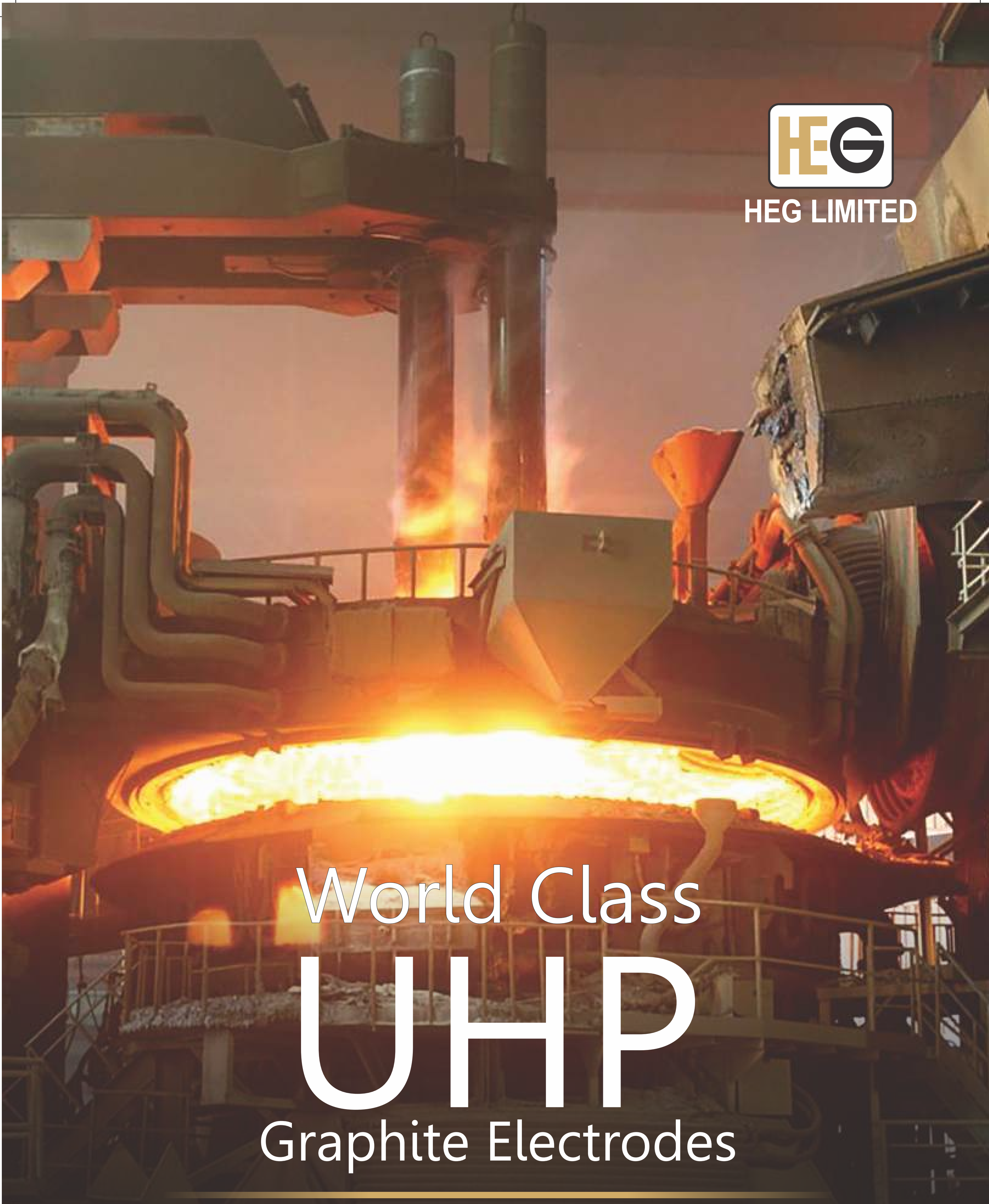


HEG LIMITED

World Class UHP Graphite Electrodes

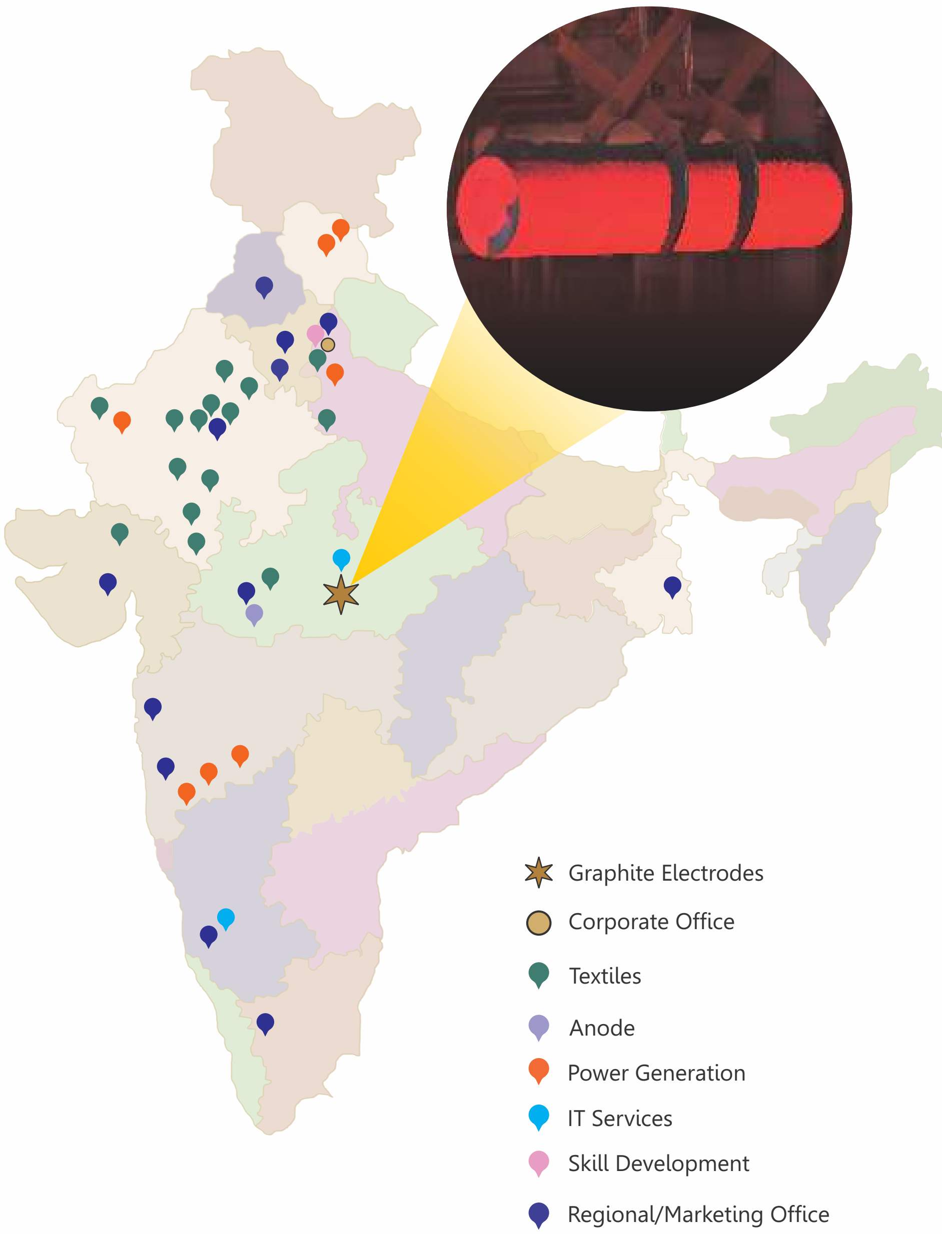
PROVEN CHOICE OF TOP STEEL MAKERS GLOBALLY

THE LNJ BHILWARA GROUP

A small journey that started in 1960 by the visionary Mr. L. N. Jhunjhunwala, has grown today to position itself as India's one of the most esteemed business conglomerates with a presence across diverse business spaces.

It all began with the setting up of a textile unit in Rajasthan, India, which has today blossomed into a globally respected business group with interests in Graphite Electrodes, Textiles, Power Generation, and IT-Enabled Services.

The main group companies are IS/ISO certified and listed on the major stock exchanges in India.



WORLD'S LARGEST SINGLE SITE PLANT OF

GRAPHITE ELECTRODES

HEG Limited, a premier company of the LNJ Bhilwara group, is among the largest Graphite Electrode manufacturers globally, located at Mandideep, District Raisen (near Bhopal), in the central Indian State of Madhya Pradesh.

Set up with technical and financial collaboration with SERS-a subsidiary of Pechiney, France.

Starting from a capacity of **10,000 MT** in 1978, kept expanding every few years to reach a capacity of **100,000 MT** in 2023.

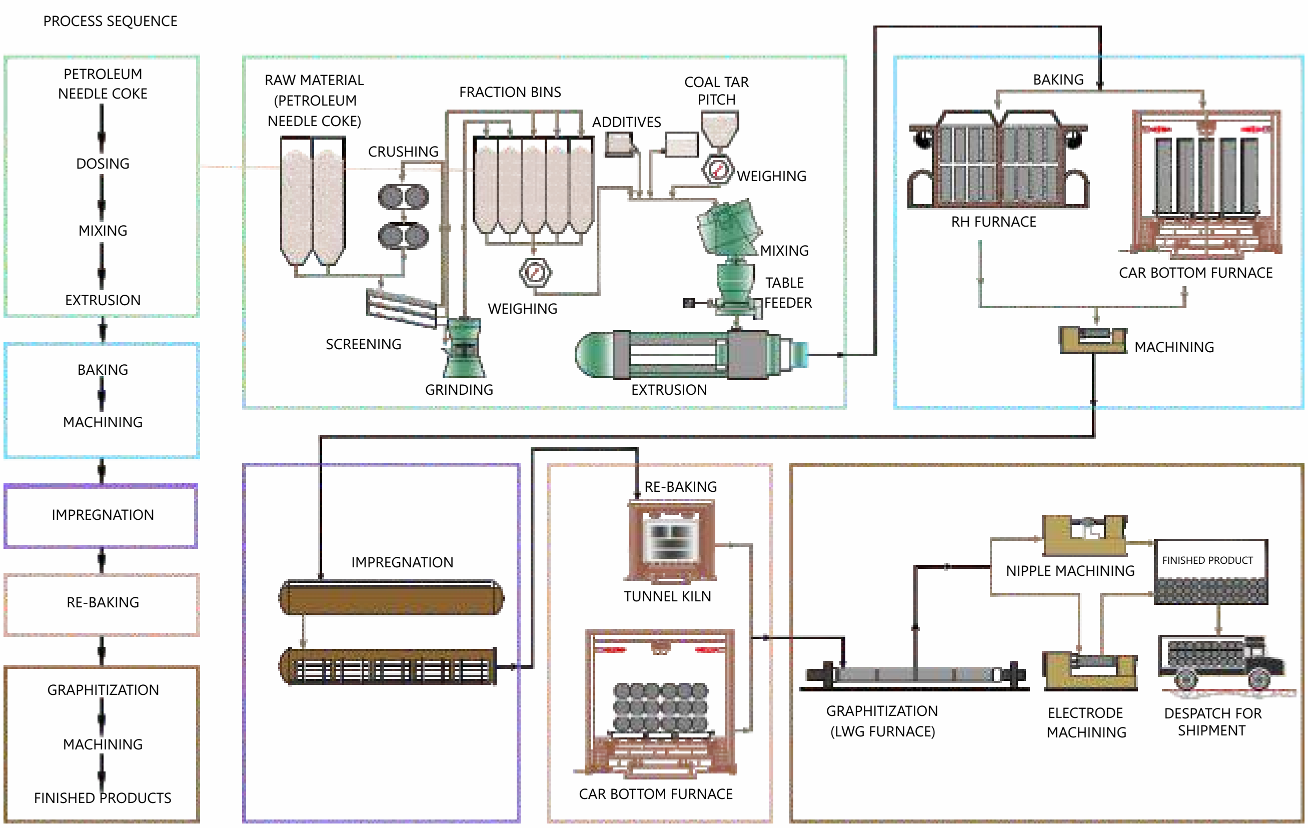
Largest Graphite Electrode exporter from India consistently exporting 65-70% of the production to **35+ countries** & **100+ global customers** for last several years.

Captive power generation assets of **86 MW**.

PRODUCTION PROCESS

- The principal raw materials used in the manufacturing of electrode are calcined petroleum coke and pitch.
- Calcined petroleum coke is crushed, screened, and mixed with pitch in controlled proportion and the paste so formed is extruded through an extrusion press as a green electrode.
- The green electrodes are then baked slowly by heating to a temperature of 800°C for coking of the pitch to form a baked electrode.
- The baked electrodes are impregnated with special pitch to fill the porosity which results in high density and mechanical strength.
- The baked electrodes then under go through a process of graphitization which involves heating them to a temperature of 2800°C-3000°C which converts amorphous carbon to graphite.
- The last process is machining which involves turning the electrodes to a required diameter and matching end sockets to fit threaded nipples.
- After every process the electrodes go through stringent quality checks to achieve the required characteristics.

PROCESS FLOW DIAGRAM



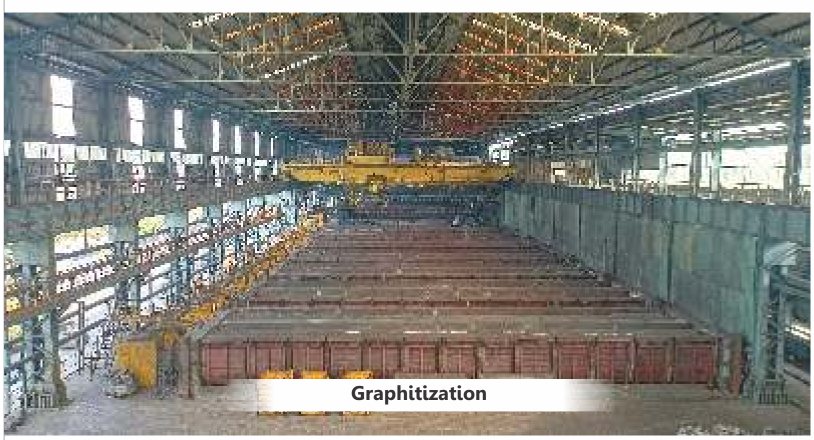
STATE OF THE ART FACILITIES


Green Electrode Extrusion


Baking


Impregnation


Rebaking


Graphitization


Machining

R&D Centre

Quality Checks

PRODUCT PROPERTIES

GRAPHITE ELECTRODES

TYPICAL VALUE									
		UHP						SHP	
PROPERTY	UNIT	DIAMETER							
		MM	INCH	MM	INCH	MM	INCH	MM	INCH
		350-450	14"-18"	500-600	20"-24"	650-800	26"-32"	300-500	12″-20"
Specific Electrical Resistance	μΩm	4.5-5.5		4.5-5.2		4.2-4.8		5.5-6.5	
Apparent Density	g/cm^3	1.67-1.75		1.68-1.76		1.72-1.78		1.65-1.74	
Flexural Strength	N/mm^2	9.0-14.0		9.0-14.0		9.0-14.0		9.0-14.0	
Coefficient of thermal expansion (25^0-525^0C)	$x10^{-6}/^0C$	1.1-1.4		1.1-1.3		1.0-1.2		1.2-1.7	
Young's modulus	kN/mm^2	9.0-16.0		9.0-16.0		9.0-16.0		9.0-16.0	

GRAPHITE NIPPLES
(CONNECTING PINS)

TYPICAL VALUE					
PROPERTY	UNIT	DIAMETER			
		MM	INCH	MM	INCH
		300-450	12″-18"	500-800	20"-32"
Specific Electrical Resistance	μΩm	≤4.5		≤4.0	
Apparent Density	g/cm^3	≥1.75		≥1.78	
Flexural Strength	N/mm^2	≥20		≥20	
Coefficient of thermal expansion (25^0-525^0C)	$x10^{-6}/^0C$	≤1.0		≤1.0	
Young's modulus	kN/mm^2	≥20		≥20	

ELECTRODE DIMENSIONS

ELECTRODE DIAMETER

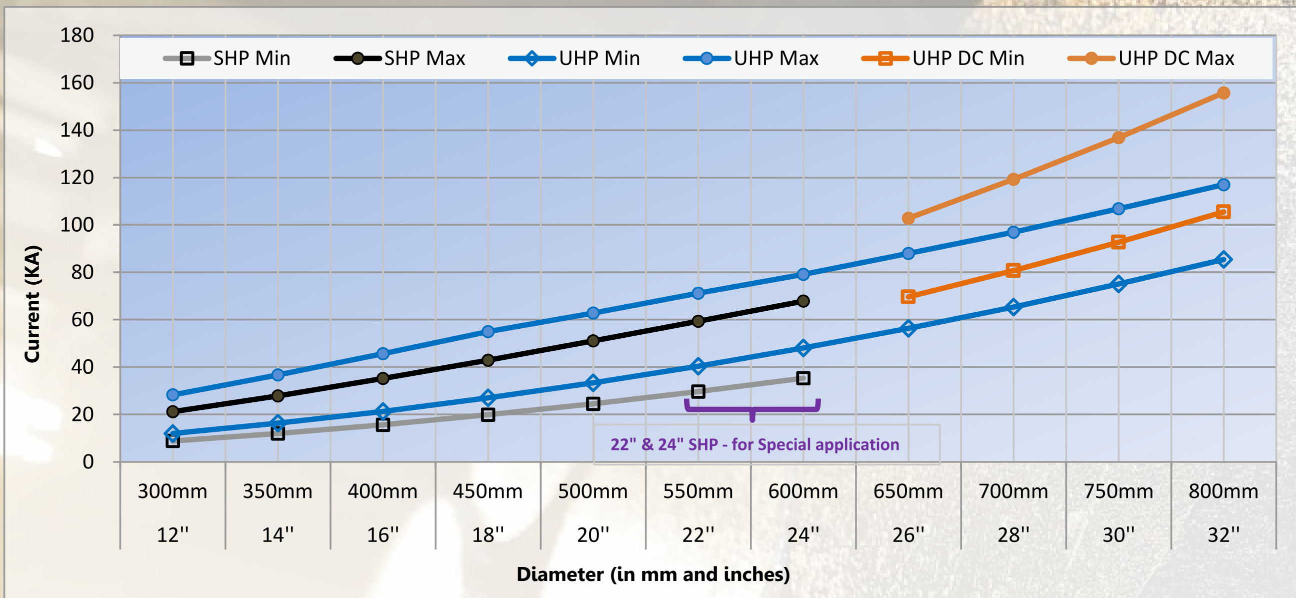
NOMINAL DIAMETER		TOLERANCE			
MM	INCH	MM		INCH	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
300	12	302	307	11.89	12.09
350	14	352	358	13.86	14.09
400	16	403	409	15.87	16.10
450	18	454	460	17.87	18.11
500	20	505	511	19.88	20.12
550	22	556	562	21.89	22.12
600	24	607	613	23.90	24.13
650	26	659	663	25.94	26.10
700	28	710	714	27.95	28.11
750	30	761	765	29.96	30.12
800	32	810	816	31.89	32.12

ELECTRODE LENGTH

NOMINAL LENGTH		TOLERANCE			
MM	INCH	MM		INCH	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
1500	60	1400	1600	55.12	62.99
1800	72	1700	1900	66.93	74.80
2100	84	1975	2225	77.76	87.60
2400	96	2275	2525	89.57	99.41
2700	110	2550	2900	100.39	114.17

* Diameter and length specs are based on the International standard IEC 60239:2005. However any special requirement on dimension can be supplied.

CURRENT CARRYING CAPACITY (KA)



RECOMMENDED JOINING TORQUE

NOMINAL DIAMETER	NOMINAL DIAMETER	TORQUE SPECIFICATIONS	
MM	INCH	KG-M	FT-LBS
300	12	65	470
350	14	90	650
400	16	112	810
450	18	150	1085
500	20	255	1850
550	22	350	2530
600	24	400	2895
650	26	500	3620
700	28	600	4340
750	30	750	5425
800	32	800	5785

PACKAGING TYPES

Wooden Packaging

Naked Packaging

Metwrap Packaging

NIPPLE DIMENSIONS - 4TPI

ELECTRODES			NIPPLES				
NOMINAL DIAMETER		IEC DESIGNATION	LENGTH		MAX. DIA		AVG. WEIGHT
INCH	MM		MM	INCH	MM	INCH	KG
12	300	177T4N	215.9	8.50	177.8	7.00	7.0
14	350	203T4N	254.0	10.00	203.2	8.00	11.0
16	400	222T4N	304.8	12.00	222.3	8.75	15.5
		222T4L	355.6	14.00	222.3	8.75	17.5
18	450	241T4N	304.8	12.00	241.3	9.50	18.5
		241T4L	355.6	14.00	241.3	9.50	21.0
20	500	269T4N	355.6	14.00	269.9	10.63	27.5
		269T4L	457.2	18.00	269.9	10.63	32.5
22	550	298T4L	457.2	18.00	298.5	11.75	42.0
24	600	317T4L	457.2	18.00	317.5	12.50	49.0
		317T4LL	558.8	22.00	317.5	12.50	57.0
26	650	355T4L	558.8	22.00	355.6	14.00	70.0
28	700	374T4L	558.8	22.00	374.7	14.75	82.0
30	750	406T4L	609.6	24.00	406.4	16.00	105.0
32	800	431T4L	635.0	25.00	431.8	17.00	125.0

NIPPLE DIMENSIONS - 3TPI

ELECTRODES			NIPPLES				
NOMINAL DIAMETER		IEC DESIGNATION	LENGTH		MAX. DIA		AVG. WEIGHT
INCH	MM		MM	INCH	MM	INCH	KG
12	300	177T3N	270.9	10.67	177.2	6.97	8.0
14	350	215T3N	304.8	12.00	215.9	8.50	14.5
		215T3L	355.6	14.00	215.9	8.50	17.5
16	400	215T3N	304.8	12.00	215.9	8.50	14.5
		215T3L	355.6	14.00	215.9	8.50	17.5
		241T3N	338.7	13.33	241.3	9.50	20.0
		241T3L	355.6	14.00	241.3	9.50	21.0
18	450	241T3N	338.7	13.33	241.3	9.50	20.0
		241T3L	355.6	14.00	241.3	9.50	21.0
20	500	273T3N	355.6	14.00	273.1	10.75	28.0
		273T3L	457.2	18.00	273.1	10.75	32.5
22	550	298T3L	457.2	18.00	298.5	11.75	43.0

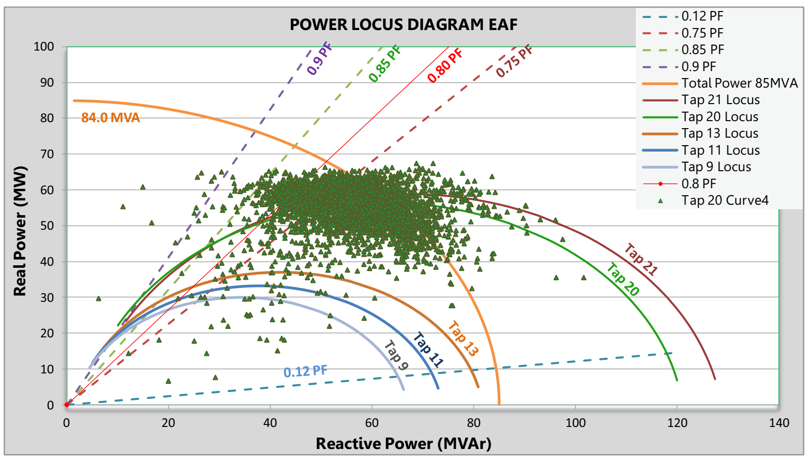
HEG offers all combinations of nipple (connecting pins) to cover diverse customer requirements. These can be selected from the above table.

CUSTOMER SERVICE THROUGH TECHNICAL EXPERTISE

With an optimum mix of expertise from various domains like Steel-making Electrics & metallurgy, Graphite Electrode Process and quality, Data analytics, Global technological development in EAF & Graphite-the Customer Technical Service (CTS) team has credentials to provide timely and complete service to customers. Several modules have been developed aiming at improving not only the electrode performance but also the efficiency of EAF operation.

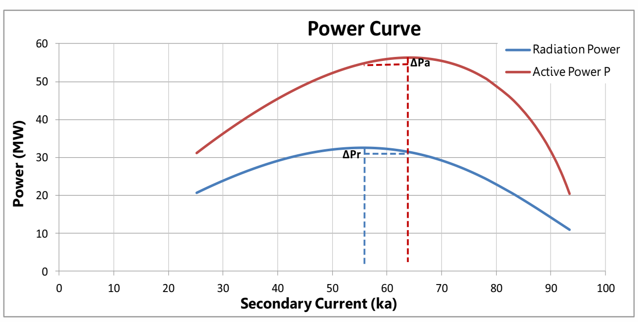
Service Modules

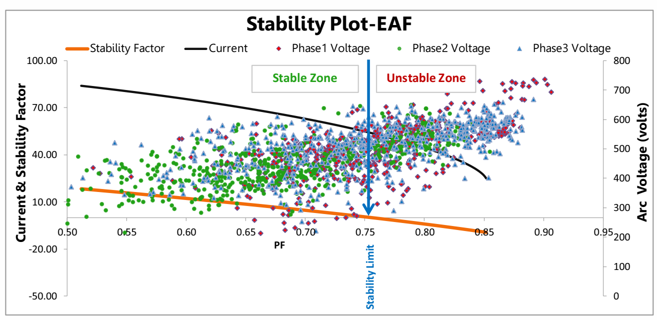
1. Establishing optimum operating points either for faster melting or for lower energy consumption
2. Analyzing arc stability and overall performance analysis of regulation system
3. Electrode consumption optimization
4. Furnace PCD effect on Electrode breakage and melting efficiency
5. Optimum Electrode Size and Grade for the EAF or LF
6. Joining practice and handling of Electrodes
7. General Power Quality Analysis of EAF



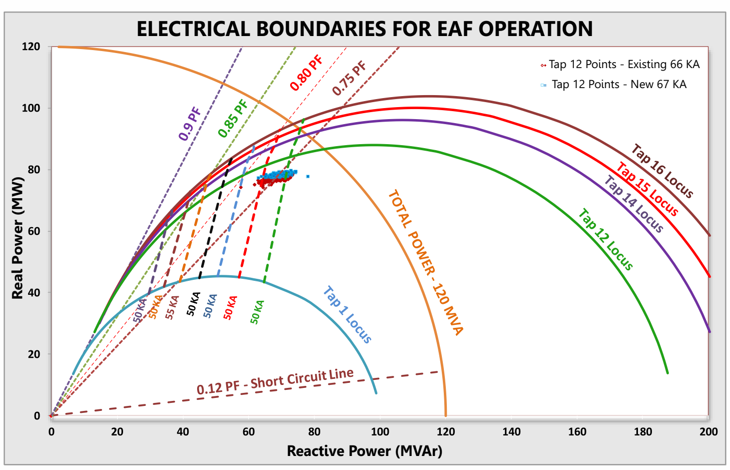
Plots and tools

Power Locus Diagram
Power Diagram-Active and Radiation power
Arc Stability Index Graph
Correlation Charts
Run Charts
Hysteresis Chart
Segmentation Graphs
Model deriving from regression
Phase balancing tool
Short circuit Dip test
Operating point tables





Boundaries of Operating Points of EAF/LRF:
The foundation for operating boundaries for different taps are derived by the power locus diagram



KNOWLEDGE SHARING

TECHNICAL INTERACTIVE SESSIONS FOR CUSTOMERS

AT HEG PREMISES

We believe that knowledge transfer is the key for mutual development. The willingness of many customers to participate in the target oriented technical sessions conducted by HEG LTD at our location is a testimony to the relation we share with them and value addition we bring for them. Leveraging on the data analytical skills and technical experience of CTS team, several modules have been developed aiming at improving not only the electrode performance but also the efficiency of EAF operation.

AT CUSTOMER LOCATION

We have dedicated CTS team for visiting customer location and provide value added services like knowledge sharing sessions on Electrode handling, EAF Electrics and for assessing the performance of Electrodes.

BEST PRACTICES

HEG provides training and analysis on best practices in EAF operation, handling & storage of electrodes, joint making at EAF & handling tools for electrodes.

- Supplying accessories for use of electrodes
- Recommendation on joining machine and tools
- Recommendation of tightening torque
- Water cooling of electrode column

CONTRIBUTION TOWARDS TECHNICAL RESEARCH ON STEELMAKING AND GRAPHITE

HEG presents the findings of research work it has done on changes and improvements related to graphite electrodes application in steel making in prestigious technical conferences globally. Some of the research work submitted by HEG LTD in Technical conference is given below,

1. To develop the indexes indicating dependency of arc stability in EAF on charge material quality and electrode regulation effectiveness
2. Optimization of Electrode Consumption in EAF for Different Operating Conditions Technical Article Published in “IRON & STEEL TECHNOLOGY I AIST.ORG“ magazine
3. Vibration Analysis on Electrode Column in AC EAF based on local force densities developed by rapid change of current and arc stability
4. Improving Energy Efficiency of EAF With Optimum Setting of Arc Stability

World Class UHP Graphite Electrodes

PROVEN CHOICE OF TOP STEEL MAKERS GLOBALLY

Notes

PROUD TO BE INDIAN
PRIVILEGED TO BE GLOBAL

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