Subject: Technology Tie-up for Selective Non Catalytic Reduction (SNCR) DeNOx System

1) Introduction:

This Expression of Interest (EoI) seeks response from OEMs of SNCR system 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, quality control, test, supply, erect, commission, repair, service and retrofit the complete SNCR DeNOx System for thermal power plants and for other applications.

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 2016-17 was US$ 4.45 Billion*. BHEL's highly skilled and committed manpower of approximately 39821 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$ 16.2 Billion*, BHEL is poised for excellent future growth. Our ongoing major technology tie-ups include agreements with 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), Sheffield Forge Masters International, UK (for Forgings) and Kawasaki Heavy Industries, Japan (for Stainless steel metro coaches & bogies). More details about the entire range of BHEL's products and operations are available at www.bhel.com.

1.2) High Pressure Boiler Plant (HPBP), Tiruchirappalli:

High Pressure Boiler Plant (HPBP), established in 1965 at southern part of India at Tiruchirappalli in Tamilnadu state is one of the major manufacturing units of BHEL dedicated to production of various kinds of Steam Generators. HPBP has established itself as leading reliable boiler manufacturer with worldwide references in numerous overseas territories including Europe, Middle-East, CIS countries and South-East Asia. HPBP not only manufactures pulverized coal fired boilers but also manufactures CFBC boilers, HRSGs, valves, oil field equipment and many other products of strategic importance for defence sector. HPBP has strong global reference base of various kind of boilers ranging from 30 MWe to 800 MWe. Valves division of HPBP manufactures around 100,000 valves a year.

[*Note: Currency conversion rate considered: 1 US $= Rs. 64.84 as on 31st March 2017]

2) Scope of cooperation:

BHEL is seeking Expression of Interest from OEMs through License and Technology Collaboration Agreement for complete SNCR system and its integration with boiler to reduce NOx emission for thermal power plants.

Interested reputed OEMs with proven SNCR system are invited to submit their offer in response to this EoI, as per indicative scope of technology transfer given in **Annexure-1**.

SNCR system would broadly include reagent unloading, storage, conveying system, reagent area safety system, solutionizing, decomposition system, reagent pumping, mixing and metering modules, distribution modules, injection system, waste reagent disposal system, electrical and C&I system, other associated systems for successful operation of the SNCR DeNOx system as per customer/site requirements.

Upon receipt of responses against this EoI, BHEL will review the responses to ascertain suitability of the offer and shortlist the Prospective Collaborators for further discussions. Detailed discussions on commercial and other terms and conditions to finalise the Technology Collaboration Agreement (TCA) shall be held with shortlisted Prospective Collaborators. 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 SNCR DeNOx 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 at least ten (10) years of experience in designing, engineering, manufacturing, supply, erection, commissioning, performance testing, operation and maintenance of state-of-the-art SNCR DeNOx system for Thermal Power Plants. **(To be substantiated by supply reference or any other relevant documentary proof)**

AND

b) Prospective Collaborator should have designed, engineered, manufactured/got manufactured/supplied, erected/supervised erection and commissioned/supervised commissioning of at least one (1) no. of aqueous ammonia as reagent for SNCR System, with NOx reduction efficiency of not less than 30%, operating in conjunction with pulverized coal fired steam generator or Circulating Fluidized Bed Combustion (CFBC) boiler, of 100 MWe and above rating. Further, such SNCR System should have been in successful operation for a period not less than one (1) year as on date of closing of this EoI. **(To be substantiated with a performance certificate issued by the end client/customer as documentary proof)**

AND

c) Prospective Collaborator should have designed, engineered, manufactured/got manufactured/supplied, erected/supervised erection and commissioned/supervised

commissioning of at least one (1) no. of urea as reagent for SNCR System, with NOx reduction efficiency of not less than 30%, operating in conjunction with pulverized coal fired steam generator or Circulating Fluidized Bed Combustion (CFBC) boiler, of 100 MWe and above rating. Further, such SNCR System should have been in successful operation for a period not less than one (1) year as on date of closing of this EoI. **(To be substantiated with a performance certificate issued by 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 (Broad technical capabilities of Prospective Collaborator and indicative technical features of SNCR DeNox System Proposed for TCA as per **Annexure-2**, Experience in the field of SNCR DeNOx system as per **Annexure-3** and detailed product reference for major supplies in last 10 years as per **Annexure-4**) are received by BHEL on or before **12th September 2017**. The response shall necessarily be accompanied with details on company background, product profile, SNCR system 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)
Corporate Technology Management
Bharat Heavy Electricals Limited
BHEL House, Siri Fort
New Delhi – 110049, India
Phone: +91 11 66337210/7218
Fax: +91 11 26492974
Email: techeoi@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 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 Prospective Collaborators 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.

Annexure-1

Indicative Scope of Technology Transfer

a)	Transfer of up-to-date Technical Information relating to the design, engineer, manufacture, assemble, quality control, test, supply, erect, commission, repair, service and retrofit of the SNCR system
b)	Training of BHEL Engineers at Collaborator's design office/manufacturing facilities to enable them design, engineer, manufacture, assemble, quality control, test, erect and commission the SNCR System in Thermal Power Plants and other applications.
c)	Transfer of improvements/modifications/developments/up gradations to meet market requirements and environment norms / statutory requirements during the period of TCA
d)	Transfer of information to enable BHEL to source/procure those items, which the Prospective Collaborator sources from outside (as these are not manufactured by the Prospective Collaborator) for use in the SNCR systems.
e)	Transfer of site feedback and troubleshooting information
f)	Transfer of applicable computer programs including logics and source code.
g)	Assist BHEL in combustion cross section temperature mapping techniques along with equipment, instruments required.
h)	Assist BHEL in stabilising manufacturing of various critical components in SNCR system. Assist BHEL in identifying sub vendors for all the sub systems and bought out items.
i)	Provide technical assistance and quality surveillance / supervision during design, engineer, manufacture, assemble, quality control, test, supply, erect, commission, repair, service and retrofit of SNCR system.
j)	Provide support through engineering services from Collaborator's design office / manufacturing facilities for design vetting of SNCR system.
k)	Deputation of Collaborator's experts either at BHEL's manufacturing facilities or project sites to assist BHEL in assimilating the technology for SNCR system in Thermal Power Plants and other applications.

(SIGNATURE)

Annexure-2

Broad technical capabilities of Prospective Collaborator and indicative technical features of SNCR DeNox System Proposed for TCA

Sl. No.	Description	Prospective Collaborator's response
1.	Indicate whether Prospective Collaborator has the capability to perform the following to address requirements of new and retrofit SNCR system at furnace / cyclone areas in various types of boilers viz. pulverized coal, CFBC boilers, AFBC boilers, Municipal Solid Waste (MSW) and other applications:	
	a) Capability in preparation of complete arrangement including layout of all equipments starting from reagent (ammonia/urea) unloading system up to injection points in furnace/boiler and selection of number of injection points and its locations in various areas of boiler system	
	b) P&ID of the SNCR System starting from reagent unloading upto furnace injection points	
	c) Design calculations for design and selection of SNCR injection nozzles / reagent requirements, etc.	
	d) Computational Fluid Dynamics (CFD) analysis for the furnace system for uniform flow distribution/ Chemical Kinetic Modelling.	
	e) Stress analysis and design of the various components and supports in SNCR system and also provide basic design and detailed engineering, for all components to enable BHEL for in-house manufacturing, even if same is outsourced by Prospective Collaborator	
	f) Design basis and selection of various components of the SNCR system along with valves, piping & instrumentation and their location and quantum for reagent unloading system including reagent conveying system from trailer to silo, solutionizing/ dissolving tank, transfer pumps to storage tank from reagent solution storage tanks & system, decomposition chamber, reagent area fogging system (safety system in all applicable areas) sprinklers, reagent forwarding pump system,	

Sl. No.	Description	Prospective Collaborator's response
	dilution water pumps system, mixing and metering modules, distribution modules, atomising air mixing system, reagent Injection nozzles/lances system, waste reagent dilution tank system along with sump to waste treatment system, temperature mapping in furnace.	
	g) Capability in preparing specification for various Bought out Items in each of the system listed in (f) above, and all other items which are required for completeness of the SNCR system.	
	h) Design of reagent (Aqueous Ammonia/Urea) handling system for various form of reagent (Aqueous Ammonia/Urea) including reagent unloading, Urea Conveying system to Bunkers and bunkers to solution tanks, Solutionizing and Storage tanks, Safety and statutory regulations, Reagent Solution transport from storage to boiler, preparation of Reagent for injection to boiler and all other components.	
	i) Selection of analysers, electrical equipment, control & instrumentation (architecture and control logics) for complete SNCR system and integration of SNCR system with boiler	
	j) Capability in preparation of design basis for complete SNCR system.	
	k) Capability in preparation of Hazard and Operability (HAZOP) study for complete SNCR system	
	l) Manufacturing drawings for the total SNCR system	
	m) Erection procedure for complete SNCR system and erection drawings for SNCR system.	
	n) Complete list of equipment required for SNCR system for handling, installation and maintenance	
	o) Capability in preparation of Complete Bill of Materials for SNCR System	

Sl. No.	Description	Prospective Collaborator's response
	p) Operation and maintenance of SNCR system	
	q) Performance guarantee test procedure	

(SIGNATURE)

Annexure -3

Prospective Collaborator's Experience in the field of SNCR Catalyst for NOx redution application in Thermal Power Plants & other applications

Sl. No.	Requirement	Prospective Collaborator's response YES/NO and remarks if any.
1)	For how many years, Prospective Collaborator is in business of SNCR (Selective Non Catalytic Reduction) system	
2)	Whether Prospective Collaborator has carried out system design of SNCR located at boiler furnace in typical utility boilers	
3)	Whether Prospective Collaborator has carried out system design of SNCR located at Furnace, Cyclone inlet/outlet/backpass in typical CFBC/AFBC boilers.	
4)	Whether Prospective Collaborator has carried out system design of SNCR for Municipal Solid Waste (MSW) or WTE applications.	
5)	Whether Prospective Collaborator has carried out system design of SNCR for other process application.	
6)	Maximum Unit Size or Capacity (MWe rating) for PF Fired Boiler with urea as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
7)	Maximum Unit Size or Capacity (MWe rating) for CFBC Boiler with urea as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
8)	Maximum Unit Size or Capacity (MWe rating) for MSW with urea as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
9)	Maximum Unit Size or Capacity (MWe rating) for PF Fired Boiler with aqueous ammonia as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
10)	Maximum Unit Size or Capacity (MWe rating) for CFBC Boiler with aqueous ammonia as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
11)	Maximum Unit Size or Capacity (MWe rating) for MSW with aqueous ammonia as reagent supplied by Prospective Collaborator (Name of the Plant with details)	
12)	Whether Company background and its product profile along with technical details of SNCR system for Thermal Power Plants which is being offered to BHEL under this EoI enclosed.	

Sl. No.	Requirement	Prospective Collaborator's response YES/NO and remarks if any.
13)	Whether Product data sheet has been enclosed	
14)	Whether information on market share has been enclosed	
15)	Whether Prospective Collaborator's detailed reference list has been enclosed	
16)	Whether Prospective Collaborator's annual audited financial reports including auditor's report for last 3 years has been enclosed	
17)	*"Prospective Collaborator should have at least ten (10) years of experience in designing, engineering, manufacturing, supply, erection, commissioning, performance testing, operation and maintenance of state-of-the-art SNCR DeNOx system for Thermal Power Plants."* Whether Prospective Collaborator meets above PQR and requisite supply reference or any other relevant documentary evidence to substantiate the above PQR has been submitted.	
18)	"*Prospective Collaborator should have designed, engineered, manufactured/got manufactured/supplied, erected/supervised erection and commissioned/supervised commissioning of at least one (1) no. of aqueous ammonia as reagent for SNCR System, with NOx reduction efficiency of not less than 30%, operating in conjunction with pulverized coal fired steam generator or* Circulating Fluidized Bed Combustion (CFBC) boiler, of 100 MWe and above rating*. Further, such SNCR System should have been in successful operation for a period not less than one (1) year as on date of closing of this EoI.*" Whether Prospective Collaborator meets above PQR and requisite performance certificate issued by the end client/customer as documentary proof to substantiate the above PQR has been submitted.	
19)	*"Prospective Collaborator should have designed, engineered, manufactured/got manufactured/supplied, erected/supervised erection and commissioned/supervised commissioning of at least one (1) no. of urea as reagent for SNCR System, with NOx reduction efficiency of not less than 30%, operating in conjunction with pulverized coal fired steam generator or* Circulating Fluidized Bed Combustion (CFBC) boiler, of 100 MWe and above rating*. Further, such SNCR System should have been in successful operation for a period not less than one (1) year as on date of closing of this EoI."* Whether Prospective Collaborator meets above PQR and requisite performance certificate issued by the end client/customer as documentary proof to substantiate the above PQR has been submitted.	

Sl. No.	Requirement	Prospective Collaborator's response YES/NO and remarks if any.
20)	Whether the Prospective Collaborator has supplied SNCR system with Ammonia slip < 10ppm	
21)	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. If yes, whether list of such Intellectual Property Rights enclosed.	
22)	Whether Prospective Collaborator has confirmed their Design & performance of SNCR as per the indicative fuel analysis and flue gas parameters provided in Annexure-5.	
23)	Whether Prospective Collaborator has offered technology license to any other company in the world for supply of SNCR system in Thermal power plants	

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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 10 years

Sl No	Customer/ Country	Ash %	Unit Rating MWe	No of units	Type of Boiler: PF (Tower / Two pass) CFBC / BFBC/ MSW or WTE	Type of fuel	Supply type: New / Retrofit	Date of order	Commissioning Date	Steaming capacity, t/h	Dust concentration at SNCR inlet g/Nm3	Inlet NOx mg/ Nm3 (at 6% O2 dry)	Outlet NOx mg/ Nm3 (at 6% O2 dry)	NH3 slip, ppm	Reagent Type	No and location of injection points	NOx reduction efficiency %

Description	Design (Yes / No)	Engineering (Yes/No)	Manufactures/Got Manufactured /Supply	Erection / Supervised Erection	Commissioning / Supervised Commissioning
Reagent unloading and conveying system					
Reagent storage tank system					
Regent fogging and spray system					
Dilution water and Atomising air system					
Reagent solution forwarding pump system					
Urea solutionizing and decomposition system					
Reagent injection & distribution system					
Mixing and metering system					

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Annexure -5

TYPICAL COAL ANALYSIS

Description (Source / Type)			
Proximate Analysis	Coal - 1	Coal -2	Range of adequacy coal
Fixed carbon %	24	40	19.25 - 40
Volatile matter %	22	30	18.75 - 45
Moisture %	14	20	10 -17.5
Ash %	40	10	32 - 44.5
Total %	100	100	
HHV kcal / kg			
LHV kcal / kg			
Ash kg / 10^6 kcal			
Ultimate Analysis			
Carbon %	34	56.4	28.85 – 62
Hydrogen %	3.1	4.5	2.3 – 4.9
Sulphur %	0.4	0.9	0.35 – 0.8
Nitrogen %	1.2	0.9	0.57 – 1.23
Oxygen % (by difference)	7.3	7.3	5.41 - 9.17
Total Moisture %	14	20	10 - 20
Carbonates %	----	0	----
Phosphorous %	----	0	----
Ash %	40	10	32 - 44.5
Total	100	100	
Hard Grove Index	50	45	45-70
YGP Index (mg/kg)	75	100	65-100
GCV Kcal/Kg	3500	5800	2900-6500
Ash Characteristics (Under reduced atmosphere)			
IT - Initial deformation temp. °C	1150	1100	1100-1200
ST - Softening temp. H = W °C	-		-
HT - Hemispherical temp. H = W/2 °C	1300	1300	1250-1350
FT - Fusion temp. °C	1400	1400	1350-1400
Ash Constituents			
A - $S_i O_2$ %	58.59	32.74	56.29-60.42
A - $Al_2 O_3$ %	26.77	30.5	25.9-30.5
B - $Fe_2 O_3$ %	8.8	18.2	7.6-18.2
B – MgO %	1	1.83	0.92-1.93
B – CaO %	1.39	6.12	1.28-7.62
B - $Na_2 O$ %	0.2	0.3	0.08-0.5
B - $K_2 O$%	----	----	----
A - TiO_2 %	1.66	1.56	1.52-1.86
P_2O_5 %	0.19	0.44	0.08-0.54
Sulphuric Anhydride%	0.05	6.95	0.04-7.65
Alkalies (by difference)	1.35	1.36	1.36-1.56
Total	100	100	

Typical flue gas parameters			
Application	**PF fired boiler**	**PF fired boiler**	**CFBC**
Flue gas flow, t/hr. at SNCR inlet (Wet Basis)	1080	2245	490
Flue gas flow, m^3/s at SNCR inlet (Wet Basis)	1215	2495	440
Flue gas flow, Nm^3/s at SNCR inlet (Wet Basis)	233	481	107
Flue Gas Temperature, °C	1125	1125	880
Density of Flue gas, kg/m^3	0.25	0.25	0.31
Flue Gas Composition at SNCR Inlet (Wet Basis)			
SO_2 % by Vol.	0.04	0.04	0.04
Moisture % by Vol.	11.4	11.4	11.4
CO_2 % by Vol.	14.174	14.174	14.174
O_2 % by Vol.	3.136	3.136	3.136
N2 % by Vol.	71.25	71.25	71.25
Flue gas pressure at inlet of SNCR, mmwc	-5	-5	-20
Inlet Dust Concentration g/Nm^3	60.5	60.5	60.5
Inlet NOx Concentration mg/Nm^3 (6% O_2)	500	500	200- 300
Outlet NOx guaranteed concentration required mg/Nm3 (6% O_2 dry)	**< 300**	**< 300**	**< 100**

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