



Expression of Interest (Eoi) for Technology Tie-up for manufacturing of Catalysts for SCR to reduce NOx emission

Subject: Technology Tie-up for Manufacturing of Catalysts for Selective Catalytic Reduction (SCR) to reduce NOx emission.

1) Introduction:

This Expression of Interest (Eoi) seeks response from original SCR Catalyst manufacturer meeting the requirements of this Eoi and willing to be associated with BHEL through a license & technology collaboration agreement on long term basis to enable BHEL to design, engineer, manufacture, assemble, test, supply, erect, commission, repair, service and retrofit the Catalysts for SCR for NOx reduction in high dust flue gases from thermal power plants and other applications. Original SCR Catalyst manufacturer shall ensure seamless transfer of technology to BHEL also covering selection / identification of raw material (preferably sourced locally in India) and conversion to catalyst batches.

1.1) About Bharat Heavy Electricals Limited (BHEL):

BHEL is a leading state owned company, wherein Government of India is holding 63.06% of its equity. BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing organization in India, catering to the core infrastructure sectors of Indian economy viz. energy, transportation, heavy engineering industry, Defence, renewable and non-conventional energy. The energy sector covers generation, transmission and distribution equipment for hydro, thermal, nuclear and solar photo voltaic. BHEL has been in this business for more than 50 years and BHEL supplied equipment account for more than 57% of the total thermal generating capacity in India. BHEL is also listed in Indian stock exchanges. The company has 17 manufacturing units, 4 power sector regions, 8 service centers, 8 overseas offices and 15 regional offices besides host of project sites spread all over India and abroad. The annual turnover of BHEL for the year 2015-16 was US\$ 4 Billion*. BHEL's highly skilled and committed manpower of approximately 42198 employees, the state-of-the-art manufacturing facilities and latest technologies, has helped BHEL to deliver a consistent track record of performance. To position leading state owned companies as Global Industrial giant and as a recognition for their exemplary performance, Government of India categorized BHEL as "Maharatna Company" in 2013, empowering the company with enhanced autonomy in decision making. With the current order book exceeding US\$ 16.7 Billion*, BHEL is poised for excellent future growth. Our ongoing major technology tie-ups include agreements with GE, USA (for Gas Turbines); GE Technology GmbH, Switzerland (for Once through Boilers and Coal Pulverisers); Siemens, Germany (for Steam Turbines, Generators and Condensers); Metso Automation Inc., Finland (for Control & Instrumentation); MHI, Japan (for Pumps); MHPS, Japan (for Flue Gas Desulfurization Systems); Vogt Power International, USA (for HRSG); GENP, Italy (for Compressors); Turbo Lufttechnik, Germany (for Fans) and Sheffield Forge Masters International, UK (for Forgings). More details about the entire range of BHEL's products and operations are available at www.bhel.com.

1.2) Ceramic Business Unit (CBU):

Ceramic Business Unit (CBU) works as strategic business unit of BHEL for ceramic products and systems. CBU is dedicated to the enhancement of business in ceramics and its associated systems. This business unit manufactures High tension Insulators, Ceramic wear resistant lined components & liners, Industrial ceramic products, LT Switchgear panels, Composite Insulators and associated systems. CBU has its headquarters at Bengaluru, Karnataka, India. At present, BHEL manufactures Porcelain Disc Insulators at two of its manufacturing facilities with state-of-the-art technology at:

[*Note: Currency conversion rate considered: 1 US \$= Rs 66.33 as on 31st March 2016]

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- Electroporcelain Division (EPD), Bengaluru, Karnataka, India
- Insulator Plant (IP), Jagdishpur, Uttar Pradesh, India

Both the units of CBU have well established manufacturing systems & procedures and have requisite skilled and experienced manpower. The Units are certified for the Quality Management System against ISO-9001:2008 and Health, Safety & Environmental Management (HSE) System for ISO-14001:2004 & OHSAS-18001:2007. The financial turnover of CBU for the year 2015-16 was US\$ 50 Million* and poised to grow further in the years to come. The products of CBU are tested and certified with respect to relevant National & Inter-National standards at reputed laboratories within the country and abroad. The CBU is the major supplier of Insulators to all the power transmission utilities, railways and power equipment manufacturers in the country. The operations of CBU are supported by Ceramic Technological Institute (CTI), Bengaluru a wing of BHEL Corporate R&D. CTI was established in 1989 with the aid of UNDP and is working on advanced Research and Development in Ceramics and allied fields.

1.3) About CBU Manufacturing Plants:

Electroporcelain Division (EPD), Bengaluru:

Electroporcelain Division, Bengaluru is one of the oldest and leading manufacturers of Porcelain Insulators for High Tension Power Transmission and Distribution in India. The unit was established in the year 1932 for manufacturing of Porcelain Insulators for Transmission lines. During 1960's and 1980's, the unit had Technology Tie-up with M/s NGK, Japan for manufacturing of higher rating Porcelain Disc Insulators and Hollow Insulators for instrument Transformers & Bushings.

EPD manufactures full range of insulators for both AC & DC transmission upto 765kV HVAC and ± 800 kV HVDC rating. EPD, Bengaluru makes BHEL the only company in the country offering DC transmission insulators upto 420 kN rating for ± 800 kV HVDC lines. Further, over the period of time, EPD-Bengaluru has developed in-house, manufactured and supplied Composite Long Rod (CLR) Insulators to major utilities of the country ranging upto 210 kN EMS rating for 400 kV AC Transmission Lines. Recently, CLR's for 765 AC applications has been developed and type tested.

In addition to Transmission Line insulators, EPD, Bengaluru also manufactures Hollow Porcelain Insulators for Instrument Transformers & Bushings upto 765 kV rating.

EPD also manufactures special high alumina ceramic components required for various industrial applications. Ceramic lined pipes and other components used in thermal power plant for coal pulverization and pneumatic conveying to burners is one significant product. Further, EPD also manufactures other high alumina ceramic components used in oil rigs, steel, cement and other industries for abrasion / wear resistant applications.

As a part of the ongoing R&D activities and development of new Ceramic Products, EPD has developed honeycomb ceramic products for pollution control and thermal storage applications.

The plant located in Bengaluru city has a total area of 156,000 sq. meters and is easily accessible from National Highways, Rail and Airport. The plant has well established factory building of about 100,000 sq meters and state-of-the-art industrial infrastructure for manufacture of diverse products enumerated above. Basic utilities like electrical power are from local utility at 11kV with in-house backup generators. Environment friendly Natural Gas is sourced from Dabhol-Bengaluru pipe line for the fuel needs of manufacturing

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operations.

Insulator Plant (IP), Jagdishpur:

BHEL Insulator Plant, Jagdishpur is the leading manufacturer of High Tension Porcelain Insulators in India. Established in the year 1984 through technological tie-up with M/s NGK, Japan, IP-Jagdishpur is serving major transmission utilities in the country with Disc Insulators up to 320 kN EMS for transmission lines up to 765 kV HVAC. IP, Jagdishpur also caters Porcelain hollow insulators upto 66 kV and bus bar support upto 24 kV system. Ceramic Liners (Ceralin) for wear resistant applications is another major product of IP, Jagdishpur.

BHEL Insulator Plant, Jagdishpur is spread in about 495,000 sq. metres area, located in Amethi District of Uttar Pradesh, 80 km from Lucknow on Lucknow-Varanasi National highway and is well connected by railroad and air as well. The plant has well established industrial building of more than 100,000 sq. metres and modern infrastructure for manufacture of the products detailed above.

Power is sourced from local state utility at 11kv with in-house backup generation facility and fuel is environment friendly Natural Gas sourced through Hazira-Bijapur-Jagdishpur (HBJ) gas pipeline.

2) Scope of cooperation:

BHEL is seeking Expression of Interest from original SCR Catalyst manufacturer for License and Technology Collaboration Agreement for manufacturing of SCR Catalysts to reduce NOx emission for thermal power plants and other applications. Interested reputed original SCR Catalyst manufacturers with proven Catalysts are invited to respond to this Eoi, as per indicative scope of technology transfer given in Annexure-1.

Upon receipt of responses against Eoi from original SCR Catalyst manufacturer, BHEL will review the responses to ascertain suitability of the offer made by the prospective Collaborator and shortlist the original SCR Catalyst manufacturers for further discussions. Detailed discussions on commercial and other terms and conditions to finalise the Technology Collaboration Agreement (TCA) shall be held with shortlisted original SCR Catalyst manufacturers. The detailed terms and conditions for such a paid-up license agreement shall be mutually agreed upon.

Business sharing option, during the initial period of technology assimilation by BHEL may also be considered.

Typical data on the coal being used and flue gas parameters in a thermal power plant for selection of De-NoX system is provided in Annexure - 5.

3) Prequalification requirements (PQR):

The prospective Collaborator shall meet following qualification requirements as on the date of submission of Eoi:

- a) Prospective Collaborator should have its own manufacturing facility for SCR Catalysts having minimum of five (5) years of experience in manufacturing of Catalysts for SCR for DeNOx application for thermal power plants and should have designed, engineered, manufactured and supplied Catalyst for SCR for large size Thermal Power Plants (500 MW or higher capacity unit or with steam generator having minimum 1500T/hr steaming capacity).

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AND

- b) Prospective Collaborator should have designed, engineered, manufactured and deployed SCR Catalyst with module and proven for high ash content Coal / Lignite fired power plants.

AND

- c) Prospective Collaborator should have proven operational experience (in 500 MW or higher capacity unit or with steam generator having minimum 1500T/hr steaming capacity) of minimum 16000 hours without any replacement of Catalyst during the period under high ash environment, with NO_x reduction efficiency more than > 80%. (To be substantiated with documentary proof)

AND

- d) Prospective Collaborator should have manufactured and supplied SCR catalyst modules in coal / lignite fired power plants with high ash content with proven performance including SCR catalyst management in the past 5 years and minimum two (2) installations should be outside the country of origin of prospective collaborator. (To be substantiated with a performance certificate from the end client/customer as documentary proof)

4) Brief Description of EoI Process:

The interested prospective Collaborators shall ensure that their response along with annexures (Indicative technical features of SCR Catalysts for NO_x reduction as per Annexure-2, Experience in the field of SCR Catalysts for NO_x reduction as per Annexure-3 and Detailed product reference for major supplies in last 5 years as per Annexure-4) are received by BHEL on or before 04th November 2016. The response shall necessarily be accompanied with details on company background, product profile, Catalysts for SCR proposed along with its technical details, Reference list of Customers, Performance certificate from customers, Product data sheet and annual audited financial reports for last 3 (three) years including auditor's report.

In case any further information is needed, kindly feel free to contact us.

The respondent shall submit their offer with all annexures duly signed. Your response may be sent to the following address:

Additional General Manager
Technology Licensing (TL)
Bharat Heavy Electricals Limited
BHEL House, Siri Fort
New Delhi - 110049, India
Phone: +91 11 66337210
Fax: +91 11 26492974
Email: rajesh.kohli@bhel.in

5) Miscellaneous:

5.1.1 Right to accept or reject any or all Applications:

- a) Notwithstanding anything contained in this EoI, BHEL reserves the right to accept or reject any Application and to annul the EoI Process and reject all Applications, at any time

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without any liability or any obligation for such acceptance, rejection or annulment and without assigning any reasons thereof. In the event that BHEL rejects or annuls all the Applications, it may, at its discretion, invite all eligible original SCR Catalyst manufacturer to submit fresh Applications.

- b) BHEL reserves the right to disqualify any Applicant during or after completion of Eoi process, if it is found there was a material misrepresentation by any such Applicant or the Applicant fails to provide, within the specified time, supplemental information sought by BHEL.
- c) BHEL reserves the right to verify all statements, information and documents submitted by the Applicant in response to the Eoi. Any such verification or lack of such verification by BHEL shall not relieve the Applicant of his obligations or liabilities hereunder nor will it affect any rights of BHEL.

5.1.2 Governing Laws & Jurisdiction:

The Eoi process shall be governed by, and construed in accordance with, the laws of India and the Courts at New Delhi (India) shall have exclusive jurisdiction over all disputes arising under, pursuant to and / or in connection with the Eoi process.

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Annexure-1

Indicative Scope of Technology Transfer

a)	Licensing & transfer of state-of-the-art technology relating to raw materials selection, catalyst formulation, Design, Engineering, Manufacturing, Assembly, Testing, Installation, Commissioning and Catalyst Management know how of the SCR Catalyst for high ash coal / lignite fired Power Plant applications and other DeNOx applications.
b)	Support BHEL in the design of plant for manufacturing of SCR Catalyst by way of providing specifications of the intended equipment for manufacturing, in process testing and final product evaluation.
c)	Transfer of all raw materials specification, batch formulations and its basis, design, design calculations, manufacturing drawings, technical and quality surveillance assistance and supervision during manufacturing, installation, testing, commissioning of SCR Catalysts and modules. This aspect shall also cover co-ordination with SCR system designers and meeting their specific requirements. Further, shall assist in selection / identification of raw material preferably locally sourced in India including its testing, evaluation and adoption.
d)	Assistance in planning & establishing the new manufacturing, raw materials identification, sampling, testing, validation through batch trial for acceptance, raw materials processing, catalyst preparation process design and optimization, catalyst acceptance testing, design and fabrication of shaping dies and tools, manufacturing process optimization, module performance testing and assembly facilities & processes / suitable augmentation at BHEL's existing facilities/processes by way of expert advice in terms of identifying, sizing & selection of equipment / machinery required for manufacturing, plant layout and testing and inspection facilities. Assistance for commissioning of the manufacturing facilities, design of special tools and dies, jigs & fixtures etc.
e)	Transfer of applicable and relevant knowledge and information pertaining to manufacture, testing and catalyst management.
f)	Transfer of improvements/modifications/developments/up gradations in line with the market requirements and introduction of new or stringent norms / statutory requirements during the period of TCA.
g)	Training of BHEL Engineers to enable them design, engineer, manufacture, assemble, quality control, test and catalyst management of SCR catalyst for DeNOx application in Thermal Power Plants and other applications.
h)	Deputation of Collaborator's experts to assist BHEL in absorbing the technology for SCR Catalyst and modules for DeNOx application in Thermal Power Plants and other applications.
i)	Support through engineering services from Collaborator's design office / manufacturing facilities for SCR Catalyst for DeNOx application in Thermal Power Plants and other applications.

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Annexure-2

Indicative technical features of SCR Catalyst & Modules offered

a)	<p>Type of SCR Catalyst:</p> <p>Standard cross section dimensions, Standard length, reactive surface area per unit volume, pitch, wall thickness, pore size & distribution, type of catalyst, openings per unit volume, and weight per unit volume. Additional information if any.</p>
b)	<p>Material:</p> <p>Base material of catalyst and other major components, casing material of construction for modules, insulation material, material used for catalyst regeneration. Additional information if any.</p>
c)	<p>Operating conditions:</p> <ul style="list-style-type: none">• Temperature, flow, velocity, composition of flue gas• Ammonia concentration range needed for SCR catalyst, SO₂ to SO₃ conversion by catalyst, life of catalyst on average in high ash conditions, catalyst efficiency with respect to NOx reduction, frequency of soot blowing needed, frequency of catalyst layer replacements, efficiency of regenerated catalyst under high ash conditions.

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Annexure -3

Prospective Collaborator's Experience in the field of SCR Catalyst for DeNOx application in Thermal Power Plants & other applications

Sl. No.	Requirement	Prospective Collaborator's response YES/NO and remarks if any
a)	Whether the Prospective Collaborator is an original SCR Catalyst manufacturer for SCR Catalyst for DeNOx application in high ash (>35 gm/NM ³) Thermal Power Plants.	
b)	Whether Prospective Collaborator has its own manufacturing facility for SCR Catalyst for DeNOx application for thermal power plants.	
c)	Whether Prospective Collaborator is having minimum of five (5) years of experience of manufacturing SCR Catalyst for DeNOx application for thermal power plants.	
d)	Whether Prospective Collaborator has designed, engineered, manufactured and supplied Catalyst for SCR for large size Thermal Power Plants (500 MW or higher capacity unit or with steam generator having minimum 1500T/hr steaming capacity).	
e)	Whether Prospective Collaborator has designed, engineered, manufactured and deployed SCR Catalyst with module and proven for high ash content (>35 gm/NM ³) Coal / Lignite fired power plants.	
f)	Whether Prospective Collaborator has proven operational experience (in 500 MW or higher capacity unit or with steam generator having minimum 1500T/hr steaming capacity) of minimum 16000 hours without any replacement of Catalyst during the period under high ash environment (>35 gm/NM ³), with NOx reduction efficiency more than > 80 %	
g)	Whether Prospective Collaborator has manufactured and supplied SCR catalyst modules in coal / lignite fired power plants with high ash content (>35 gm/NM ³) with proven performance including SCR catalyst management in the past 5 years	
h)	Whether Prospective Collaborator has supplied minimum two (2) installations outside the country of origin of prospective collaborator	
i)	Whether Prospective Collaborator has supplied Catalyst module of minimum 60,000 hrs. expected mechanical life	
j)	Whether Company background and its product profile along with technical details for Catalysts for SCR for DeNOx application in Thermal Power Plants is being offered to BHEL under this Eoi enclosed.	

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k)	Whether Product data sheet has been enclosed	
l)	Whether information on market share has been enclosed	
m)	Whether Prospective Collaborator's detailed reference list has been enclosed	
n)	Whether Prospective Collaborator's annual audited financial reports including auditor's report for last 3 years has been enclosed	
o)	Whether the Catalysts for SCR for DeNOx application in high ash (>35 gm/NM ³) Thermal Power Plants offered for technology transfer is the latest being marketed by the Prospective Collaborator	
p)	Whether customers (end users) letters / documentary evidence of minimum 16000 hours of SCR Catalyst operational experience without any replacement of Catalyst during the period under high ash environment (>35 gm/NM ³), with NOx reduction efficiency more than > 80% is being offered to BHEL under this Eoi enclosed.	
q)	<p><i>"Prospective Collaborator should have manufactured and supplied SCR catalyst modules in coal / lignite fired power plants with high ash content with proven performance including SCR catalyst management in the past 5 years and minimum two (2) installations should be outside the country of prospective collaborator".</i></p> <p>Whether a performance certificate from the end client/customer as documentary proof to substantiate the above PQR has been submitted by Prospective Collaborator.</p>	
r)	Whether the Prospective Collaborator has supplied Catalysts for SCR with SO ₂ Oxidation rate of ≤ 1% and Ammonia slip < 3ppm	
s)	<p>Whether the Prospective Collaborator owns the Intellectual Property Rights for the technology being proposed for transfer under the Technology Collaboration Agreement (TCA) or have an unencumbered right from the owner of the Intellectual Property Rights to sub-license the technology, if applicable.</p> <p>If yes, whether list of such Intellectual Property Rights enclosed.</p>	
t)	Whether the Prospective Collaborator has any experience in establishing a new manufacturing, testing and assembly facilities, if so please specify.	
u)	Whether Prospective Collaborator has confirmed their Design & performance assurance of Catalysts for SCR as per the indicative fuel analysis and flue gas parameters provided in Annexure - 5	

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Annexure -4

Reference List: The Prospective Collaborator shall furnish a summary of their product reference as detailed below for major supplies in last 5 years

Sl. No	Project Name / Location	Plant Rating	Type of SCR, Pitch	Ash content	Velocity, Temp & Space Velocity	Year of Supply	No. and Year of Replacements	Total Hours used per cycle	SO ₂ Oxidation rate	% NOx reduction achieved	NH ₃ slip	Other Remarks if any

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Annexure -5

TYPICAL FUEL ANALYSIS

DESCRIPTION (Source / Type)	UNIT	DESIGN COAL	WORST COAL	BEST COAL
PROXIMATE ANALYSIS				
Fixed carbon	%	29	26	25.5
Volatile matter	%	20	19	27.5
Moisture	%	9	12	12
Ash	%	42	43	35
Total	%	100	100	100
HHV	kcal / kg	3455	3220	4250
LHV	kcal / kg			
Ash	kg / 10 ⁶ kcal			
ULTIMATE ANALYSIS				
Carbon	%	37.6	33.5	41.7
Hydrogen	%	2.1	2.4	3.4
Sulphur	%	0.55	0.45	0.25
Nitrogen	%	1.5	1.3	1.0
Oxygen (difference)	%	7.25	7.35	6.65
Moisture	%	9	12	12
Ash	%	42	43	35
Carbonates	%			
Phosphorous	%			
HARD GROVE INDEX		53	50	49
ASH CHARACTERISTICS				
IT - Initial deformation temp.	°C	1150	1100	1200
ST - Softening temp. H = W	°C	-	-	-
HT - Hemispherical temp. H = W / 2	°C	1300	1250	1350
FT - Fusion temp.	°C	>1400	>1400	>1400
ASH CONSTITUENTS (avg)				
A - Si O ₂	%	58.7		
A - Al ₂ O ₃	%	28.35		
B - Fe ₂ O ₃	%	7.41		
B - CaO	%	1.07		
B - MgO	%	0.7		
B - Na ₂ O	}	0.72		
B - K ₂ O				
A - TiO ₂	%	2.06		
P ₂ O ₅	%	0.40		
SO ₃	%	0.0		
Others	%	0.59		
Base / Acid Ratio				
Fe ₂ O ₃ / CaO Ratio				
Chloride				

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DESCRIPTION (Source / Type)	UNIT	Imported Coal		
PROXIMATE ANALYSIS				
Fixed carbon	%	40		
Volatile matter	%	26		
Moisture	%	30		
Ash	%	4		
Total	%	100		
HHV	kcal / kg	5000		
LHV	kcal / kg			
Ash	kg / 10 ⁶ kcal			
ULTIMATE ANALYSIS				
Carbon	%	47.72		
Hydrogen	%	2.38		
Sulphur	%	0.22		
Nitrogen	%	1.58		
Oxygen (difference)	%	14.1		
Moisture	%	30		
Ash	%	4		
Carbonates	%			
Phosphorous	%			
HARD GROVE INDEX				
ASH CHARACTERISTICS				
IT - Initial deformation temp.		°C		
ST - Softening temp. H = W		°C		
HT - Hemispherical temp. H = W / 2		°C		
FT - Fusion temp.		°C		

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TYPICAL FLUE GAS PARAMETERS

Typical Data for Selection of De-NO_x System

Sl No	Description	Units	Load
			BMCR-DC
1	Flue gas flow at Economiser Outlet	kg/hr	2731017
2	Typical Range of Flue gas temperature entering SCR	deg C	240 to 350
3	Flue gas temperature entering SCR	deg C	324
4	Total Volumetric Gas Flow at Sl No 3	m ³ /hr	4636701
5	Total Volumetric Gas Flow	Nm ³ /hr	2122078
6	Flue gas constituents, Wet Basis - % By Weight		
i	CO ₂	%	21.852
ii	N ₂	%	68.913
iii	O ₂	%	3.458
iv	SO ₂	%	0.174
v	H ₂ O	%	5.603
7	SO ₃ in Flue gas at SCR Inlet @ 6% O ₂ (Considering 1.5 % Conversion)	ppm	10.08
8	Inlet (APH) Particle Dust Concentration	gm/Nm ³	73.9
9	NO _x concentration to SCR Inlet	mg/Nm ³	> 300
10	NO _x required at Chimney	mg/Nm ³	<100

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