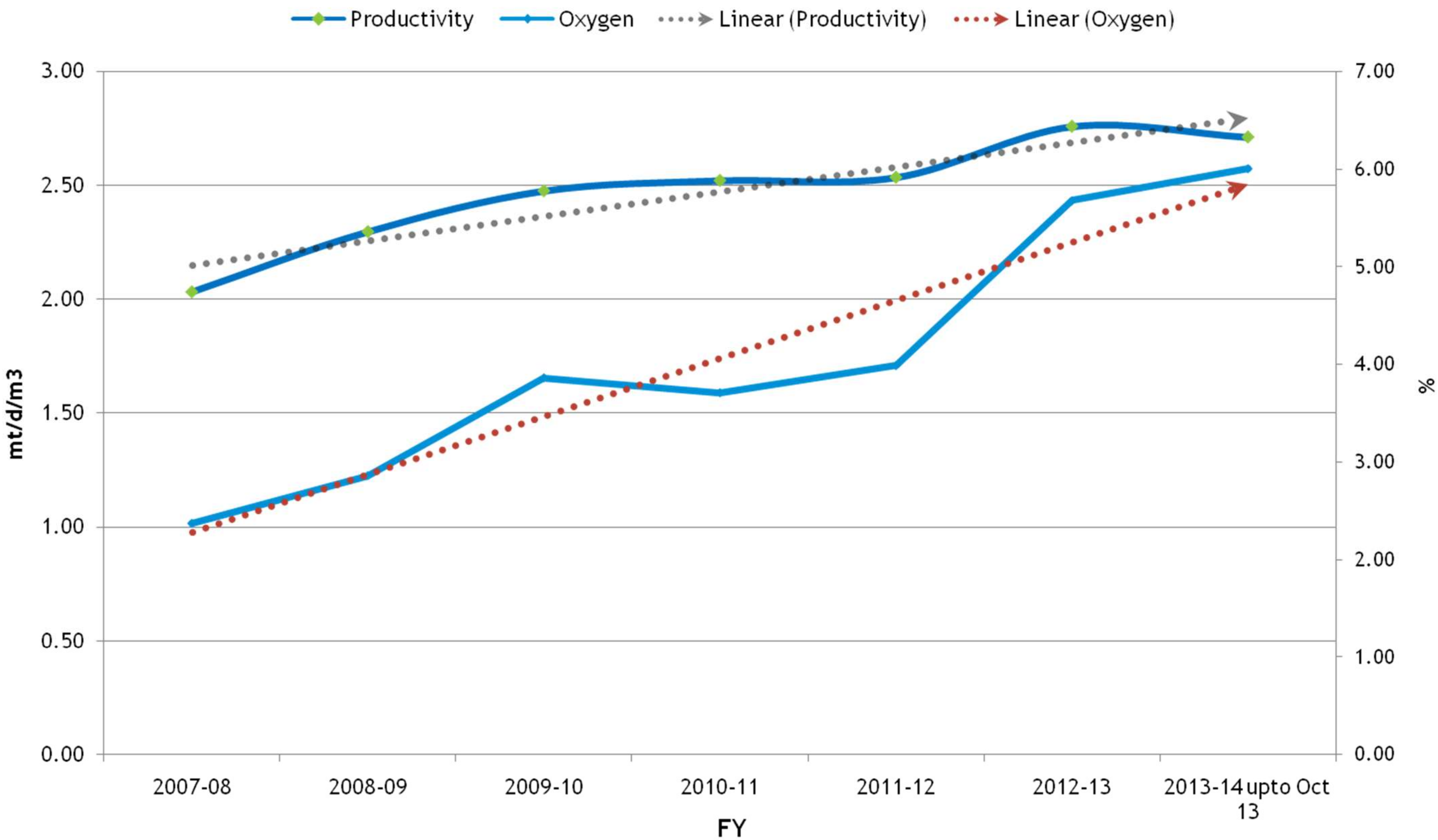
Coke & PCI Rate



Productivity & Oxygen enrichment



Conclusion

Smooth operation of Blast Furnace requires :

1. Stringent control over input & product quality.
2. Efficient monitoring system.
3. Good maintenance practices.
4. Vigil over cost and safety factors.
5. Timely taken corrective measures and updation of technology & resources.

At JSPL an emphasis has already been there to incorporate advance measures for improvement in performance. Use of pilot oven for pre-determination of coke quality before charging into coal blend, in house manufacturing of injection device for ilmenite injection through tuyeres, in-house development of above burden probe and dewatering wheel are some of the initiatives taken in this line in last few years with ultimate aim to produce quality hot metal at lowest cost.

Thanks for your Patience

AKB - 25 NOV 2013

DANIELI CORUS

Ironmaking
Steelmaking
Energy & Environment
Since 1977

Hot Blast Stove System

Refractory Quality Control

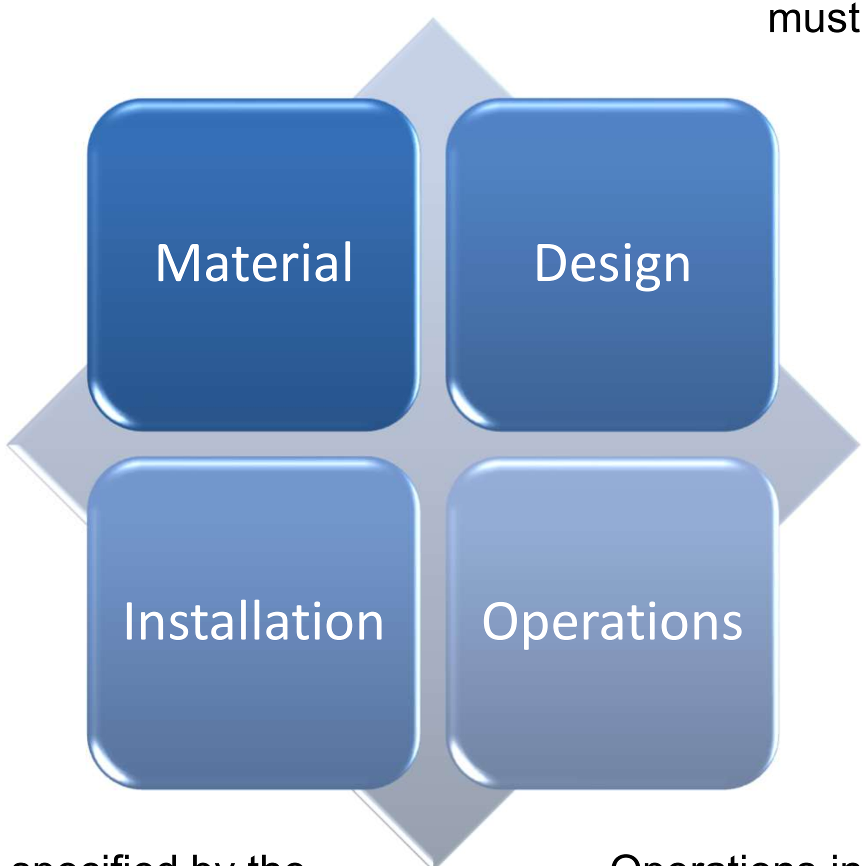
National Seminar on
“Recent Advances in Blast Furnace Operation

30 November 2013

Refractory Performance

The refractory material base must be compatible with the expected process conditions

The design must not only cope with normal operation - extreme fluctuations must be taken into account



Correct installation as specified by the designer and manufacturer to get the required end properties

Operations include process control, monitoring, inspection and maintenance in compliance with modern requirements

Refractory Performance

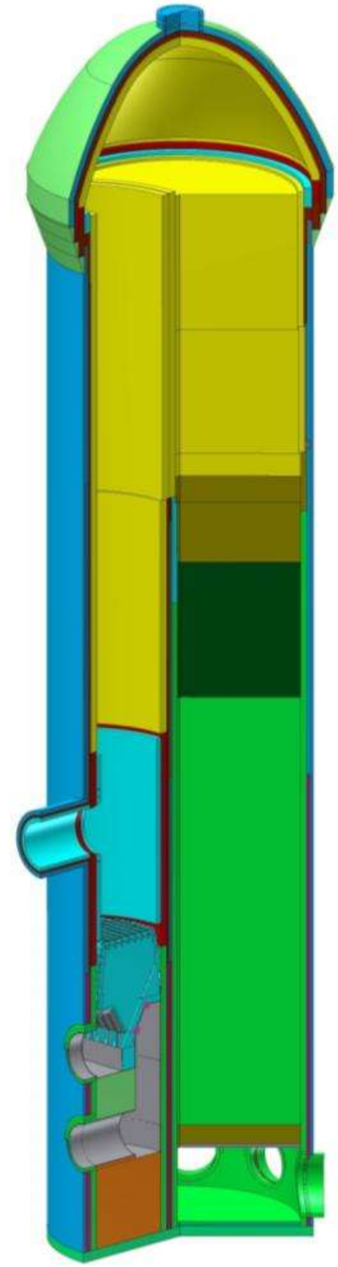
- Failure could lead to loss of
  - Production time
  - Equipment
  - Product itself

- Refractory important for
  - Safe operation
  - Energy consumption
  - Product quality

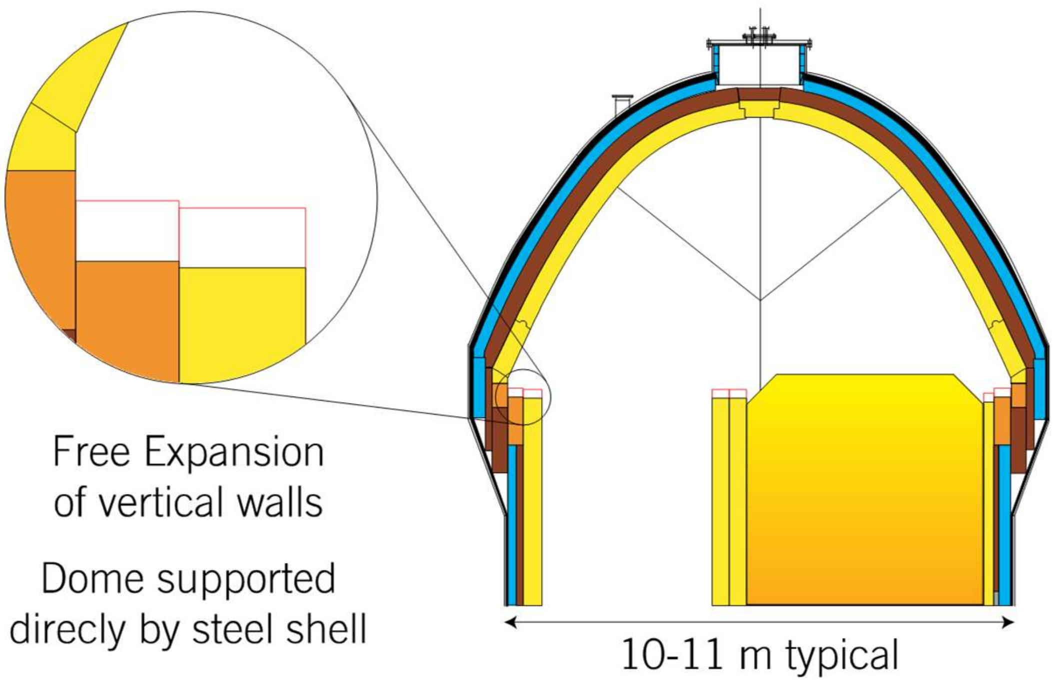
- Refractory Materials should be best suited to each application

Danieli Corus Hot Blast Stove

- Hot Blast Temperature 1250°C
- Campaign Life > 30 years
- Low CO Emissions
- High Efficiency > 80%
- Gas and air pre-heating
- Stress corrosion protection of shell
- Fast Heat-Up and Cool-Down
- Internal combustion chamber
    - Ceramic burner
    - Free-standing parabolic (mushroom) dome
    - Special insulation in partition wall
    - Special ring brickwork of hot blast outlet
- Hot blast of up to 9,000 Nm³/min (@10.7m dia)
- Over 90 projects and 210 stoves as references



Danieli Corus Hot Blast Stove – Mushroom Dome

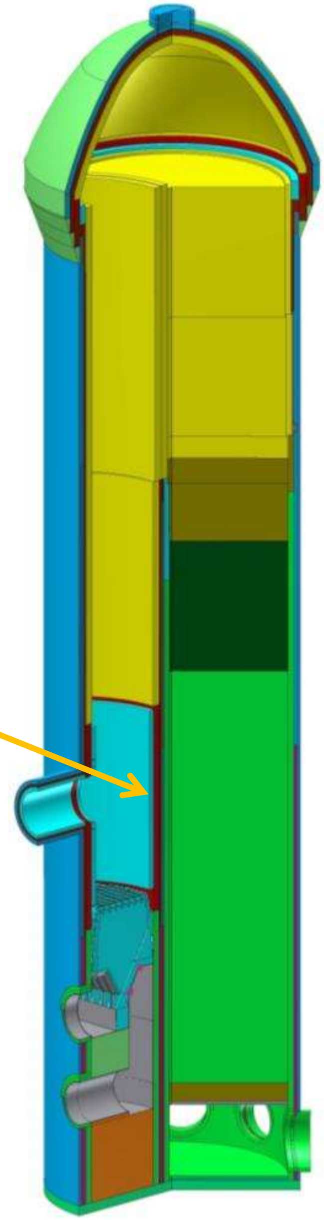


Danieli Corus Hot Blast Stove - Hot blast outlet design

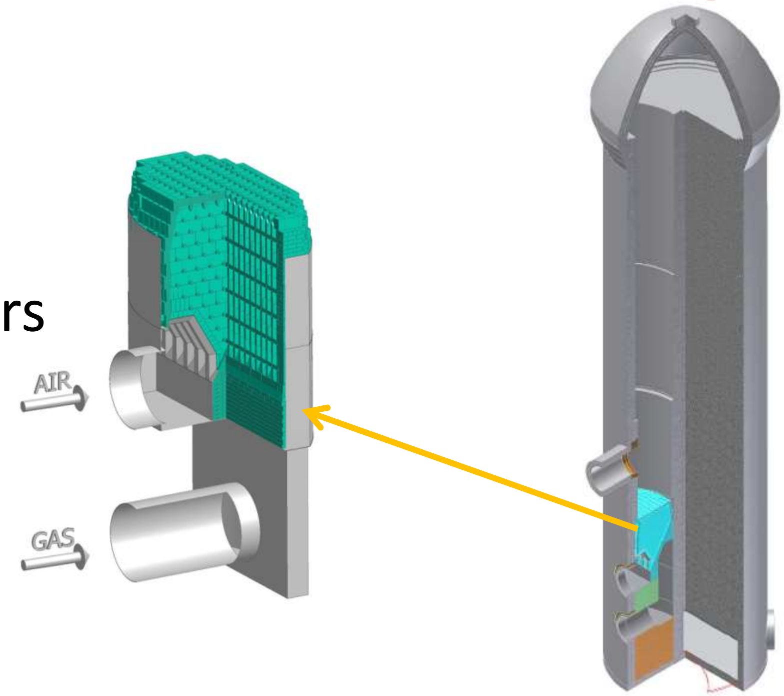
Special ‘ring’ brickwork and expansion provisions prevent cracking at the hot blast duct outlet

Danieli Corus Hot Blast Stove – Partition wall design

Additional protection wall in the area directly above the burner to prevent premature deterioration of main walls in the burner impact area: insulation + heat-resistant material insert



Danieli Corus Hot Blast Stove – Low CO emissions



1. Latest generation Ceramic Burners

2. Combustion Control

Measuring:

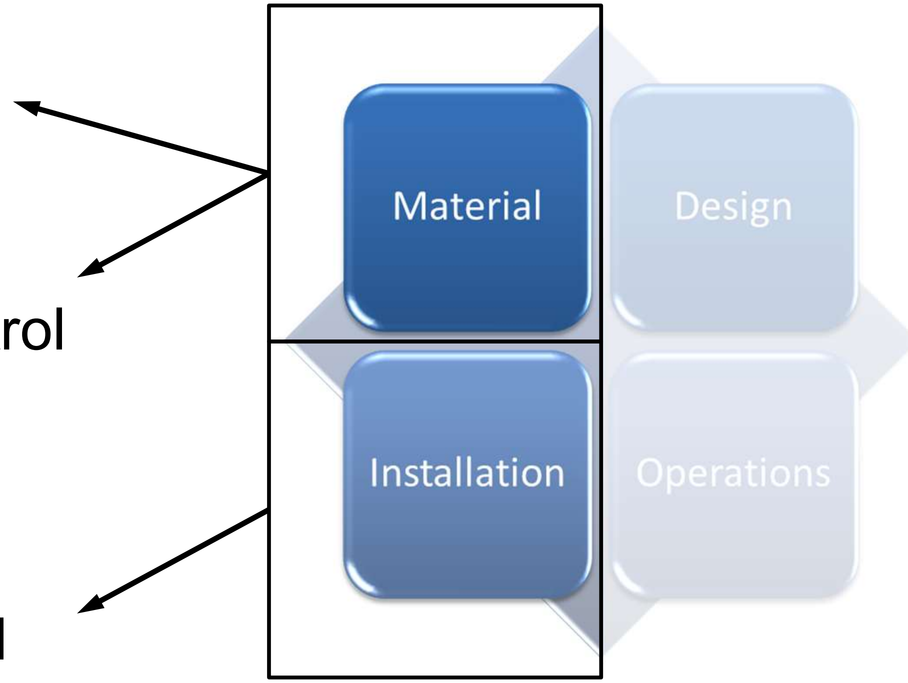
- Combustion air and combustion gas flow to the mechanical burner
- Calorific value of the combustion gas
- Waste gas CO as input for control system

Adjusting:

- Combustion air / gas ratio (automatically)

DC Quality Control

- Approved Suppliers
- Pre-Shipping Quality Control
- Installation Quality Control



Supplier Approval Procedure

- Step I - Approval of Company
  - Questionnaire
- Step II - Approval of Plant
  - Questionnaire and plant visit
- Step III - Approval of product
  - Testing of sample in CRC The Netherlands
  - Trial order

DC Expectations of a Reliable Supplier

- DC requires Consistent Quality from Reliable Supplier
- Reliable Refractory Quality
  - Variation of each production step should be within limiting values, Statistical Process Control
  - Independent internal QA/QC procedures are monitored by the supplier, deviations should be processed in order to improve production (ISO series)
- Reliable Refractory Supplier
  - DC is informed about deviations
  - QA/QC results of DC are accepted by Supplier without discussions

Pre-shipping Quality Control

- Supplier Quality Control

- DC Quality Control – Basically a checking supplier's QC procedures
  - Supplier's internal Quality Control records
  - Visual & Dimensional Inspection by DC inspector
  - Pre-assemblies
  - Selecting of samples by DC inspector
  - Testing of samples in CRC laboratory The Netherlands

Examples of Refractory Quality Problems

Inspection

- Deviations from tolerances
- Corner damage
- Cracks (external, internal)

Testing

- Physical properties
  - Low density/high porosity (BD, AP)
  - Low strength (CCS)
  - Low creep
  - High shrinkage (PLC)
  - Insulating brick: High thermal conductivity
- Chemical properties
  - High amount of impurities (such as Iron, Alkalis)
  - Silica bricks: “free Silica” too high

On-site Quality Control

- Material Handling
- Equipment
- Logistics, organization, house-keeping
- Installation tolerances
- Material properties of monolithic materials

On site QC - Material handling

Wrong

Right

On site QC - Equipment

Wrong

Right

On site QC - Logistics

Wrong

Right

On site QC - Alignment of checkers

Wrong

Right

On site QC - Expansion provision installation

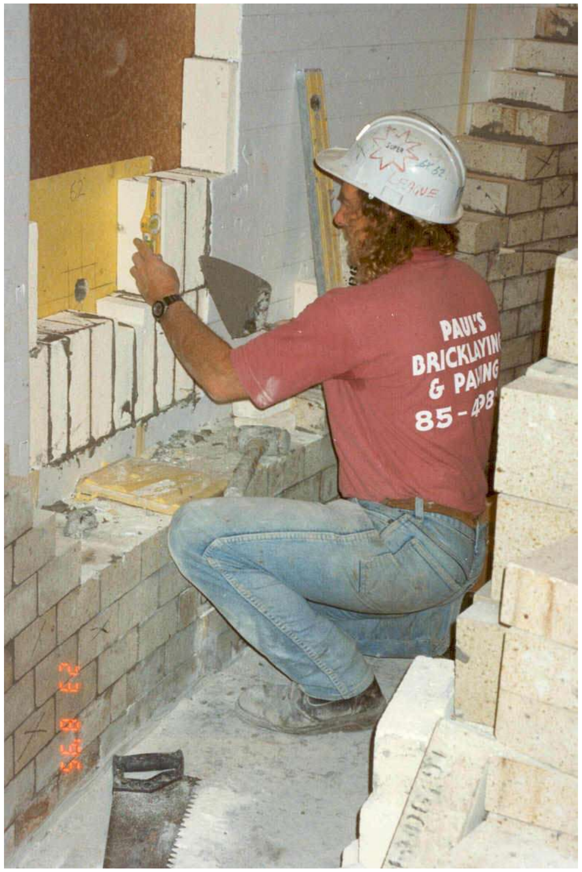
Wrong

Right

On site QC - Mortar and voids

Wrong

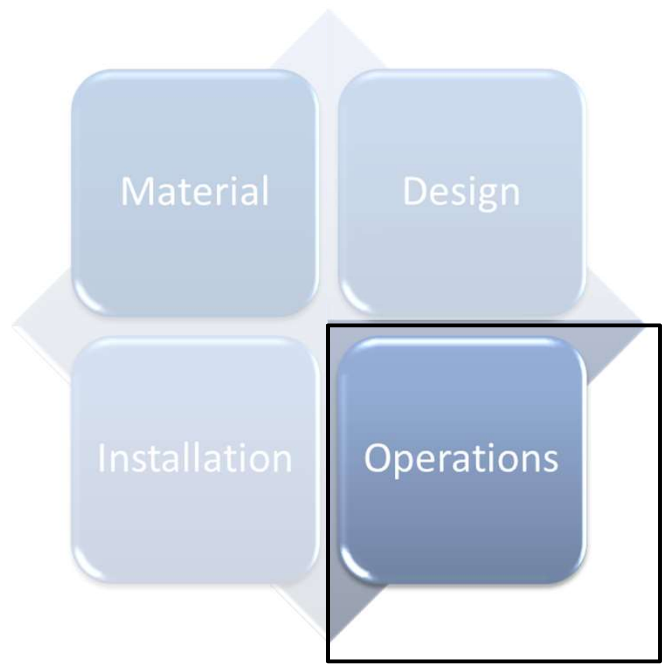
Right



Operations and maintenance

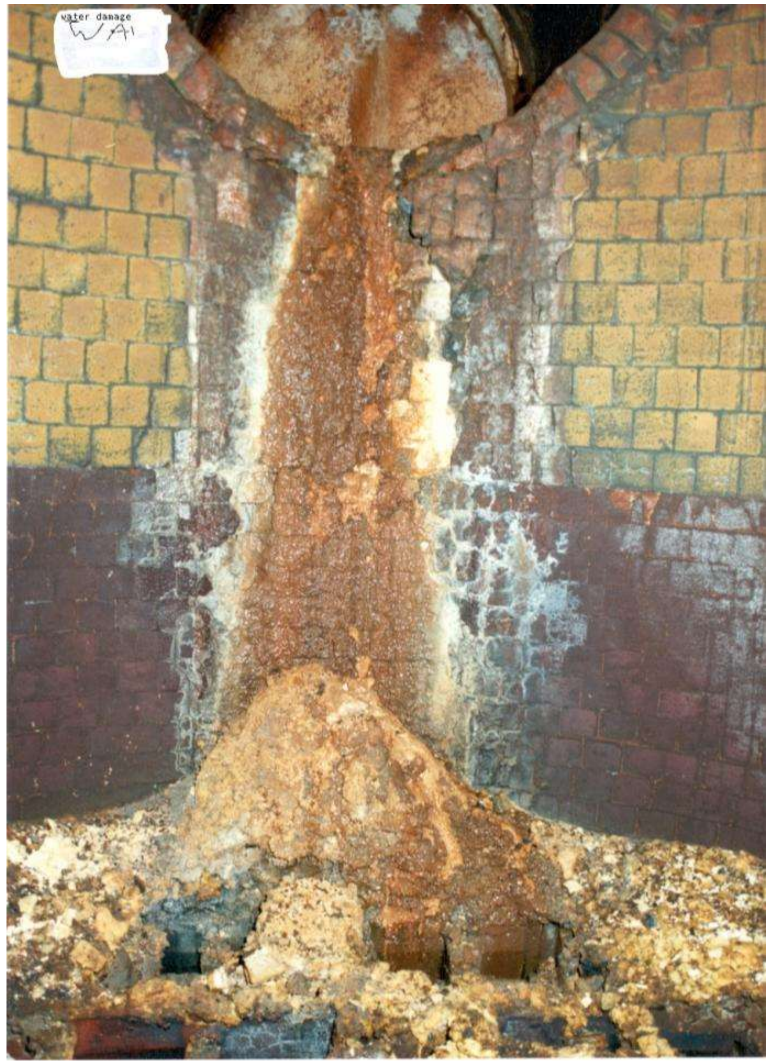
- Lack of process control
  - Too long wind times
  - Dirty gas

- Lack of maintenance
  - Leaking valves
  - Gas leakages at flanges
  - Lack of monitoring: No corrective action in case of hot spots



Operations – Lack of process control

Maintenance – Leaking valve



Maintenance – Lack of corrective actions

Leaking dome flange

Developing hot spot

Conclusions

Life-time of the stove

- Material Quality
- Installation
- Operation

INTEGRATED STEELMAKING PLANTS
DANIELI CORUS

Pulverised Coal Injection Technology

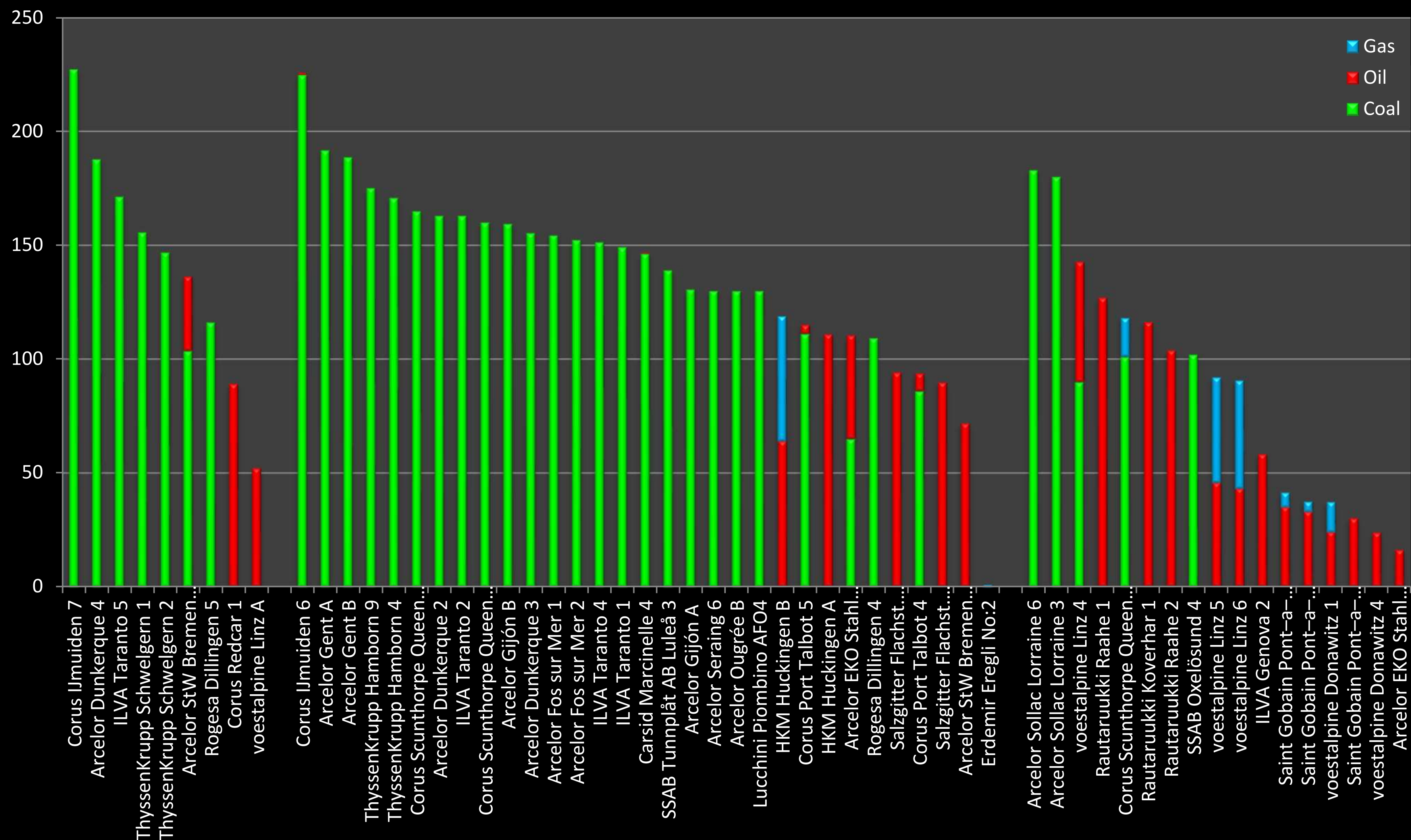
National Seminar on
"Recent Advances in Blast Furnace Operation"

SAIL Bokaro Steel
Bokaro Steel City
30 November 2013

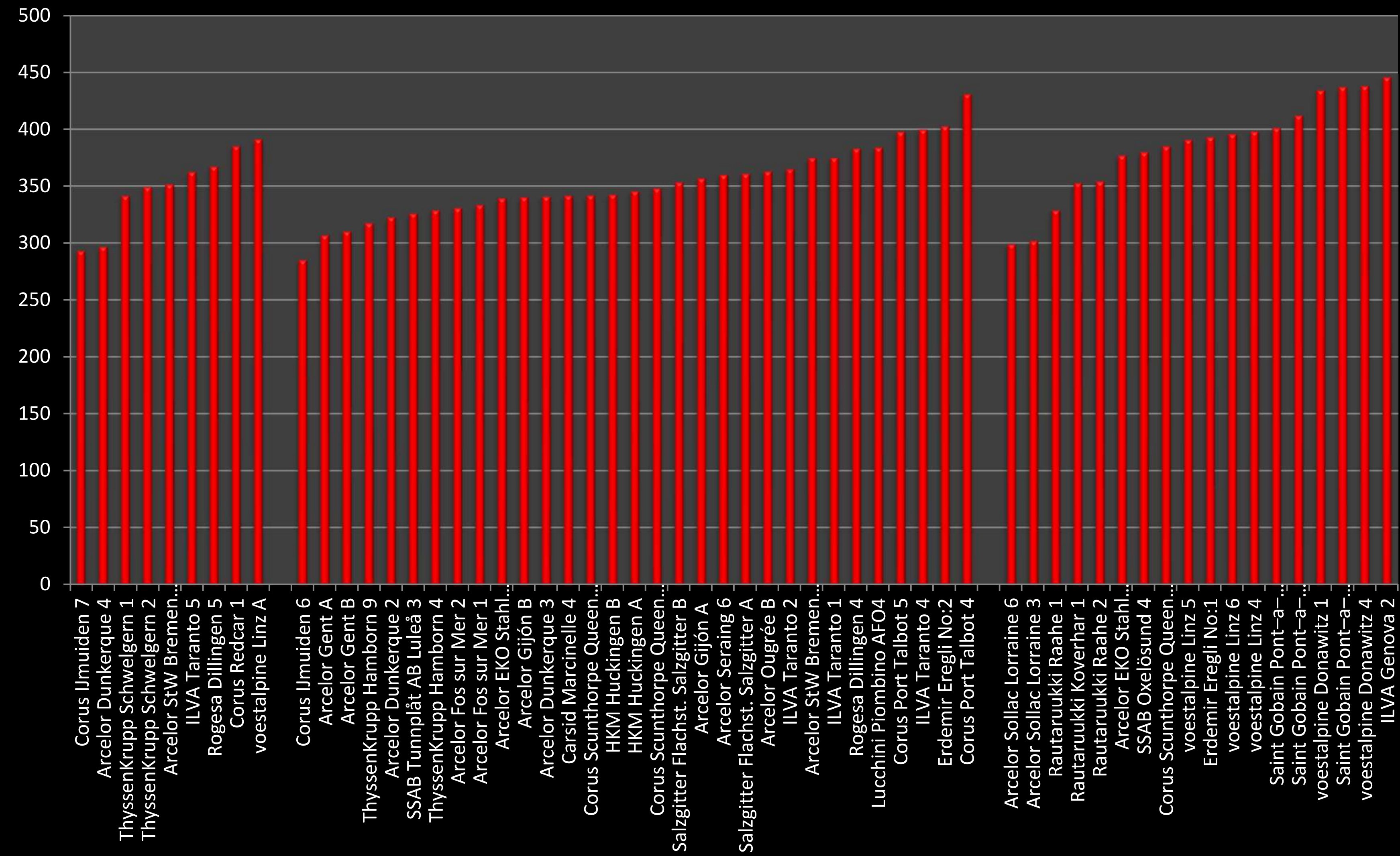
Unique Selling Points

- World record injection levels – highest proven sustained levels in Industry
- Simple technology - proven and safe
- Easily adjustable injection rates
- Very low maintenance costs, 100% availability
- Sixty-three (63) reference plants world-wide
- PCI building to Furnace up to 1,600 m
- Training & Operational Assistance

Record Coal Injection Rates (annual average)



Coke Rates (annual average)



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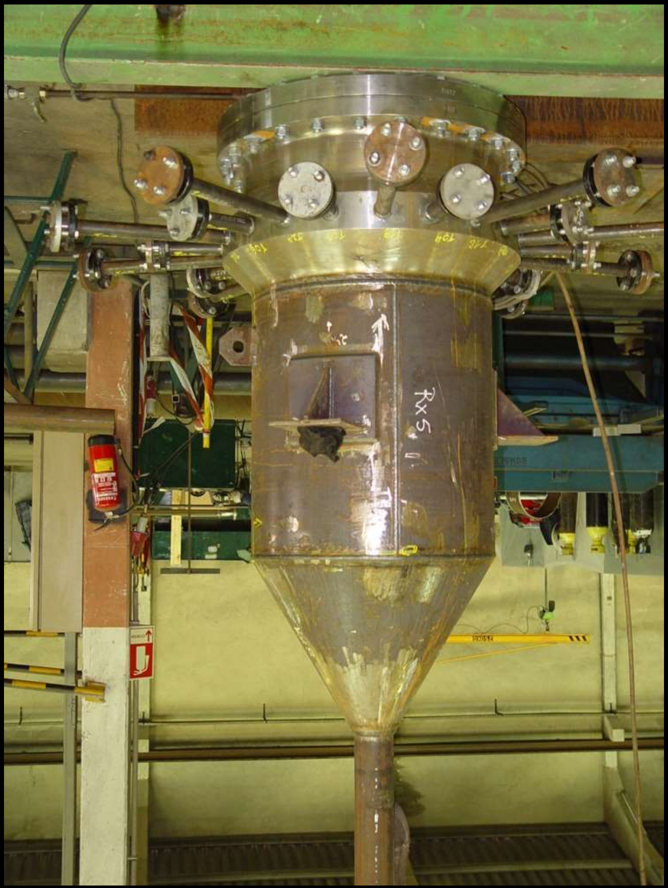
Distributor



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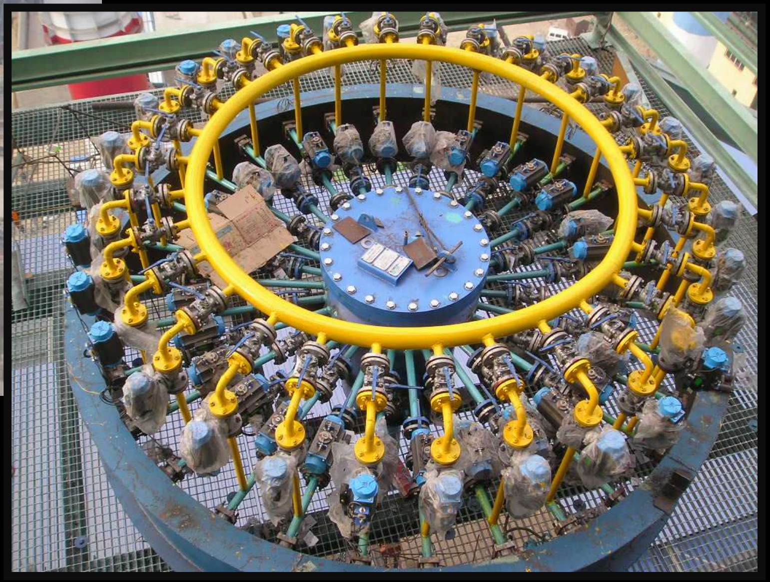
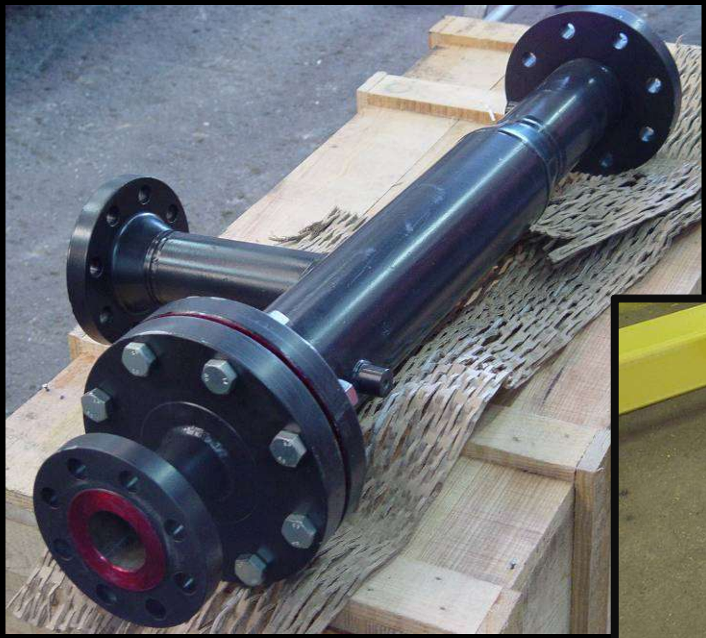
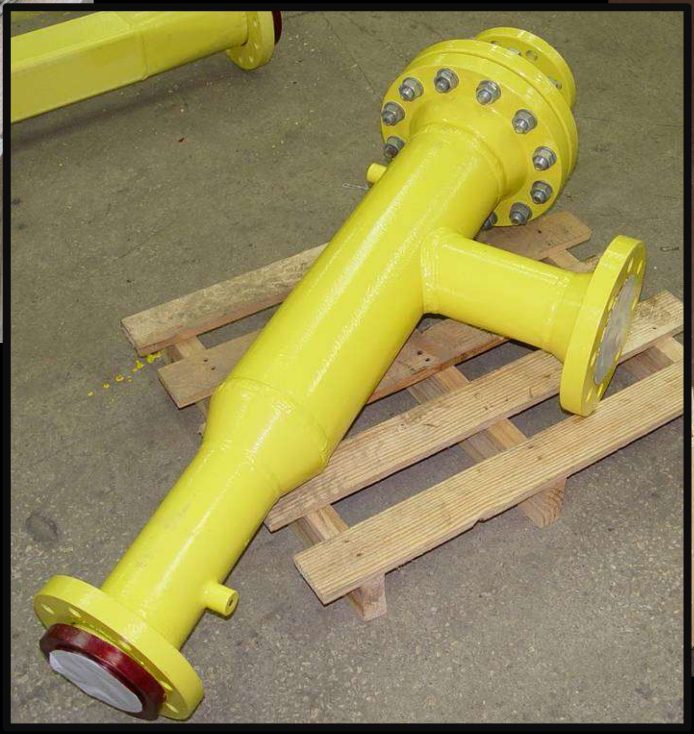


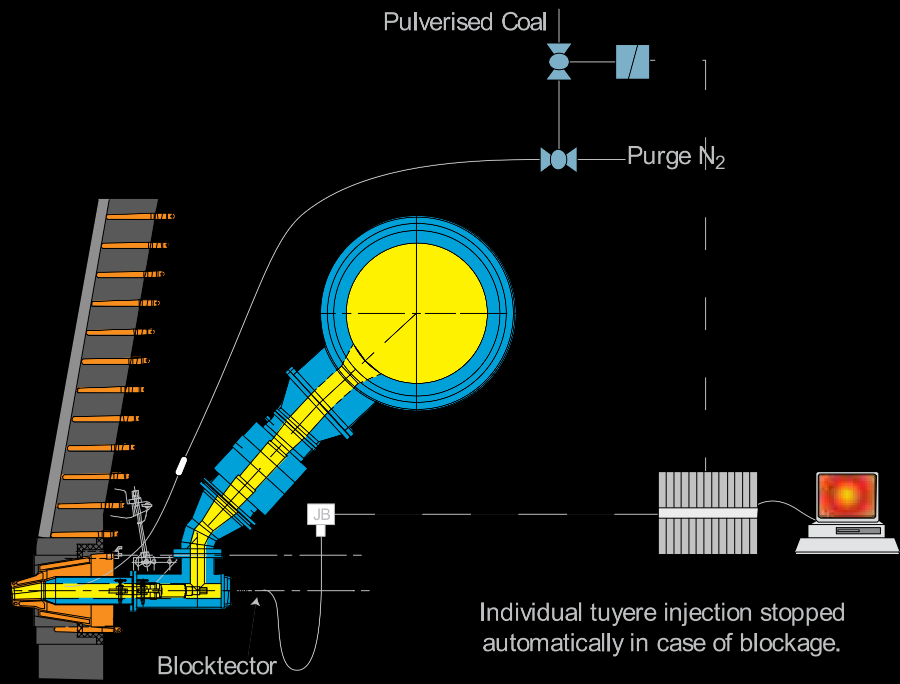
Mixing Tee

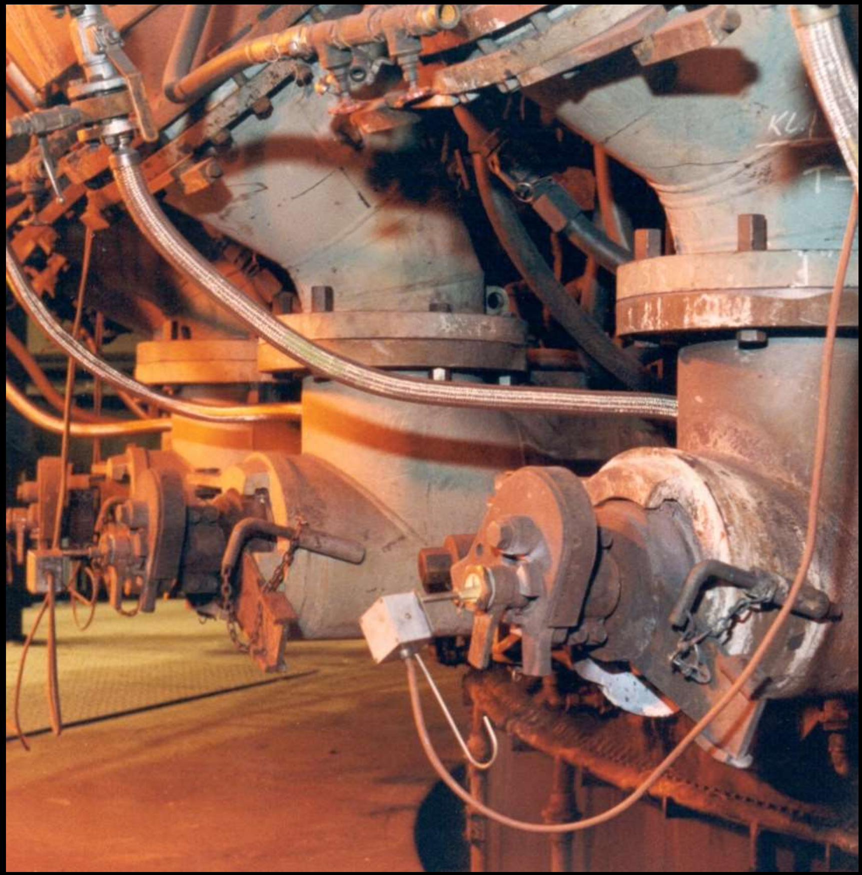




Injection Lances

Blocktector





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Reference Plants

At all major iron makers in the world

- Tata Steel
- SAIL
- NMDC
- Jindal
- Nippon Steel
- POSCO
- Nisshin Steel
- US Steel
- Baosteel
- China Steel
- MaSteel
- Taigang
- Shougang
- etc

Company	Country	Furnace	WV, m³	Start–up	Injection Rate, kg/THM
NMDC	India	Blast Furnace No 1	4,506	07/14	200 (design)
Taigang	China	Blast Furnace No 6	4,350	02/11	250 (design)
SAIL	India	Rourkela No 5	4,060	03/11	200 (design)
Shougang	China	Qian'an No 3	3,600	09/09	220 (design)
Handan Steel	China	Handan No 7	3,800	08/08	220 (design)
NingBo Steel	China	NingBo No 2	2,300	05/08	200 (design)
SeverStal	USA	Dearborn "C"	1,700	03/08	220 (design)
SAIL	India	Bhilai No 7	2,000	01/07	150 (design)
Baotou	China	Blast Furnace No 4	2,200	12/06	200 (design)
Baotou	China	Blast Furnace No 6	2,500	12/06	200 (design)
US Steel	USA	Gary No 14	3,425	03/06	200 (design)
Shougang	China	Qian'an No 2	2,650	08/06	250 (design)
Bhushan	India	Meramandali No 1	1,450	12/06	250 (design)
Taigang	China	Taiyuan No 1	4,000	9/05	250 (design)

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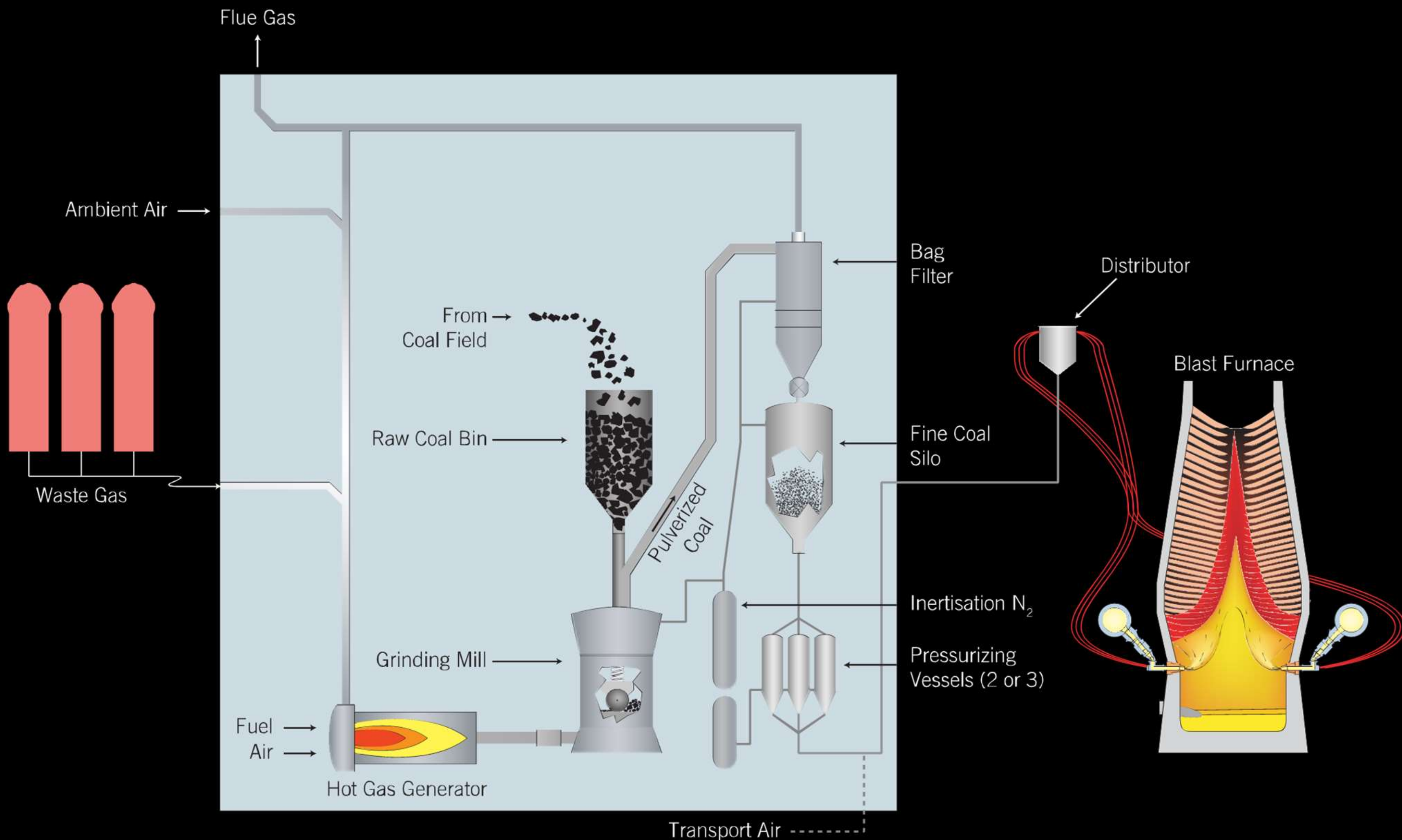
Training & Operational Assistance

Many major steel makers

- SAIL
- CSN
- CST
- VSZ
- US Steel
- ArcelorMittal
- Acominas
- POSCO
- Baosteel
- Shougang
- etc

Company	Country	System
CSN	Brazil	BMH
US Steel	USA	DC
Inland Steel	USA	Küttner/PW
VSZ	Slovakia	Küttner/PW
Açominas	Brazil	BMH
Iscor	South Africa	DC
CSC	Taiwan	DC
CST	Brazil	Küttner/PW
AHMSA	Mexico	Simon McCawber
Posco	Korea	DC
Baosteel	China	DC
China Steel	Taiwan	DC
MaSteel	China	DC
LianYuan Steel	China	DC
SAIL	India	DC
Taiyuan	China	DC
Shougang	China	DC
Baotou	China	DC
NingBo	China	DC
Handan	China	DC
Shougang Qian'an	China	DC

Pulverised Coal Injection System

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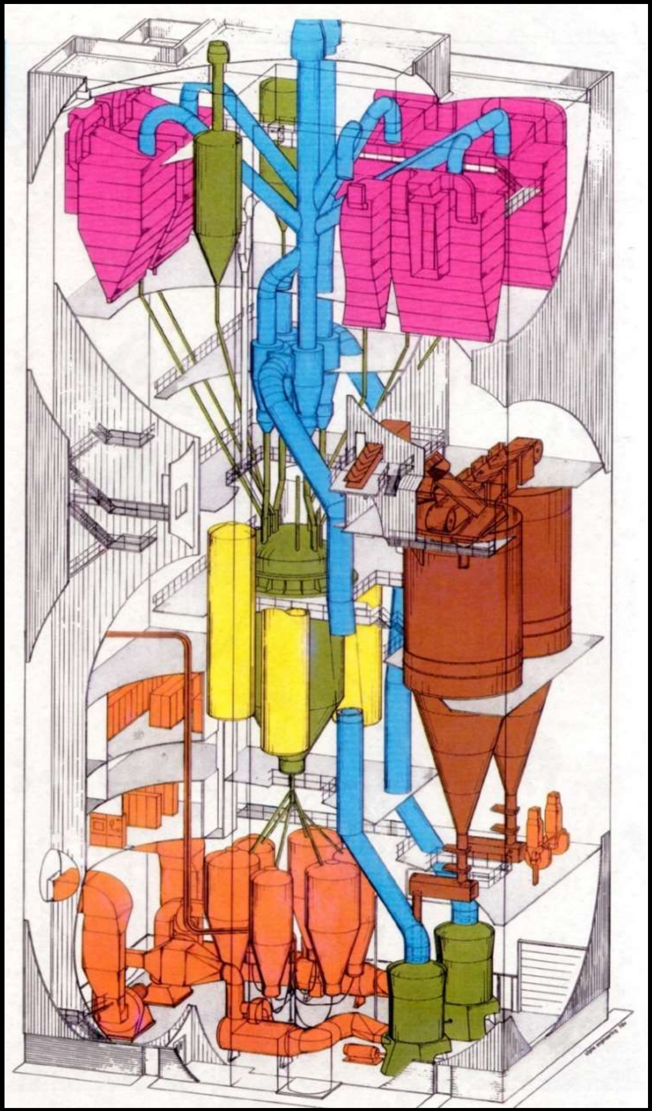
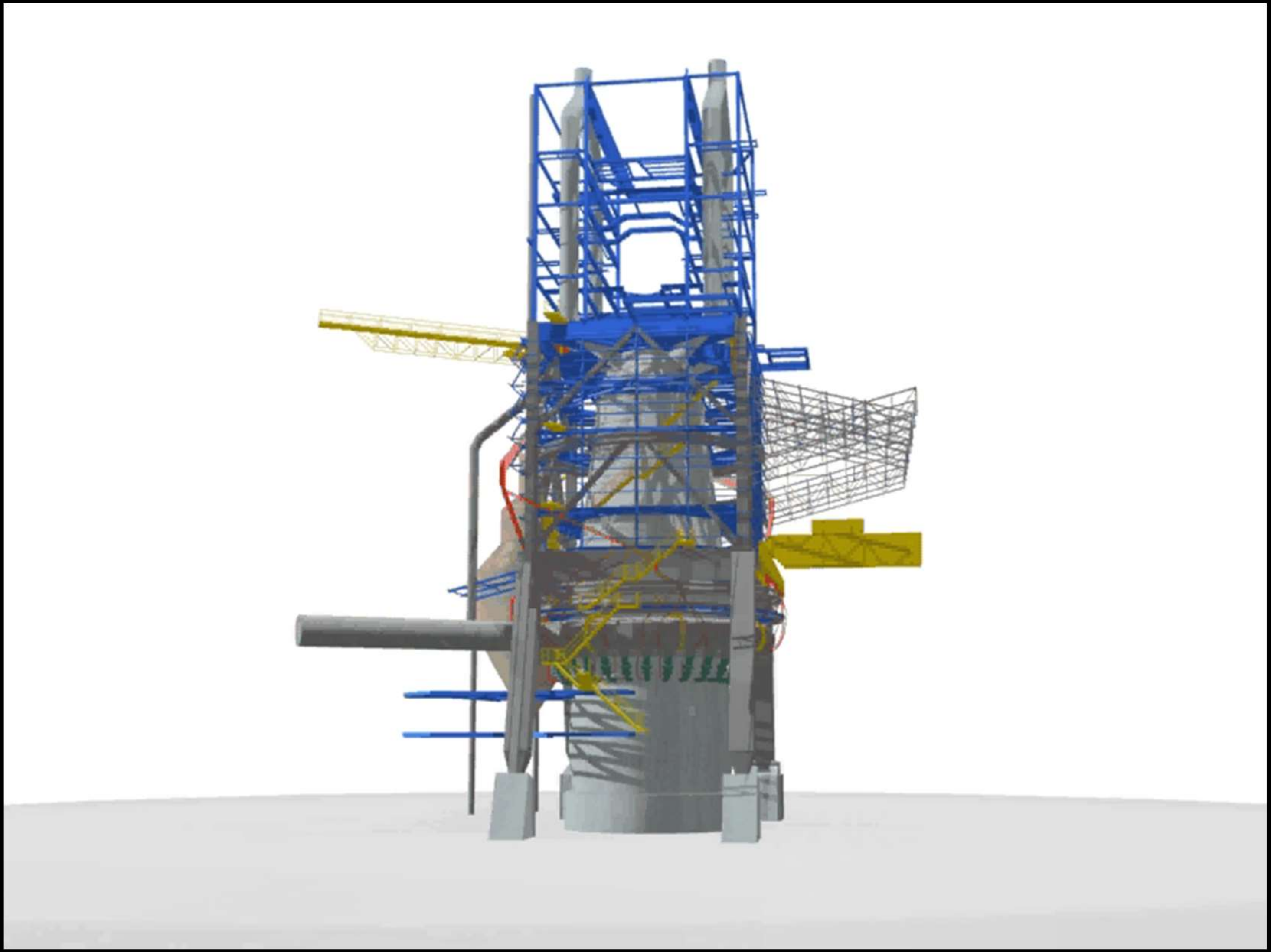
PCI Equipment



Pipe Routing around Blast Furnace



High PCI Rates

- High PCI levels depends on a stable Blast Furnace operation which require the following
  - Good Furnace availability
  - Raw materials meeting quality and consistency standards
  - Burden distribution to promote smooth burden descent & gas ascent
  - Casting according to dry hearth practices
  - Correct coal selection & preparation
  - Good discipline regarding lance positioning & maintenance
- These items, among others, are the subject matter for the Modern Iron Making Course and Blast Furnace Operators Course