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MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (hereinafter referred to as "MoU") entered into on this First day of December 2005 by and between:

NTPC Limited, a company incorporated under the Companies Act, 1956, having its registered office at NTPC Bhawan, SCOPE Complex, 7 Institutional Area, Lodhi Road, New Delhi – 110003, India (hereinafter referred to as 'NTPC' which expression shall, unless repugnant to the context or meaning thereof be deemed to mean and include its successors and permitted assigns), of the **First party**;

AND

Indian Institute of Technology Kharagpur, through Director, IIT Kharagpur, having its office and laboratory at Kharagpur, West Bengal, India (hereinafter called as 'IITKGP' which the expression shall unless repugnant to the context or meaning thereof be deemed to mean and include its successors and permitted assigns) of the **Second Party.**

NTPC and **IITKGP** are hereinafter individually referred to as the 'party' and collectively as 'Parties'

WHEREAS,

i) NTPC is a premier power Utility Company in India having expertise and strength in areas such as setting up of thermal power stations, operation and maintenance of power stations and sale of power. NTPC has developed comprehensive in-house expertise in various facets of power generation from concept to commissioning, efficient operation to nurture ecology and environment in accordance with National Power Policy of Government of India.

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SCOPE Complex, Lodhi Road, N. Delhi-3

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NTPC is also setting up Hydro-Electric Power stations and has its foray in other energy systems.

ii) NTPC, in its new initiative for meeting the future destinations, has setup Energy Technologies to take up the development of technology through fundamental R&D route.

iii) Indian Institute of Technology Kharagpur (IITKGP) is a premier institute of national and international importance engaged in education, training and research, passed by Act of Parliament.

iv) Both IITKGP and NTPC are leading premier national organizations in their respective fields and are desirous of working together to work as a team to achieve national objectives, undertaken with their best abilities and maximum mutual cooperation with intent of helping each other in the power sector - a vital component in India's march towards becoming a developed nation.

NOW, THEREFORE, IT IS HEREBY AGREED BY THE PARTIES AS FOLLOWS:

1.0 INTENT :

NTPC intends to conduct research, carry out experiments, build software and knowledge base leading to development of the following technology in collaboration with IITKGP in the following area hereafter known as "Research Work":

Development of Urea to Ammonia Conversion Reactor and associated component for UREA –FGC

2.0 SCOPE OF THE MoU:

The scope of MoU shall be to carry out the Research Work for the technology comprising of:

Development of Urea to Ammonia Conversion Reactor and associated component for UREA –FGC

a) Production of 50 kg/hr ammonia from Urea
b) Development, design and characterization of a reactor system for in-situ production of ammonia.
c) Performance analysis of the designed reactor for Flue Gas Conditioning
d) Detail analysis of synthetic gas mixture after reactor and ESP
e) Mathematical modeling of the system for performance prediction
f) Implementing technology in any unit of NTPC.

Details of the project proposal are placed as Annexure I

3.0 Roles and Responsibilities:

The Research Work shall be carried out in collaborative mode between NTPC and IITKGP. The Roles & Responsibilities of NTPC and IITKGP in conducting Research Work shall be as follows:

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3.1. NTPC

a) NTPC in consultation with IITKGP will identify Principal Collaborator for the project, who shall be responsible for all the work to be executed by NTPC.

b) NTPC will provide relevant data from the station required with specific reference to the Research Work.

c) NTPC will depute their research scientists as Co-Investigator(s) for associating with Research Work, at IITKGP.

d) NTPC will fully participate in joint publications in international journals and seminars on the subject matter pertaining to the topic.

3.2. IITKGP

a) IITKGP will nominate Principal Investigator(s) for the identified technology development project who shall be key person(s) responsible for all the work to be executed by IITKGP. For this project, it is Dr. B. C. Meikap and CoPrincipal Investigator is Dr. A. Patwardhan of Chemical Engineering Department

b) IITKGP will ensure that the project is executed as per the schedule enclosed as Annexure-I of this MoU.

c) The Principal Investigator of the technology development project nominated IITKGP will submit monthly progress report on the identified project.

4.0 PROJECT MANAGEMENT

a) Detailed Research Work time schedule along with deliverables shall be finalized in the kick-off meeting of the Research Work.

b) Based on the above, research project will be reviewed by the Energy Technology center of NTPC within the collaborative framework model.

c) Research Work shall be carried out by using the infrastructure facilities available with IITKGP from the project funds provided by NTPC.

d) A 'Project Monitoring Committee' consisting of 6 members, out of which 3 members shall be nominated by NTPC and 3 members shall be nominated by IITKGP, will review the progress of the project every six months.

e) After the completion of the Research Project IITKGP in association with NTPC will be responsible for preparation of the project report

5.0 FINANCIAL CONSIDERATION AND PAYMENT TERMS:

a) Total cost of Research Work will be funded ("Research Fund") by NTPC within the allocation as indicated in Annexure I.(deleted as the allocation depends on the deliverables)

b) All the procurement related to the Research Work shall be done by IITKGP as per their norms.

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c) First installment of the Research Fund shall be released to IITKGP upon signing of this MoU.

d) Subsequent installment of Research Fund shall be released upon completion of deliverable as per the 'Payment Schedule' (Annexure I) after approval by 'Project Monitoring Committee'.

e) IITKGP shall submit audited annual financial statement within one month from 31st March each year indicating commitments and expenditure on the Research

f) Project to NTPC. If NTPC desires to see any relevant document, the same shall be made available at IITKGP. Further if any relevant detail is required by NTPC, IITKGP will furnish the same as per Govt. of India rules.

6.0 EFFECTIVE DATE

This MOU shall come into effect for all its intents and purposes from the date of signing by both the parties.

7.0 OWNERSHIP OF TECHNOLOGY DEVELOPED ("Technology Element")

a) Upon development of a particular Technology Element, NTPC shall evaluate its usefulness and based on it shall decide to obtain the Intellectual Property Rights ("IPR") over such Technology Event in consideration thereof pay a "Fair Compensation as may be mutually agreed as per guideline mentioned below at Clause 7.0 (c).

b) In the event NTPC decides to acquire the license of the technology pertaining to the patent in respect of any Technology Element obtained from the Research Work, Principal and Co-Investigators from both NTPC and IITKGP will constitute as 'inventors'.

c) The maximum value of the 'Fair Benefit' for any IPR Technology Element shall be the lower of (i) 50% of the project cost or (ii) two times the salary component of the respective project.

d) There shall be stage wise payment of the aforesaid "Fair Compensation" ' with each stage being linked to following milestone:

   i. Upon filing and subsequent grant of PCT-IPR patent: 75% of the 'Fair Compensation' amount, upon grant of patent in any country which has been identified by both the parties at the time of filing PCT application.
   ii. Within 6 months from the grant of PCT patent the balance 25% of the 'Fair Compensation' amount

e) Technology License shall be available to NTPC on an exclusive basis, non-transferable basis for its use for twenty years or any other period mutually agreed upon; and, as may be permitted under the Law on a royalty free basis in consideration of the Fair Compensation to IITKGP as mentioned above.

f) IITKGP shall assist NTPC in filling the patent application; however, NTPC shall pursue the said application. IITKGP shall sign all the documents required for obtaining Patent / Copy Right.

g) If NTPC does not intend to file any application for obtaining the IPR, then IITKGP may apply for the IPR as Applicant; and, NTPC shall sign all the requisite documents for this purpose. Upon grant of IPR, if IITKGP desires to grant license to

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any of the third party for the use of IPR/Patent, then such offer should be made to NTPC on the first right of refusal basis. If NTPC decides to acquire the, license, it shall be granted to NTPC on exclusive basis upon payment of fair compensation as mentioned at 7.0 (c) plus filing fee and legal expenses incurred by IITKGP in obtaining IPR/Patents by NTPC. However, in such an event, NTPC shall not be entitled to grant license to any third party to use the said patent.

h) For purpose of the above, "IPR" shall mean the rights under the Patent Act, 1970, Designs Act, 2000 or Copy Right Act, 1957 and any subsequent amendments thereafter.

8. CONFIDENTIALITY:

The Parties, to the extent of their respective rights to do so, shall exchange such technical information and data as is reasonably required of each Party to perform its responsibilities under this MoU. Each Party agrees to keep in confidence and to use the same degree of care as it uses with respect to its own proprietary data to prevent the disclosure to third Parties of all technical information, data and confidential business information (hereinafter referred to as "Consolidated Data").

Exchange, use and maintenance of Confidential Data shall be mutually discussed and agreed to by the parties.

The preceding provisions of confidentiality and restriction on use of Consolidated Data shall not apply to:

- Information in the public domain or information, which subsequently enters into public domain without committing breach of this Article.
- Information in possession of the Party at the time of disclosure and was not acquired, directly or indirectly, from the other Party.
- Information, which a Party requires to disclose under law, rules or regulations or court orders.

IITKGP and NTPC shall obtain secrecy undertaking from their respective personnel involved in the Research Project.

Confidentiality obligations contained herein shall be applicable for a period of three years from the expiry/termination of this MoU.

9. DISPOSAL OF STORES ITEMS:

At the end of the Research Work, all equipment and other items acquired out of Research Funds provided by NTPC shall become the property of NTPC.NTPC will arrange to take back the equipment within one year of the completion of the project

10. SETTLEMENT OF DISPUTES

In the event of any dispute / difference arising between NTPC-IITKGP under these presents, such disputes / differences shall be resolved amicably by mutual consultation between Director, IITKGP and Director (Operations), NTPC.

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10. TERMINATION OF MOU

a) This MoU may be terminated by either party by giving 60 days notice in writing to the other party of its intension to do so.

b) In the event, when both the parties mutually agree to terminate this MOU, or the MOU is terminated on account of Force Majeure or non-fulfillment of the obligations of the respective parties viz. NTPC / IITKGP or otherwise for any other reasons, the termination shall take effect from the date and time to be agreed upon mutually.

c) Upon termination all the equipments and other items, along with the data generated and any Confidential Data shall become the property of NTPC.

12. INDEMNITY

a) Either party shall indemnify and hold the other party harmless from any and all claims, liabilities, costs, damages and expenses of every kind and nature in respect of the sickness, injury or death of any third party and damage to or destruction of any property of any third party, arising directly or indirectly during the performance of Research Work.

b) NTPC shall indemnify and hold IITKGP harmless against any and all claims, liabilities, costs, damages and expenses resulting from any third party claims made or suits against NTPC or suits against NTPC or IITKGP for IPR infringement by third parties, in respect of IPR obtained pursuant to this MoU.

c) IITKGP hereby authorizes and empowers NTPC to institute and prosecute such suits or proceedings as NTPC may deem expedient, to protect the rights and for the recoveries of damages and penalties for infringement of such rights and to secure to NTPC and IITKGP full benefits of the IPR and for any such purposes to use the name of IITKGP with prior written permission after providing full details.

13. ANNOUNCEMENTS

No party to this MOU shall make any public announcement or communicate any information to third parties concerning the existence or subject matter of this MoU, except by prior agreement between the parties or as may be required by a legal authority under applicable law.

14. FORCE MAJEURE

Force majeure is herein defined as any cause which is beyond the reasonable control of NTPC or IITKGP as the case may be, which with a reasonable amount of diligence could not have been foreseen and which substantially affects the performance of the respective obligations of the parties, such as but not limited to:

a) Act of nature such as flood, drought cyclone, lighting, earthquake, etc.

b) Rebellion, civil mutiny, commotion, riot, accident by fire, explosion, epidemic, or any other cause beyond the control of parties.

c) Acts of any Government including but not limited to war, declared or undeclared priorities, quarantines.

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d) Any direction, order of any court or Authority adversely affecting the enforcement of the MoU in any manner.

e) Strikes and Lockouts for a continuous period of 30 days.

Provided that either party shall within 7 days from the occurrence or cessation of such a cause notify the other in writing of the same.

In the event Force Majeure event continue for more than 30 days, the parties shall mutually discuss and decide the future course of action. If not mutually agreed, the parties shall have the right to terminate the MOU.

NTPC or IITKGP shall not be liable for non-performance of their respective obligations or delays in respect thereof as a result of force majeure as referred to and / or defined above.

15. MISCELLANEOUS:

a) Nothing in this MOU shall be deemed to constitute a partnership or agency relationship between the Parties to this MoU and neither Party to this MoU shall have any authority to bind or obligate the other party in any manner whatsoever in relation to third parties.

b) Neither NTPC nor IITKGP shall be liable to each other for any financial liability or any consequential loss incurred by any Party individually in respect of any other activities arising out of compliance with the provisions of this MoU after the date of signing.

c) Any Amendment to this MoU in order to be valid and binding shall be made by an instrument in writing and signed / executed by the Parties hereto.

15. PERIOD OF MoU

a) This MOU shall remain valid for a period of 36 months from the date of signing of these presents unless terminated earlier by mutual consent.

b) However, if during the course of Research Work, some new research area crops up which has a significant bearing upon the completion of the existing project and should NTPC & IITKGP decide to take up, the same MoU will hold good for various aspects such as legal & financial procedure, confidentiality, notice etc except the actual financial amounts and IPR. For other issues, matter may be decided mutually by the Director (IITKGP) & Director (Operations-NTPC) or by their nominated representatives to make whatever changes as may be required.

c) MoU may be converted to agreement if both parties agree in future for mutual benefit.

17. NOTICE

All Notices, permitted or required to be made under this MoU shall be in writing and signed by the authorized representatives of the party giving such notices and shall be delivered personally against acknowledgement or by fax or Registered-AD mail to the other party at its address set forth herein below or at such addresses, as the other party may subsequently notify.

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Addresses:

ATTN: Executive Director (Energy Technologies),
NTPC Limited
Engineering Office Complex (EOC)
5th Floor Engineering office Complex, Plot A- 8A, Sector 24,Noida
201301, Telephone: 91 120 2410267

ATTN Dean (Sponsored Research & industrial Consultancy)
Indian Institute of Technology Kharagpur
Kharagpur-721302 West Bengal, India.
Telephone: 91-3222-282002

In witness whereof the parties through their authorized representatives have signed these presents on the Day Month and Year mentioned above.

For Indian Institute of Technology Kharagpur

DEAN 1-12-05

Prof. Partha P Chakrabarti
Dean
Sponsored Research & Industrial Consultancy
I.I.T. Kharagpur - 721302, India

Witness:

1. 01.012.05

2. 01.12.05

For NTPC Limited

EXECUTIVE DIRECTOR 1/12/05

Witness:

1. 1.12.05

2. 1/12/05

Development of Urea to Ammonia Reactor and associated components for Flue Gas Conditioning

1. **Client:** NTPC Limited, Energy Technologies, Engineering Office Complex, Plot A-8A, Sector-24, NOIDA 201301

2. **Project Title:** Development of Ammonia to Urea reactor and associated components for Flue gas conditioning

3. **Objectives:** This is an R&D project proposal with the following aim:
   - Production of 50 kg/ hr ammonia from urea for flue gas conditioning
   - Development, design and characterization of a reactor system for in-situ production of ammonia.
   - Performance analysis of the designed reactor for Flue Gas Conditioning
   - Detail analysis of the synthetic gas mixture after reactor and ESP
   - Characterization of the reactor system
   - Mathematical Modeling of the system to predict performance of the ammonia based flue gas conditioning
   - Performance analysis of the ESP for particulate capturing and its implementation in one of the NTPC unit

   This assignment will be executed in three phases sequentially as follows:

   Phase-I: Development of Basic Engineering Document and design as described under the scope of work for Phase-I.

   Phase-II: Fabrication and erection of necessary hardware.

   Phase-III: Commissioning, testing and analysis and implementation in one of the NTPC unit.

3. Scope of Work:

a) Phase-I activity:

To develop the design details for reactor capable of producing 50Kg/hr of NH3 in gaseous form along with diluents in the form of Basic Engineering Package (BEP) document.

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Battery limit:

- Develop design document for reactor capable of producing 50Kg/hr of NH3 in gaseous form along with diluents from Urea.
- To design the distributor for NH3 gas along with its diluents in the flue gas.

CONTENTS OF BASIC ENGINEERING PACKAGE

PART I: DESIGN BASIS & PROCESS DESCRIPTION

1. **Introduction**
   - 1.1 Documentation Organization
2. **Design Basis**
   - 2.1 General
   - 2.2 Section wise capacity
   - 2.3 On Stream Numbering
3. **Process description**
   - 3.1 Process description
   - 3.2 Process control steps & analytical methods
   - 3.3 Raw material specifications
   - 3.4 Process flow diagram.
   - 3.5 Material & energy balance
   - 3.6 Raw material consumption figures
   - 3.7 Utility specification & consumption with peak demand data.
   - 3.8 Suggested Effluent treatment method if any.
4. **Operating procedures**
   - 4.1 Start-up & Normal operation
   - 4.2 Normal shut-down procedures
   - 4.3 Emergency shut down procedures.
   - 4.4 Requirement of emergency power supply if any.
5. **Safety & health considerations**
   - 5.1 Materials safety data sheets
   - 5.2 Detectors & location of detectors if any.

Annexure-I of basic engineering package: Will contain Process flow sheet, Material & Energy balance.

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Annexure-II of basic engineering package: Will contain Material safety datasheet of chemical/material used

PART II: EQUIPMENT LIST & SPECIFICATION SHEETS

1. Equipment list
2. Tentative equipment layout
   - 2.1 General layout plans
   - 2.2 Elevations
3. Equipment specification sheets / data sheets.

PART III: INSTRUMENTATION & ELECTRICAL ASPECTS

1. Instrumentation philosophy
2. Interlocks & alarm description

   Annexure-III of basic engineering package: Will contain Interlocks &, alarm diagrams

PART IV: PIPING & INSTRUMENTATION

1. Piping & instrumentation diagram
2. Pipe size, schedule and material of construction.

b) Phase-II activity:

- The appointment of vendor for fabrication of the hardware as per the BEP document.
- Get various items fabricated from the fabrication vendor or vendor of packaged item supplier. Stage inspection of the various equipments / packaged items as per the requirements given in the BEP document.
- Supply of the necessary hardware to IIT-Kgp site.
- Monitoring of the installation / erection of the equipments and various package items at the site by the vendor as per the general layout given in the BEP document.
- Final or pre-commissioning inspection of the entire plant.
- Testing of the entire hardware jointly by vendor, IIT Kgp and NTPC.

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c) Phase-III activity:

- The testing of entire hardware, control loops and controlling equipments etc.
- Actual trials of the Urea reactors will be carried out so as to generate the Urea at the desired quantity. Similarly the generated NH3 will be injected in the flue gas.
- Training of NTPC power station personnel for generation, handling and testing of the system. The safety information will be also shared with NTPC technical staff.
- Joint study by NTPC and IIT Kgp will be carried out to study the effect on fly ash recovery after injection of NH3 in the flue gas in one of the NTPC unit.
- Prepare a R&D report on the joint study.

4. Key deliverables & Schedule:

S.No	Deliverables	Schedule
1	Development of Urea to Ammonia Flow sheet	1 Month
2	Design of Urea to ammonia Reactor	3 Month
3	BEP document for generating ammonia from Urea	2 Month
4	Fabrication of Urea reactor and fabrication / procurement of balance components of Urea-FGC system	6 Month
5	Characterization and detail reactor studies	6 Month
6	Mathematical modeling	4 Month
7	Study the effect of NH3 treatment on Fly ash, ESP internals, duct and chimney.	6 Month
8	Testing in situ for fly ash removal at NTPC site	6 Month
9	Final Report on Urea -FGC system development [Parallely with activity no: 6]	2 Month
	Total expected time	**36 Month**

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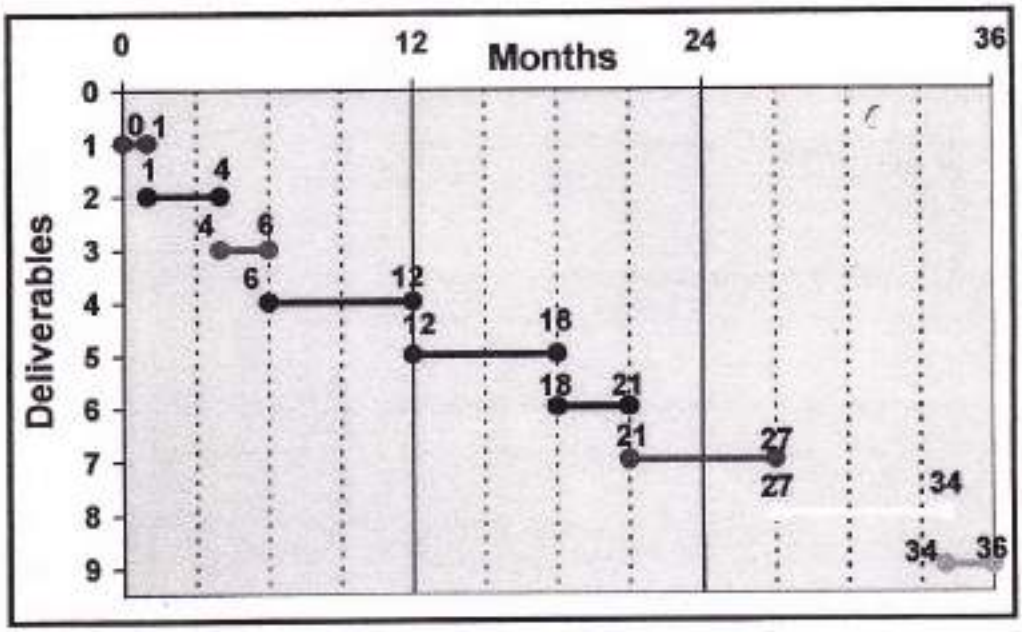

5. Total Project Budget:

S.No	Budget Head	First Year	Second Year	Third Year
1	Equipment	Rs. 10.5 Lac	Rs. 18.0 Lac	Rs. 1.0 Lac
2	Material	Rs. 1.0 Lac	Rs. 1.5 Lac	Rs. 1.5 Lac
3	Consumables	Rs. 0.6 Lac	Rs. 1.00 Lac	Rs. 0.82 Lac
4	Salary	Rs. 3.36 Lac	Rs. 3.36 Lac	Rs. 3.36 Lac
5	Overheads*:	Rs.(0.80+3.5)Lac	Rs.(1.4 +3.0)Lac	Rs. (1.30+3.0)Lac
6	Travel	Rs. 1.0 Lac	Rs. 1.0 Lac	Rs. 1.0 Lac
7	Contingency	Rs. 1.0 Lac	Rs. 1.0 Lac	Rs. 1.0 Lac
	TOTAL	**Rs. 21.760 Lac**	**Rs. 30.260 Lac**	**Rs. 12.98 Lac**

*Overhead component contains Rs 9.5 Lac towards faculty salary.

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6. Payment Schedule:

S.No	Milestones	Linked Amount [Lac Rs]	Adjustment of Apportioned Amount [Lac Rs]	Amount Payable [Lac Rs]
1	**Initial Amount:** Upon signing of MoU	8.0	0	8.0
2	**Completion of Milestone No-1:** Development of UtoA FGC Flow Sheet	0.855	0	0.855 *
3	**Completion of Milestone No-2:** Completion of Design of UtoA Reactor	2.565	1	1.565 *
4	**Completion of Milestone No-X:** Placement of Purchase Order for Equipment, Material, Consumables and Computational Items[To be done in phased manner]	As Per Actual PO Amount	0	As Per Actual PO Amount
5	**Completion of Milestone No-3:** Development of Detailed Engineering and Drawings of U2A FGC system	1.710	1	0.710 *
6	**Completion of Milestone No-4:** Erection & Commissioning of U2A-FGC system	5.130	1	4.130 *
	Completion of Milestone No-5: Characterization and completion of reactor studies.	5.380	1.5	3.880*
8	**Completion of Milestone No-6:** Completion Mathematical Modeling	2.690	1	1.690*
9	**Completion of Milestone No-7:** Study the effect of NH3 treatment on Fly ash, ESP internals, duct and chimney.	5.310	1	4.310 *
10	**Completion of Milestone No-8:** Testing in One of the NTPC site	6.113	1.5	4.613 *
11	**Completion of Milestone No-9:** Submission of Final Report	1.747	0	1.747*
NB: 1	[*] Subject to the total released amount does not exceed the total cost of project			
NB: 2	Milestones completion sequence can be other than indicated above.			
	Starting of some schedules may overlap or continue simultaneously.			

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7. Other Terms & Conditions

Other terms and conditions of the project shall be as per the mutually agreed MoU.

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