



Subject: Technical Collaboration for Excitation Systems

1) INTRODUCTION

This Expression of Interest (EOI) seeks response from Original Equipment Manufacturers(OEMs), who are willing to be associated with BHEL through a license & technical collaboration agreement, to enable BHEL to design, manufacture, supply and commission state of the art Excitation Systems (both direct & indirect excitation systems) to meet market requirements.

1.1) BHEL is a leading Government of India owned Public Sector Undertaking. BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing organizations in India, catering to the infrastructure sectors of Indian economy viz. energy, transportation, industry and non-conventional energy. The energy sector covers generation, transmission and distribution equipment for hydro, fossil, and gas fuels. BHEL has been in this business for nearly 50 years and BHEL supplied equipment account for 61 % of the total thermal generating capacity in India. Nearly 68% of the equity is owned by the Government of India. The company has 15 manufacturing units, 4 power sector regions, 8 service centers, 10 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 2012-13 was **US \$ 9.22 Billion**, with profit before tax of **US \$ 1.73 Billion**. BHEL's highly skilled and committed manpower of approximately **49390** employees, the best of manufacturing facilities and practices together with the latest technologies, has helped BHEL to deliver a consistent track record of performance. With the current order book exceeding **US \$ 21.19 Billion**, BHEL is poised for excellent future growth. Our ongoing major technology tie-ups include agreements with GE, USA (for gas turbines); Siemens, Germany (for steam turbines, generators and condensers); Metso Automation Inc., Finland (for control & instrumentation); Alstom, France (for Super-Critical Boilers & pulveriser); MHI, Japan (for pumps & FGD); 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 can be obtained by visiting our web site www.bhel.com.

1.2) The Electronics Division (EDN) (www.bheledn.com) of BHEL has been operating in the areas of Automation and Power Electronics since 1976. Most of the power plants and industries in the country today are equipped with electronic products and systems which have been manufactured and supplied by BHEL EDN. BHEL also has a good international reference by way of exports to European, Middle-



East and South-East Asian markets. BHEL EDN has been accredited with ISO 9001, ISO 27001, ISO 14001 and OHSAS 18001 standard certifications.

As part of Power Plant automation, BHEL-EDN has been manufacturing Excitation systems from 1978. Over 1600 units of Excitation systems covering all types of applications have been designed, manufactured and supplied by BHEL (both direct and indirect type), based on different hardware platforms and are in operation in India as well as abroad. This includes about 1000 sets (both direct and indirect type) supplied with well proven microprocessor based hardware presently being used by BHEL.

- 1.3) The current trend in the country is for adoption of higher size of units of the range from 660 MW - 800 MW as majority of the new thermal plants are going to be with super critical technology. Similar trend is likely with hydro and nuclear plants also. The country aspires to add another 200 GW of power generating capacity within the next ten years in the areas of thermal, Hydro, Nuclear, Industry and Gas based plants including installation of large size Super Critical Power Plants. The customers in India, however, generally insist for proven equipment by specifying in the Qualification Requirements that at least one unit of similar design and rating should have operated satisfactorily for a minimum of 1 year as on the date of submission of the offer.
- 1.4) In order to meet such market requirements and to upgrade the present level of technology for Excitation systems for all ratings, BHEL intends to enter into a technology transfer arrangement with a leading Original Equipment Manufacturer (OEM). The scope of technology transfer should be sufficient to enable BHEL to design, manufacture, test, erect, commission, repair and service and retrofit the Excitation System Panels and to manufacture & test the Printed Circuit Boards & subassemblies. The detailed terms and conditions for such a paid-up license agreement can be mutually agreed upon.

2) Scope of cooperation

BHEL therefore seeks a partner for entering into a Technology Collaboration Agreement (TCA) for state of the art & proven Excitation systems. The duration of the TCA shall be around 8 years. Business sharing during the initial period of technology assimilation by BHEL can be considered. Indicative scope of technology transfer for Excitation systems along with its associated subsystems is given in **Annexure-1**.



2.1) The TCA shall enable BHEL to engineer, design, manufacture, assemble, test, install, commission, retrofit and service the Excitation systems for synchronous machines of rating ranging from 1 MW to 800 MW with the proposed hardware platform. TCA shall also cover the manufacture & testing of PCB's and subassemblies used in the Excitation systems by BHEL at its works. The documentation and training shall be in English.

3) Prequalification requirements:

3.1) The prospective collaborator shall own the IPRs for the technology being proposed for transfer under the TCA, OR have unencumbered right from the owner of the IPRs to sub-license the technology.

3.2) The prospective collaborator shall have an experience of minimum 10 years in the design, engineer, manufacture and installation of Excitation Systems (both direct & indirect Excitation Systems) **AND** shall have designed, engineered, manufactured, erected and commissioned (E&C could be directly or through associates), Excitation Systems, with any hardware platform, for 500 sets or more, consisting of both direct and indirect Excitation Systems, for different types of machines of various ratings. The above experience shall include microprocessor based static excitation equipment for at least 2 turbo-generators of rating 800 MW or more which are in successful operation for more than 2 years. Information corroborating OEM's experience as above may be provided as per **Annexure-2**.

3.3) Further, with the state-of-the-art hardware platform being proposed for technology tie up, OEM should have supplied and installed at least 20 sets of Excitation Systems; including at least 1 (one) Static Excitation System for turbo generator of 800 MW or more which is in successful operation for a period of 6 months or more as on the closing date of this EOI. Information corroborating OEM's experience as above with the software/hardware platform being proposed for technology transfer may be provided as per **Annexure-4**.

3.4) The minimum technical specifications to be met by the system being proposed under the technical collaboration agreement are listed in **Annexure-3**.

4) The interested OEM's shall ensure that their response is received by BHEL on or before September 30, 2013. The response shall necessarily be accompanied with details on company background, technical features/ product catalogue, reference list, annual financial reports for last 3 (three) years etc. In case any further information is needed, kindly feel free to contact us.



Your response may be sent to the following address:

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Annexure - 1

Indicative Scope of Technology Transfer

a)	Licensing & transfer of state of the art technology relating to the design, engineering, manufacture, assembly, quality control, testing, installation, commissioning, maintenance & operation and retrofitting of the excitation systems.
b)	Information to enable manufacture & testing by BHEL of all types of electronic cards/sub-assemblies required to be used in the excitation system, as per the present design of the OEM.
c)	Information to enable BHEL to source/procure the items, which the OEM sources from outside (as they are not manufactured by the OEM) for use in the excitation systems.
d)	Transfer of computer programs including logics and source code
e)	Information to enable manufacturing by BHEL of all types of power modules viz Thyristor stacks and IGBT stacks being used by the OEM at present to meet the different requirements economically.
f)	Improvement/modification/developments/up gradations carried out by the OEM over the duration of the technology transfer for taking care of new market requirements and obsolescence of components used in the system.
g)	Transfer of Site feedback and trouble shooting information

Agreement would also include Technical Assistance to be provided by OEM by way of training of BHEL personnel, deputation of OEM's experts, engineering services by OEM etc., so as to enable BHEL to design & manufacture assemble, quality control, test, install, commissioning, maintain & operate the Excitation Systems.



OEM'S EXPERIENCE IN THE FIELD OF EXCITATION SYSTEMS

Sl No	Requirement	OEM's Response
1	Whether the prospective collaborator is an Original Equipment Manufacturer (OEM) of Excitation systems owning the IPRs.	
2	Whether the OEM has an experience of minimum 10 years in the design, manufacture and installation of Excitation system (both Direct & Indirect Excitation systems).	
3	Number of excitation systems supplied till date by the OEM: a) Direct (Static)Excitation systems: b) Indirect (Brushless)Excitation systems : (Please attach reference list)	
4	Number of excitation systems supplied by the OEM in last 2 years: a)Direct Excitation systems: b)Indirect Excitation systems: (please attach list)	
5	If more than one family of hardware is being used for Excitation systems for different ratings or for Direct & Indirect Excitation systems, OEM to provide following information :	
5.a	How many types of electronic hardware platform are being used concurrently?	
5.b	Whether all the above hardware platforms will be covered in the technology transfer to enable BHEL to meet all types of market requirements optimally?	
6	Number of R & D and design engineers working exclusively on Excitation systems:	
7	Year of introduction of the Excitation system, being proposed for technology transfer, in market:	
8	Number of Excitation systems supplied with the version of Excitation system being proposed for technology transfer : A)Direct Excitation systems: a)Supplied: b)Commissioned:	



	B)Indirect Excitation systems: a)Supplied: b)Commissioned:	
9	The highest rating of the machine that the OEM has supplied excitation system for the following categories may please be furnished :	
a)	Synchronous generators for thermal power plants : a)Direct excitation systems: b)Indirect excitation systems:	
b)	Synchronous generators for hydro power plants: a)Direct excitation systems: b)Indirect excitation systems:	
c)	Synchronous generators for gas turbine sets: a)Direct excitation systems: b)Indirect excitation systems:	
d)	Synchronous generators for nuclear power plants: a)Direct excitation systems: b)Indirect excitation systems:	
e)	Synchronous motors in industry : a)Direct excitation systems: b)Indirect excitation systems:	
10	Maximum field ratings (continuous) for which direct (static) excitation systems have been supplied :	
11	Maximum rating of an individual power converter (stack) for a direct (static) excitation system:	
12	Whether the electronic hardware are manufactured in-house by the OEM <u>OR</u> sourced from outside.	

Annexure -3

**LIST OF MINIMUM TECHNICAL FEATURES OF EXCITATION SYSTEM
PROPOSED FOR TCA**

SL No	Feature	Response Yes/No
1	The excitation system platform offered for technology transfer shall be the latest generation being marketed by the OEM and shall be suitable for use in both direct and indirect excitation systems.	
2	The same family of hardware shall be suitable for both direct and indirect excitation systems from very low to very high ratings.	
4	The microprocessor/microcontroller used in the main controller shall be of reputed make and at least 32 bits with floating point support.	
5	The excitation system shall be suitable to be configured to meet redundancy requirements in the electronic hardware(controller level as well as I/O) as well as control functions like dual auto channel (closed loop voltage/MVAR) control and manual channel (field current regulator).	
6	The excitation system platform being proposed for TCA shall have Qualified for type test for environmental conditions, mechanical stability and EMI/EMC immunity. (Details to be provided)	
7	The excitation system being proposed shall use standard AC/DC auxiliary power supplies.	
8	The excitation system being proposed shall be suitable for operation up to an ambient temperature of 55 deg C and relative humidity of 95% non-condensing.	
9	The regulation function in the excitation system shall have the following features:	
a)	Automatic voltage regulator function with	
	i) Reference value setting	
	ii) V/F limitation	
	iii) Active/Reactive current compensation	
b)	Field current limiter	
c)	Under excitation limiter	
d)	Stator current limitation(Inductive/Capacitive)	
e)	Temperature dependent field current and stator current limitation.	
f)	Minimum field current limitation.	



g)	Power system stabiliser(PSS)	
h)	Power factor(PF) controller mode of operation.	
i)	MVAR controller mode of operation.	
j)	Adaptability for Line charging operation.	
k)	Line drop compensation.	
l)	Field current regulation with reference value setting (for manual channel operation)	
m)	Firing pulse generation and amplification.	
n)	Pulse supervision(for pulses of all the operating channels)	
o)	Follow up control feature for tracking the operating channel by the non-operating channels for bump less transfer of control.	
p)	Soft start feature during initial voltage build up.	
q)	Monitoring of power converters like thyristor conduction monitoring, monitoring of cooling etc.	
r)	Facility to directly write the reference value from the plant control system for MVAR/PF regulation function.	
10	The hardware shall be suitable for brushless excitation systems with PMG frequency of : 75 Hz, 150 Hz, 300 Hz, 400 Hz	
11	The power converters shall be air cooled (natural or forced) & suitable for parallel operation (with equal current sharing) to meet the required rated field current requirements (up to 7000A) and also redundancy requirements with on line maintenance facility. The power converters along with the subassemblies shall be covered under TCA	
12	The system shall have provision to use both conventional field discharge circuit breaker as well as electronic field suppression system with DC/AC circuit breakers and crowbar. The required subassemblies for field suppression system shall be covered under TCA.	
13	The system shall have interface for connectivity with higher order control system / third party DCS system.	
14	The excitation system shall have suitable local AND remote terminal for operation with GUI/HMI based software for parameter setting, commissioning, troubleshooting (trending & event recording) and upload/downloading the software. A GUI/HMI PCbased Engineering tool shall be available for configuring project specific software.	
15	In addition to the above, the following features are asked for in Indian Market as part of excitation systems regularly. The OEM to confirm the availability of these features in the system being proposed for TCA. In case these features are not readily available	



	<p>in the system being proposed for TCA, the OEM shall agree to undertake development/joint development along with BHEL to meet these local requirements like.</p> <ol style="list-style-type: none">1. Adaptive PSS.2. Independent manual channel (field current regulator) along with single or dual automatic channels (voltage regulator).3. Any additional requirement of redundancies.4. Meeting higher type test requirements.	
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Annexure -4

Reference List: The OEM shall furnish a reference list with the hardware platform being proposed for technology transfer covering the following

S.No	Utility/Project name/location	Type of Generator (Turbo/Hydro /Sync Motor)	Generator rating (MW)	Type of excitation system (Direct/Indirect)	Generator /exciter field current (Amp)	Year of supply	Year of commissioning	Hardware Platform

- Note : Abbreviations/terms used in the document

EOI : Expression of Interest

OEM: Original Equipment Manufacturers

BHEL : Bharat Heavy Electricals Limited

EDN : Electronics Division

TCA : Technology Collaboration Agreement

PCB : Printed Circuit Boards

IPR : Intellectual Property Rights

EMI : Electro Magnetic Interference

EMC : Electro Magnetic Compatibility

PMG : Permanent Magnet Generator

DCS : Distributed Control system

GUI : Graphic User interface

HMI : Human Machine Interface

Direct Excitation Systems : Static excitation systems

Indirect excitation systems : Brushless excitation systems