
SECTION IV TECHNICAL SPECIFICATION

1. PLANT DESCRIPTION

The 4th thermal power plant is composed of eight (8) boilers and six (6) turbines/generators. All of the super-heater outlet steam pipes of the boilers are connected to the main steam header, from which steam is led to each turbine.

On the other hand, feed water to the boilers is led from the feed water main header (See attached drawings MON-K-0-13). Boilers are of indoor with pulverized coal firing, radiant, non-reheat, natural circulation type and Generators are of hydrogen cooled horizontally mounted cylindrical rotor, rotating field type. Their main features are as follows;

(Boilers)

Maximum continuous evaporation 420 t/h

Steam pressure at super-heater outlet 140 kgf/cm²

Steam temperature at super-heater outlet 560 °C

(Turbines)

Rated output 80MW(#1,5,6), 100MW(#2,3,4)

Inlet steam pressure 130 kgf/ cm²

Inlet steam temperature 555 °C

(Generators)

Rated capacity 125,000 kVA

Power factor 0.8 (lagging)

Rated voltage 10,500 V

Rated current 6,875 A

Rated frequency 50 Hz

The layout of the power plant is shown on the attached drawing No. MON-K-0-11.

The boilers and turbines are supervised and controlled from the central control room (CCR). The CCR is divided into two (2) rooms; one for #1, 2, 3, 4 boiler and #1, 2, 3 turbine, the other for #5, 6, 7, 8 boiler and #4,5, 6 turbine. All the generators including excitation systems are supervised and controlled from each local panel and/or from the electrical central control room (ECCR). (Refer to attached drawings No. MON-K-0-10, MON-K-0-11)

2. SCOPE OF THE GOODS AND SERVICES

2.1 General

In General, scope of Works of the Package-4 is modification and replacement of existing excitation system for the conversion to full static excitation system for Unit #1 to #4 generators. However some existing equipment including instrument will be remained so that modification of existing system shall also be included. Detailed system diagram including replacement and modification area for existing excitation system is shown hereafter (See attached drawings MON-K-4-01).

The Works to be performed modification and rehabilitation of existing excitation system comprises the design, manufacture, shop test, marine and inland transportation to the Site designated by the Purchaser, the supervision work for the erection work at the Site, the commissioning works, the trial run under operation of turbine/generator, and other necessary Services.

Scope of the Works shall include:

- Replacement of AC exciter and Permanent Magnetic Generator (PMG)
- Replacement of Rectifier
- Replacement of Automatic Voltage Regulator (AVR) and its control panels
- Modification of instrumentation and protection devices
- Designing and Manufacturing
- Transportation
- Supervision, Commissioning, Trial run and Training

2.2 Scope of the Works

The Works to be supplied and performed by the Supplier under this Contract shall be referred to Clause 12 to 16. Whereas the Goods is specified in Clause 12, and the Services is specified in Clause 13 to 16

The Supplier shall:

- (1) Perform the visual inspection at the Site for the design (modification work, interface with the existing equipment, etc.) before design of the Goods.

- (2) Co-operate with the Purchaser to ensure proper matching of design, manufacture, supply and trial run, including start-up, shut-down and emergency conditions.
- (3) Co-operate with the Purchaser in formulating procedures for handling and maintenance of the Goods.
- (4) Facilitate witness of the Purchaser.
- (5) Co-operate with the Package-5 Contractor.

The Services to be provided by the Supplier shall include, among others, the provision of supervisory services by experts in the number and qualification adequate for the successful erection work. The Supplier shall be responsible for the safety, protection and security of the experts and other personnel dispatched to the Site by him.

3. TIME SCHEDULE, KEY DATES AND PERIOD

3.1 Implementation Schedule

The completion of the Rehabilitation Project is reckoned from the effective date of the contract up to the Provisional Acceptance of the Works, "Implementing Schedule" drawing No.MON-K-0-01 is attached.

The supplier shall submit his proposal for the detailed schedule together with his Bid.

The schedule shall include the following items :

- effective date of the contract
- design and engineering
- manufacturing
- transportation
- removal existing equipment and civil work
- erection and installation
- test and commissioning
- trial run
- date of provisional acceptance

3.2 Key Dates and Periods

The following are considered contractual key dates and periods in the execution of the Rehabilitation Project.

3.2.1 Effective Date of Contract

The effective Date of Contract is the Contract signed date.

3.2.2 Delivery Dates of the Goods at the Site

The Supplier shall deliver and unload all the Goods at the Site or the specified place by the Purchaser, by the date not later than :

Delivery 1(1st Unit) : Ten (10) months after the effective date of the Contract

Delivery 2(2nd Unit) : Ten (10) months after the effective date of the Contract

Delivery 3(3rd Unit) : Twenty-two (22) months after the effective date of the Contract

Delivery 4(4th Unit) : Twenty-two (22) months after the effective date of the Contract

The Supplier shall submit his proposal for the above delivery dates filling in the Technical Schedules. (Form is attached to Table-TS-4-08)

3.2.3 Date of Completion of Erection Work

All the Goods shall be assembled, installed, connected and made ready for starting the commissioning, by an erection Contractor of Package-5 under supervision of the Supplier.

3.2.4 Commissioning

The Supplier shall execute the commissioning for all the Goods to be supplied under this Contract.

Upon the notice of the Supplier, the Purchaser shall give the certificate of completion of the commissioning for each Unit.

The details of the commissioning shall be referred to Clause 13.

3.2.5 Trial Run

Upon the completion of the commissioning the Supplier shall start the Trial Run under support of the Purchaser.

The Trial Run shall be continued for not less than five (5) days.

For further details of the Trail Run shall be referred to Clause 14.

3.2.6 Date of Provisional Acceptance for all Work

Upon completion of the Trial Run for each Unit the Purchaser shall issue the Provisional Acceptance Certificate.

3.2.7 Warranty

The Supplier shall warrant the Works to the Purchaser for a period of twenty-four (24) months starting from the date of the issuance of the Provisional Acceptance Certificate for each unit.

The Supplier shall be responsible for making any defect in or damage to any part of the Goods which may appear or occur during the Warranty Period and which arises from any defective materials, design, workmanship, transportation or commissioning.

The Supplier shall make good the defect or damage as soon as practicable and at his own cost.

The Supplier shall also refer to this Bidding Document Section II , Clause 13 "Warranty".

4. LIQUIDATED DAMAGE

In the event the Supplier fail to complete the delivery of the Goods and documents/drawings within the contracted time period, such failure shall be a default under the Contract, the Supplier shall be liable for payment to the Purchaser as liquidated damage and not be way of penalties.

The liquidated damages shall be in the amount of one-tenth of one percent (0.1%) per day of one-fourth (1/4) of the total Contract Price except those specified in the following Table.

The total amount of liquidated damage under Clause shall be limited to a maximum ten percent (10%) of the total Contract Price:

Portion of the Goods and Documents	Liquidated Damages
Each delivery of the Goods	0.1% of 1/4 of the total Contract Price per day
Each delivery of the materials needed during the civil work periods	100,000 J. Yen per day
Submission of drawings and information necessary for the foundation work of the Goods	100,000 J. Yen per day
Submission of operation manuals	100,000 J. Yen per day
Submission of maintenance manuals	100,000 J. Yen per day
Each period from the date of commencement of the commissioning up to the date of Provisional Acceptance	0.1% of 1/4 of the total Contract Price per day

5. DATA, DRAWINGS AND DOCUMENTS

5.1 Drawings Attached to the Bidding Document

5.1.1 Purchaser's Drawings

(1) Purchaser's Drawings attached to the Bidding Document

The drawings contained in the Bidding Document shall be utilized for bidding purposes only. They are not considered as necessarily defining the design of the Goods to be furnished, but are merely illustrative to show the general layout of the equipment, except where limiting or mandatory dimensions and elevations are indicated.

The Works shall be executed in accordance with the detailed design drawings prepared by the Supplier.

(2) Copyright

Copyright for drawings of existing equipment shall remain to the Purchaser.

5.1.2 Proposal Drawings, Documents and Technical Schedules

The Supplier shall submit the Technical Schedules fully completed together with documents and drawings specified in this Bidding Document and other documents which the Supplier deems useful to better evaluate his Bid.

5.2 Supplier's Drawings, Documents, Data and Instructions

5.2.1 General

The Supplier shall submit to the Purchaser for approval or reference, drawings, plans, erection manuals, calculations, codes and standards, copies of all documents necessary for implementing the Works in accordance with the provisions of the Contract Document. The sequence of submission shall be such that information is available for review or approval of each drawing or document when it is received.

The scope of these submittals shall include, but not be limited to those specified and shall be sufficiently comprehensive to fully establish that all parts and procedures to be used in performing the Works comply with the objectives of the Contract. The Purchaser will have

the right to require the Supplier to submit such additional information as may reasonably be required.

The Supplier shall, within one (1) month after the effective date of the Contract, prepare and submit to the Purchaser for approval a schedule of documents which he proposes to submit in accordance with the requirements of Clause 5.2.4 below and the other clause of this Bidding Document, together with the dates on which he proposes to submit such drawings and documents.

The schedule of documents summarizing all existing and proposed drawings and documents of items intended for submission to the Purchaser shall be updated monthly to show the status of the drawings and documents submitted and any additional proposed drawings. These updated lists shall be submitted to the Purchaser by seventh (7th) day of the every month.

Any manufacturing, test and transportation of the Goods prior to the approval of drawings pertinent thereto shall be at the Supplier's risk. The Supplier shall be responsible for any extra cost that may arise in consequence to such risks.

When submitting drawings for approval, including drawings prepared by a sub-supplier (if any), the Supplier shall certify that the Supplier has fully examined such drawings and that drawings comply with the requirements of the Contract.

The Supplier shall be responsible for any discrepancies, errors, or omissions in the drawings, documents and data supplied by him whether these have been approved by the Purchaser or not.

The Purchaser shall have the right to require the Supplier to make any changes to the drawings, documents and data which may be necessary, in the opinion of the Purchaser, to make the Works conform to the intent of the Contract.

All revisions of drawings shall be clearly described in the revision column and be indicated on the drawing by means of a triangle bearing the revision number.

All drawings, documents, data and information to be submitted shall be in English language and be drawn using the metric system of measurements. Refer to Clause 7 (2).

Every drawing shall carry a title block with the Contract Number and a space shall be made in the title block for incorporating the Project Drawing Number.

The first lines of the title block shall read:

Rehabilitation Project of the 4th Power Plant in ULAANBAATAR, MONGOLIA (PHASE-II)

CONTRACT NO. _____

Where applicable, drawings shall show a graphic scale key plan and north arrow. Lettering, notes and title block shall be in English language. Dates on drawings shall be spelled out (e.g. 28 Dec. 2002).

5.2.2 Processing Drawings for Approval

Prior to fabrication of the Goods at the factory or to the award of order to the Sub-Suppliers, the Supplier shall submit to the Purchaser seven (7) copies of printed drawings and documents for approval, with a mark or stamp "FOR APPROVAL". All the others shall be submitted as "FOR INFORMATION".

The Approval procedure shall in principle be treated in accordance with following procedure.

- (1) The Purchaser will review the submitted drawings and documents within fifteen (15) days after receipt. The Supplier shall confirm the receipt date of submitted drawings and documents. It is noted that even for "FOR INFORMATION", the Purchaser treat it as "FOR APPROVAL" and send comment.
- (2) After the drawing and documents are approved or reviewed by the Purchaser, the Purchaser will send his comments to the Supplier by a facsimile discriminating with marks "APPROVED", "APPROVED WITH NOTES", "NOT APPROVED" or "FOR INFORMATION".

In case that the Supplier has not received any comments from the Purchaser after twenty (20) days after submission, the Supplier shall be deemed that submitted drawings and documents are "APPROVED".

- (3) The drawings and documents "FOR INFORMATION" with the comments of the Purchaser are deemed to be "FOR APPROVAL".
- (4) The drawings and documents with the mark "APPROVED", "APPROVED WITH NOTES" will authorize the Supplier to proceed the Works if the Supplier completely

accept the Purchaser's comments. Any design or manufacturing done before approval of the drawings shall be at the Supplier's own risk.

- (5) The drawings and documents marked with "NOT APPROVED" shall be revised by the Supplier and resubmitted for approval to the Purchaser.
- (6) In any case, the Purchaser will not return the Supplier's drawings or documents
- (7) Initially supplied drawings and documents shall have the revision number "Rev.0". Subsequent revisions shall be numbered as Rev.1, Rev.2 . . . until approval. All revisions shall be clearly described in the revision column and indicated on the drawings with Rev number in framed by triangle.

5.2.3 As-Built Drawings

- (1) Revision and/or modification made to the Goods during erection work and commissioning periods shall be correctly and completely reflected into all the concerned drawings and documents as the "AS-BUILT" drawing by the Supplier.
- (2) Record Drawings

Prior to the Provisional Acceptance of the Works for the final Unit, the Supplier shall submit to the Purchaser five (5) prints and two (2) CD-ROM of all duly checked and approved "AS-BUILT" drawings.

5.2.4 Submission of Drawings, Documents and Data

The Supplier shall prepare and submit to the Purchaser for approval or reference, drawings and technical data/documents including but not limited to the following:

- (1) Codes and Standards

The Supplier shall, within one (1) month after the effective date of the Contract, submit for approval by the Purchaser a list of the Codes and Standards which shall govern the design, manufacture, construction, erection, test, commissioning and trial run of all the related Works under this Contract. Each one (1) copy of the applied code or standard shall be supplied to the Purchaser.

- (2) General Arrangement Plans for Machinery and Equipment.

The Supplier shall supply layouts, arrangement and location of the Goods including the outline dimensions and sizes of the Goods.

The Supplier shall, within two (2) months after the effective date of the Contract, submit for approval the above.

(3) Drawings, Documents and Specifications of Electro-Mechanical Equipment for Approval

The data, drawings and documents to be submitted by the Supplier for approval as listed below.

- (a) Design specification of static excitation systems such as auto voltage regulator (AVR), thyristor rectifier, excitation power transformer and their related instruments and devices
 - (b) Static excitation system diagram including all instrumentation and diagram of adapted parts for existing excitation system
 - (c) Control, measurement and protection schematic including interface diagrams
 - (d) List of interface between local to ECCR, protection devices, instrument, alarm and cables
 - (e) Protection system and their set points
 - (f) Characteristic curves and design parameters of AVR
 - (g) List of control and instruments required in this Contract Technical Schedule
 - (h) Detailed schematic connection diagrams, control wiring diagrams, detailed terminal wiring diagrams and terminal lists for measurement and control system
 - (i) Detailed single line and control wiring diagrams for power supply schemes at points of consumption of electric power
 - (j) Arrangement drawing of the electrical central control room (ECCR)
 - (k) Surface arrangement drawings for AVR control panels
 - (l) Dimensional drawings for all panels and desks
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(m) Spare parts list

(4) Drawings, Documents and Specifications for Electro-Mechanical Equipment for Reference use

- (a) Weight of each main components of the static excitation systems
- (b) Final specification and data sheets for all Goods (equipment, controllers and protection devices covered by this Specification)
- (c) Final specification and data sheets
- (d) List of special tools for maintenance
- (e) Utility consumption - kW consumed

(5) Progress Report

(a) Monthly Reports

The Supplier shall submit to the Purchaser and the representative of the Purchaser (such as Engineers if required) by tenth (10th) day of every month, a written detailed progress report, in an approved form, indicating the stage reached and anticipated completion dates for the design, ordering, procurement, manufacture, and testing of the components up to the completion date of transportation of the Goods. The report is to be forwarded promptly so that on receipt by the Purchaser the information is not unduly out of date. Further the Supplier shall submit the progress report during site test and commissioning period in the same manner as above.

(b) Weekly Meeting

All Parties concerned to this Contract shall have a weekly meeting every week after commencement of erection work at the Site and make the minutes of meeting.

(6) Instructions for Erection Work

The erection work will be undertaken by an Erection Contractor under supervision of the Supplier. The Supplier shall provide the instructions for the erection work of the

Goods supplied by this Contract. The preliminary instructions for the erection work shall be submitted not later than three (3) months after the effective date of the Contract, and the following items shall be included at least and other necessary information shall be included:

- Outline of erection procedures
- Equipment and instrument list
- Layout of equipment
- Dimensions and weight of equipment
- Approximate cable length
- Preliminary wiring diagrams
- Recommended erection schedule
- Other necessary information

The final erection instructions shall be submitted three (3) months before the commencement of the erection work and the following items shall be included at least:

- Erection procedures
- Layout of all Goods
- Dismantling procedure of the existing equipment and foundation
- Detailed equipment & instrument list
- Outline drawings of all equipment
- Civil work drawings for foundation of equipment
- P & I diagrams
- Piping drawings
- Cable wiring diagrams
- Cable tray and/or duct drawings
- Special erection tools and machines to be recommended
- Other necessary information

(7) Test Procedures and Reports

The Supplier shall submit to the Purchaser comprehensive test procedures/ programs two (2) months prior to the start of the actual tests of the Goods.

The procedures shall include the following items, but not limited to:

- description on the test activities
- test circuit diagram including test instrumentation

- evaluation criteria for the test results
- form of test record

The Supplier shall submit reports or test results upon completion of the tests carried out in accordance with the Bidding Document including those in the manufacturer's works.

(8) Operation Manuals

The excitation system operation manual shall be prepared and submitted on the basis of existing excitation manual prepared by the Purchaser.

Two (2) sets of draft of the manuals shall be submitted for review of the Purchaser within twelve (12) months after the effective date of the Contract.

Each ten (10) sets of the completed manuals in English and Mongolia shall be submitted by the Supplier within fifteen (15) months after the effective date of the Contract.

(9) Maintenance Manuals

The Supplier shall submit maintenance manuals for all the Goods supplied in this Contract.

Two (2) sets of draft of the manuals shall be submitted for review of the Purchaser within fifteen (15) months after the effective date of the Contract.

Each ten (10) sets of the completed manuals in English and Mongolia shall be submitted within nineteen (19) months after the effective of the Contract.

For each equipment supplied under this Contract, the following shall be developed:

- Procedure covering preventive maintenance of the specific detail of equipment.
 - Detailed dismantling and assembling procedures
 - Checks and tests prior to returning the equipment to service.
 - Detailed assembly drawings and illustrations including parts lists and numbers for replacement ordering.
 - Setting and running clearances and tolerances.
 - Cleaning and preservation procedures.
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- A preventative maintenance schedule for all the Goods.
- A lubrication schedule showing requirements and specifications for all the Goods.
- Printed circuit board schematics and module schematics.
- Detailed drawings and method for use of special maintenance tools.
- List of recommended spare parts and list of consumables
- Troubleshooting guide.

6. PATENTS, TRADE MARKS

- (1) The Goods may bear patent numbers, trade marks or trade names in English of each one of the suppliers thereof.

Nothing contained herein shall be construed as transferring any patent or trademark rights or copyrights in such Goods, and all such rights are hereby expressly reserved to the true and lawful owners thereof. No copyright for drawings and documents of the Project in any case can be transferred to the Purchaser.

- (2) The Supplier shall defend the Purchaser and hold harmless the Purchaser from patent liability or claim of patent infringement of any nature or kind, including costs and expenses for, or on account of, any patent or unpatented invention made or used in such Goods, including the costs and expenses of litigation, if any.

7. APPLICABLE STANDARD AND UNITS OF MEASUREMENT

(1) Applicable standard

Unless otherwise specified in the Specification, all the Goods shall conform to the latest edition to one of the following codes and standards or equivalent.

(a) Japanese standards

JIS - Japan Industrial Standards

JEC - Standards of the Japanese Electro-technical Committee

JEM - Standards of Japan Electrical Manufacturer's Association

JCS - Japanese Cable Maker's Association Standards

(b) U.S.A. standards

ASME - American Standards of Mechanical Engineers

ANSI - American National Standard Institute

ASTM - American Society for Testing and Goods

ISA - Instrument Society of America

MSS - Manufacturers Standardization Society of the Valve and Fitting Industry

NEMA - National Electrical Manufacturers Association

NFPA - National Fire Protection Association

IEEE - Institute of Electrical and Electronics Engineers

OSHA - Occupational, Safety and Health Act

NEC - National Electric Code

UL - Underwriters Laboratories

(c) International standards

ISO - International Organization for Standardization

IEC - International Electro-Technical Commission

(2) Units of measurement

Weights and measures shall be given in the metric system and the following symbols shall be used for the drawings and documents submitted by the Supplier.

mm : millimetre

cm : centimetre

m	:	metre
km	:	kilometre
cm ²	:	square centimetre
cm ³	:	cubic centimetre
kg	:	kilogram
kgf	:	kilogram force
kgf/cm ²	:	kilogram force per square centimetre
t	:	metric ton (1,000 kilogram)
sec.	:	second
m/s	:	metre per second
A	:	ampere
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt-ampere
MVA	:	megavolt-ampere
kW	:	kilowatt
MW	:	megawatt
MWH	:	megawatt-hour
N-m	:	Newton-meter
ppm	:	Parts per million
Micro-S	:	Micro-Siemens
°C	:	degree Celsius
rpm	:	revolution per minute
Hz	:	hertz
g/kW-h	:	gram per kilowatt-hour
kcal/kg	:	kilocalorie per kilogram
%	:	per cent

8. SHIPPING INSTRUCTION

(1) Packing

All the Goods shall be packed and then containerized along all the routes to Mongolia, unless otherwise specified.

The Supplier shall take suitable precaution for the packing of the Goods to ensure safe handling during the transportation up to the Site.

The packing shall be sufficiently strong to avoid loss or damage and adequately sealed for cold weather condition so that each item will be kept serviceable at least sixty (60) days after the arrival thereof at the Site.

Precaution shall be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points, wrapping impregnated with anti-rust composition, to avoid chafing and indentation due to movement which is likely to occur in transport, shall be used and be suitable for at least ninety (90) days.

Woodwool shall be avoided as far as possible. Straw packing shall be prohibited.

Wooden boxes for export packing shall fulfil the requirements of JIS-Z-1402, 1403 and 1405 or equivalent.

All stencil marks on the outside of casings shall be either of waterproof materials or protected by shellac or varnish to prevent erasure in transport.

Where practicable, all indoor items to damage by moisture such as instruments and panels, machine components, etc., shall be covered in polyethylene sheeting, sealed at the joints and the enclosure provided internally with an appropriate desiccant. In addition, for the Goods of less durability to low temperature shall be fully insulated.

All items of the Goods shall be clearly marked for easy identification on the packing. The container shall each contain a list of packages included in it on the outside, and shall bear an identification mark relating them to the appropriate shipping documents.

All packages shall be clearly marked on the outside to show where the weight is concentrated and the correct position of the slings.

If the Supplier ships dangerous goods as defined in the International Maritime Organization (IMO) code, he shall pack them in accordance with the authorized rules issued by the organization of the Supplier's country or equal to "Rules for the Carriage and Storage of Dangerous Goods in Ships" issued by the Ministry of Transportation of Japan and shall submit the following documents two (2) weeks prior to cargos becoming available for shipment, with one (1) copy to the Purchaser.

- (a) Advance notice of dangerous goods to the Port Authority (4 copies)
- (b) Declaration of dangerous goods to a shipping company (4 copies)

Any items not stipulated herein shall be according to the Supplier's Standard of export packing for cold weather condition.

(2) Packing List and Container Stuffing List

All container shall have a copy of packing list for the packages contained which shall be covered in a waterproof envelope and be placed outside of the container. The packing list shall give all information on the package, such as package number, packing appearance, net weight, gross weight, dimension, measurement, name of the Site (4th Thermal Power Plant, Ulaanbaatar, Mongolia) and description of Goods which is contained in each package.

In case that the containers having serial numbers of packages are contained, the master packing list shall be placed inside the container which has the lowest package number.

The Supplier shall submit for each delivery the Container Stuffing List indicating the numbers of packages in each container.

(3). Marking

- (a) Each package shall be clearly marked on two (2) sides in black with a stencil and water proof ink or oil paints by means of block letters not less than 30 mm high as follows:

The marking for each package shall be of Supplier's standard.

CONSIGNEE : The 4th Power Plant in Ulaanbaatar, Mongolia
PROJECT : Rehabilitation Project of the 4th Power Plant (Phase-II)
LOAN NO. : JBIC Loan MON -P6
DESCRIPTION OF CONTENTS :
PORT OF SHIPMENT :
NET WEIGHT : (kg)
GROSS WEIGHT : (kg)
DIMENSION : (L) x (W) x (H) (cm)
PACKAGE SERIAL NO. :
SUPPLIER :

These marks shall be protected against weathering by clear water-resistance varnish.

- (b) Bags, bundles, other packages and loose pieces, which cannot practically be marked as aforesaid, shall have two metal labels securely fastened thereto by wire, and each label shall be stamped or printed with the above markings.

9. SHIPMENT, INLAND TRANSPORTATION AND STORAGE

- (1) The Supplier shall, on his responsibility and his cost, ship, transport and unload all the Goods to the Site.
- (2) The Supplier shall, on his responsibility and his cost, send the documents specified in Section II Clause 9 to the Purchaser upon shipment one week before arrival of the Goods.
- (3) The Supplier shall notify the Purchaser of the following information by fax upon shipment.
 - (a) Loan agreement (with JBIC) Number and Project Name.
 - (b) Items Shipped.
 - (c) Name of Company Responsible for all Transport.
 - (d) Number of Packages and Containers Shipped.
 - (e) Name of Ship and Train Number for the place at the border.
 - (f) Name of Shipping Company and its Agent in Mongolia and other country if any.
 - (g) Bill of Lading Number.
 - (h) Port of loading in the country of the Supplier and Expected Date of Arrival in China or Russia.
 - (i) Date of Shipment in the country of the Supplier and in China or Russia.
 - (j) Expected Date and Place of Arrival at the Border and Ulaanbaatar.
 - (k) Total Gross Weight and Measurement of Each Container Shipped.
- (4) The Supplier shall be responsible for customs clearance of all Goods supplied under the Contract. The Supplier shall submit to the Purchaser six (6) copies of bills of lading of the Goods immediately after the customs clearance.
- (5) The Supplier shall observe all regulations which limit loads on wharves, rails, and roads over which the Goods will be transported. The handling and storage of any Goods supplied under the Contract during transportation thereof shall be at the risk of the Supplier and without responsibility to the Purchaser.

(6) Inspection of the Goods

- (a) Upon arrival of the Goods, the Supplier shall unpack, check and inspect them for verification of losses, shortage and/or damages, at the presence of the Purchaser.
- (b) The Purchaser and Supplier shall sign the checklist to be prepared by the Supplier.
- (c) If shortage damage of any Goods is found in the packages, the Supplier shall forthwith supply a substitute of the Goods within a shortest time on his account cost to the checklist thus mutually signed.

(7) Storage and Keeping of the Goods

The Purchaser shall supply indoor/outdoor storage area and bridge crane free of charge. The Supplier shall be responsible for handling, keeping in the warehouse and handing over of the Goods to the erection Contractor under control of the Purchaser.

According to the erection schedule, the erection Contractor will give notice prior to receiving the Goods from Supplier. List of the Goods handed to the erection Contractor should be provided by the Supplier to the Purchaser.

10. NAME PLATE AND CAUTION PLATE

Name plates of all panels, equipment and related instruments shall be indicative with English language. However, Caution plates shall be indicative with Mongolian language by Cyrillic alphabet.

Such Mongolian language shall be translated by the Supplier on Supplier's account.

11. TECHNICAL REQUIREMENT

11.1 General

(1) Quality

- (a) All Goods to be used for the Project shall be new, unused, free of any defects in quality and workmanship, and of first-class commercial quality in strength, reliability and other necessary features. Any defect and imperfection will not be acceptable.
- (b) The Goods shall be designed, manufactured, erected and tested according to the most recent relevant standards (codes). All Goods (materials, equipment, calculation sheets, drawings, quality and class, methods of inspection, constructional peculiarities and parts) specified in this Clause shall comply in every respect with the applicable standard (see Clause 7). Especially in cases a particular code specified in Clause 13 shall be conformed.

(2) Spare Parts and Consumables

- (a) Supplier shall supply spare parts and consumables necessary for three (3) years operation of the Goods. Whereas the duration of one (1) year operation should be regarded as nine thousand (8,000) hours.
- (b) The Bidder shall specify scope of supply in accordance with Clause 12.
- (c) List of spare parts and list of consumables shall be listed at the Technical Schedules (Attachment - A: BID FORM "A" Technical schedule). Unit price of each spare part shall be provided in the Price Schedules.

(3) Power supply

The Supplier shall comply with following electric characteristics.

- (a) AC source
 - Voltage : 6,000V, 380V, Three (3) phase or 220V, Single phase, 50Hz
 - Voltage fluctuation : - 5%, + 10%
 - Frequency fluctuation : \pm 5%

- (b) DC source
- Voltage : 220V

(4) Meteorological Condition In Ulaanbaatar

The Supplier shall comply with following Meteorological condition.

- Temperature (mean) Maximum : +30 °C
Minimum : -30 °C
- Relative humidity (mean) Maximum : 90 %
Minimum : 30 %
- Monthly precipitation Maximum : 80 mm
Minimum : 2 mm
- Elevation : 1,350 meters above sea level

(5) Goods and Services Supplied by the other Supplier

Following Suppliers/Contractor shall co-operate each other in Implementation of this Rehabilitation Project.

Package-1 Supplier : Conversion of firing system for boiler No.5 to No.8

Package-2 Supplier : Rehabilitation of C&I for boiler No.5 to No.8

Package-3 Supplier : Rehabilitation of boiler tubes for boiler No.5 to No.8

Package-4 Supplier : Replacement of exciter for generator No.1 to No.4

Package-5 Contractor : Erection work for the Goods supplied by Package-1 to Package-4

11.2 Technical Information of the Existing Excitation systems

Existing excitation system for generator was designed and supplied by former USSR's manufacturer. The systems for each unit (Unit 1 to Unit 4) are AC exciter type which have rotating main exciter and sub-exciter (PMG) both of which are coupled to the shaft of generator (See attached drawings MON-K-4-02) for which the excitation power is fed to slip ring of generator by excitation panel located on the first floor. Since the electrical machinery excitation system is encountered with shortage of spare parts due to the manufacturer has stopped the manufacturing of above excitation system. The power plant has many trouble

with it and the plant is using the emergency exciter often. It is recorded many cases of broken coupling pins for the electrical machinery exciter.

The technical data of the existing Generators including existing AC exciters are shown below (Table TS-4-01, Table-4-02).

Table TS-4-01 Technical Data for the existing Generators (Unit 1 to Unit 4)

Manufacturer	ELECTROSILA (USSR)	
Type	TVF-120-2UZ Hydrogen gas cooled, horizontally mounted cylindrical rotor, rotating field type	
Rated Output	125	MVA
Rated Frequency	50	Hz
Rated Voltage	10.5	kV
Rated Current (maximum)	6,875 (7760)	A
Rated Power Factor (maximum)	0.8 (0.85)	(lag.)
Rated Speed	3,000	rpm
H2 Pressure (maximum)	2.5 (3.5)	kg/cm ²
Field current at generator no-load	600	A DC
Field voltage at generator no-load	80	V DC
Field current at generator rated output	1,715	A DC
Field voltage at generator rated output(maximum)	277 (296)	V DC
Direct-axis synchronous reactance (Xd)	190.7	%
Transient reactance (Xd')	27.8	%
Sub-transient reactance (Xd'')	19.2	%
Negative sequence reactance (X2)	23.4	%
Zero-sequence reactance (X0)	9.73	%

Table TS-4-02 Technical Data for the existing Exciters (Unit 1 to Unit 4)

(Main Exciter)		
Manufacturer	ELECTROSILA(USSR)	
Type	VTD-490-3000UZ Rectified by AC Generator type	
Rated Power (maximum)	490 (560)	kW
Continues Power	600	kW
Instantaneous Power (20 sec)	1,960	kW
Rated Voltage	280	V
Continues Voltage	310	V
Instant Voltage (20 sec)	560	V
Rated Current	1,750	A
Continues Current	310	V
Instant Current (20 sec)	3,500	A
(Sub-Exciter)		
Manufacturer	ELECTROSILA(USSR)	
Type	PPM30 / 400UZ PMG	
Rated Power	30	kW
Rated Voltage	400/280	V
Rated Current	54/93	A
Frequency	400	Hz

11.3 Operation and Technical Requirement

New excitation system shall be static type with digital automatic control system, which controller by redundant automatic voltage regulator (AVR) and manual voltage regulator.

The system is to be full static excitation and based on the removal of both Sub-and Main Exciters. The system shall be provided with all related system components including power transformers, thyristor bridges, field suppression equipment, excitation control desks and panels, and all connections between them. All control system must be isolated from the noise and line surge caused by radio noise, thunderbolt, induced voltage and etc.

The excitation system shall provide necessary signals to the existing turbine/generator control desks located in the ECCR. Upon executive of a signal, automatically or by manual mode, an initial excitation system shall ensure voltage build-up.

During operation in automatic voltage control mode by AVR, the terminal voltage and the reactive load of the existing Generator shall be kept stable, without hunting, within the specified limits of accuracy at the prevailing set point and shall adjust to any point within the entire permissible area of the Generator capability diagram during steady state and transient conditions.

11.4 Existing Equipment and Instruments to be adapted to the new System

11.4.1 General

Based on the scope of the Works of the Package-4 specified in Clause 2.1 and attached drawings MON-K-4-01, the following existing equipment and instruments for all of the existing AC excitation system shall be remained and adapted to the new system.

- (1) one (1) set of the field flashing unit and their related panel in each unit (Unit #1 to #4).
- (2) one (1) set of the voltage transformer (3pcs of one phase VT) in each unit (Unit #1 to #4).
- (3) one (1) set of the current transformer in each unit (Unit #1 to #4).
- (4) one (1) set of the common backup excitation system including their machinery equipment.
- (5) one (1) set of the backup excitation control panel including current breaker in each unit (Unit #1 to #4).

Further, the Supplier shall comply with the technical data for the above which are shown below (see Table TS-4-03, 04 and 05).

Table TS-4-03 Technical Data for the existing VT (Unit 1 to Unit 4)

Type	3NOL-0.6-10UZ	
Nominal Voltage	10.5kV / 173 V	kV/V
Rated Capacity	630	VA
Instant Voltage	15.75	kV
Accuracy	±3	%

Table TS-4-04 Technical Data for the existing CT (Unit 1 to Unit 4)

Type	TSHL-20-1Y3	
Nominal Voltage	20.0	kV
Rated Capacity	30	VA
Instant Voltage	15.75	kV
Transformer ratio	8000/5	
Accuracy	±3	%

Table TS-4-05 Technical Data for the existing Field Flashing Unit (Unit 1 to Unit 4)

Rated Voltage of the main circuit	500	V DC
Rated Current of the main circuit	3200	A DC
Celling Factor (ratio of overloading of the main circuit to rated parameters by voltage and current)	2	Coefficient
Allowable time for overloading	50	sec
Discharge resistance	12	ohm

11.4.2 Alternative

The Bidder can propose the following alternatives. Each alternative differs substantially in the following specifications from those specified in this Bidding Document.

Alternative-1

- (1) Existing voltage and current transformers shall be completely replaced in each unit
- (2) Discharge resistor with accessories for existing field flashing unit shall be replaced in each unit.
- (3) Differential relay and accessories for excitation power transformer shall be supplied in each unit

Alternative-2

- (1) The excitation control system shall be designed with single digital auto voltage regulator (AVR) and single manual current regulator in each unit
- (2) Existing voltage and current transformers shall be completely replaced in each unit
- (3) Discharge resistor with accessories for existing field flashing unit shall be replaced in each unit.
- (4) Differential relay and accessories for excitation power transformer shall be supplied in each unit

11.5 Technical Specification

11.5.1 Performance

- (1) The ceiling level of field voltage shall be at least 1.6 times the maximum continuous rating of field voltage, for stator voltages between 0.6 and 1.0 per unit of rated value.
- (2) The offered excitation system shall have high initial response time with a response ratio such that excitation increases from rated load excitation voltage 1.0 P.U. to a voltage greater than 1.6 P.U. in 0.1 sec in response to a step change in generator terminal voltage of 2.5%.
- (3) The excitation system shall be capable of providing the peak power required for operation at ceiling voltage level.

This requirement is based on an operating duty cycle of rated output for a sustained period, then ceiling voltage for 10 seconds, then return to rated output for a sustained period.

11.5.2 Static Thyristors Excitation System

- (1) Thyristors
 - (a) The thyristor bridge shall comply with the requirements of IEC 146.
 - (b) A three-phase fully-controlled thyristor bridge shall be provided with sufficient redundancy to permit operation of the generator at full excitation power with 20% of the thyristors failed in any set of parallel paths i.e. arm of the bridge. It shall be possible to either replace faulty thyristors with the generator in service, or the extent of thyristor redundancy shall be sufficient, having regard to their reliability, to permit full excitation power without replacing damaged thyristors more often than once every 8,000 hours.
 - (c) Thyristor cooling system shall have sufficient redundancy to ensure generator continuous rated output.
-

(2) Excitation Power Transformer

- (a) A power transformer shall be provided to supply the power requirements of the excitation system under all operating conditions. This transformer shall be silicone-insulated dry-type with class H or F thermal insulation or the resin-molded dry-type.
- (b) The transformer cooling system shall be a natural air cooled type with cover for outdoor applications to be manufactured to the appropriate IEC standard. Further dimensions and weight shall also be IEC standard.
- (c) Additional stray and eddy current losses generated by the harmonics supplied to the load shall be considered for designing of excitation power transformer. The Supplier shall calculate the extra losses due to harmonics by reference to ANSI/IEEE C57.110.
- (d) The transformer shall have necessary protections. At least over current and over temperature protection relay shall be provided.
- (e) The transformer shall be equipped with the following accessories:
 - thermometer with separate alarm and trip contact
 - rating and name plate, according to standards
 - other accessories according to manufacturer's standards

(3) Sliprings and Brushgear

- (a) The slip-rings and brush-gear will remain.

The existing slip-rings and brush-gear will be adapted to the new system. For the purpose of the above requirement, the Supplier shall investigate the site condition for each unit.

(4) Field Suppression

Main field circuit breaker complying with IEC 947 Parts 1 and 2, and a non-inductive resistor shall be provided for generator de-excitation. The Main circuit breaker shall be capable of breaking the field current under the most onerous operating conditions. On opening the breaker, the field winding shall be short-circuited through the resistor which shall ensure that the rotor winding voltage remains adequately below its test voltage. Main field circuit breaker shall have two trip coils which are electrically and mechanically independent. Further, the existing field flashing including back-up breaker will remain so that the Main field circuit breaker shall be adapted to the above back-up breaker.

(5) Supervision and modification of existing control panel and desk in the ECCR.

Existing excitation control circuit breaker has interlock with the plant control circuit breaker. Further the excitation control system shall have interface for the existing turbine/generator control desk and alarm windows in the ECCR.

At least the following interface shall be provided:

- (a) ON/OFF signal for excitation system
- (b) OPEN/CLOSE condition signal of unit circuit breaker
- (c) RAISE/LOWER signal for the voltage setting of AVR
- (d) CLOSE/OPEN signal for field circuit breaker
- (e) Trip and Alarm signals of excitation system
- (f) Signals of excitation voltage and field current meters
- (g) Operating condition signals of AVR and so on

At least the following interface for protection and alarm signals shall be provided:

- (a) Over current relay for excitation power transformer
- (b) Over temperature for excitation power transformer
- (c) Thyristor failure
- (d) Thyristor cooling fans failure (if required)
- (e) Field circuit breaker trip
- (f) Pulse failure
- (g) Control power supply failure
- (h) Field current earth fault

The Supplier shall provide a new AVR control patch panel with necessary components, which shall be adapted to the existing control desk, for each unit. The applicable panel configuration for the AVR control patch panel and specification of the existing instruments on the existing panel of turbine/generator, which shall be newly supplied by the Supplier, are attached (refer to the drawings MON-K-4-07, 08, 09).

(6) Isolator

An off-line isolator shall be provided between the excitation transformer and the thyristor cubicle. A fixed earth switch on the thyristor side of the isolator shall also be provided. These are to enable electrical isolation of the thyristor cubicle for maintenance purposes without de-energizing the generator and unit auxiliary transformers. The design of the isolator and earth switch shall be such that the status of the contacts can be seen to confirm electrical isolation and earthing respectively.

11.5.3 Excitation Control System

(1) Construction and Reliability

The excitation control system shall be provided with complete, reliable and stable automatic regulator for the generator excitation.

(a) Technology

The regulator shall be microprocessor based.

(b) Redundancy for Automatic Control and Provision for Manual Control

The automatic voltage regulator (AVR) shall have two completely independent reference, amplifier and control circuits, henceforth called Channel 1 and Channel 2 respectively. Channel 1 and Channel 2 shall use the separate existing measuring voltage transformers and commonly use the existing measuring current transformer. Each channel shall be interfaced with manual excitation current regulator.

(c) Operation of Duplicate Circuits

The aim of having redundant regulators is to ensure that generator excitation remains under automatic control, notwithstanding a single failure in the control system.

In the following requirements, it is assumed that the two Channels will operate on the duty/standby principle.

The normal condition of operation when the generator is connected to the system will be for excitation to be under automatic voltage control of the selected Duty Channel, with the Standby Channel being also selected to automatic mode. If the Duty Channel in automatic mode fails, control will be transferred "bumplessly" to the Standby Channel (automatic mode). If the Standby Channel automatic control subsequently fails, control shall be transferred to the Standby Channel manual controller if allowable, otherwise excitation shall trip, and manually transferred to "Existing backup Exciter".

The equipment shall be designed and constructed so as to facilitate maintenance of one Channel while the other remains in service.

In case of both channel cannot control the excitation due to the fault in measuring circuit, the operation will be transferred to the manual mode, that allows to operator to control the excitation by current regulator.

The status of each Channel shall be indicated in the ECCR. Operator shall be able to select Channel (1 or 2) and mode (Auto/Manual) from the ECCR.

(2) Characteristics

The excitation control system shall have the following characteristics:

(a) Sensitivity

The excitation system shall give its maximum or minimum output with variations in generator terminal voltage of not greater than $\pm 3.5\%$ from set point.

(b) Regulation

Nominal capacity of the generator shall be kept on the changes of terminal voltage by $\pm 5\%$. If the terminal voltage changes within $\pm 5\%$ to $\pm 10\%$ limits the generator's output will as follows:

Voltage % (from nominal)	110	109	108	107	106	105	100	95	90
Full capacity % (from nominal)	90	92	94	96	98	100	100	100	94
Stator current % (from nominal)	82	84	87	90	92	95	100	105	105

Voltage fluctuation more than 110 % not allowed, if generator power factor will different from nominal value, the power factor shall be regulated according to the power diagram shown in the drawing MON-K-4-10. Nominal capacity of the generator shall be kept on fluctuation of frequency for $\pm 5\%$.

(c) Range of Control

The regulator shall be capable to perform the automatic control of the generator terminal voltage between the limits of 85% and 110% of rated voltage under all operation conditions of the generator operation, when there is no contribution from any of the Supplementary Control circuits.

(d) Stability and Damping

It is intended that the excitation control system will be adjusted so that, with the generator operating on open circuit at rated voltage a step change in the AVR input equivalent to a step change of either +2.5% or -2.5% terminal voltage, shall result in an oscillation in field voltage with a settling time of less than 1.5 seconds.

(The settling time of a quantity is defined here as the time interval from the instant of the step change until the resulting oscillation settles to less than $\pm 10\%$ of the maximum induced change.)

It is also intended that the excitation control system will be adjusted so as to maintain stable operation of the generator for a $\pm 0.5\%$ step change in terminal voltage with the

machine operating at all loads and power factors within the capability limits shown on drawings MON-K-4-10. The under excited capability limit shown on this drawing is based on a theoretical model with the generator connected to an infinite bus bar through a reactance of 0.5 P.U. (on rated MVA of the generator) and with rated voltage maintained at the generator terminals (achieved by adjustment of the infinite bus bar). The criterion of stability is a settling time of less than 5 seconds in generator terminal voltage and rotor angle oscillations.

In order to achieve these requirements, the Supplier shall carry out the necessary calculations before Commissioning based on the Purchaser's data. Above calculations shall be confirmed between the Supplier and the Purchaser.

(e) Low and High Frequency Operation

The regulator shall function satisfactorily at system frequency changes between 45 Hz and 53 Hz.

(3) Supplementary Controls

The output of the excitation regulator shall be varied in accordance with the requirements of at least the following supplementary control circuits.

(a) Automatic Start-up and Shut down

On closing the field switch during start-up of the generator, excitation shall be applied proportional to speed and increased until minimum set point voltage is achieved at not less than 95% normal speed. At the end of the excitation raising sequence, excitation shall be under automatic voltage regulator control.

The shut down sequence shall ensure that excitation is controlled so as not to over voltage any transformers which may be connected to the generator.

(b) Reactive Power (Var) Control

Reactive power controller shall allow the parallel operation of the Generators with controlled reactive power. Operator shall be able to set the set point remotely for each controller by Raise/Lower commands or an analog signal (4 to 20 mA) from the ECCR.

The control mode calculates the corresponding reactive power for the adjusted set point and subtract this signal from the actual reactive power. If the result is larger than a set band, the AVR will slowly move until the difference will equal or smaller than the dead band.

(c) Stabilizing Controls

Stabilizing signals, derived from generator power output, terminal frequency and rotor speed shall be provided to enhance the damping of generator and power system oscillations over the frequency range 0.2 to 2.0 Hz. These shall be provided on both channels.

(d) Over-Excitation Limit

The regulator shall have an over-excitation limiter to restrict the period of operation of the generator beyond its continuous over-excited capability. The limit action shall have a time inverse characteristic corresponding to a small margin from the short time capability of the generator rotor and excitation system, and shall return operation to continuous rating. It shall operate smoothly, and without causing hunting. The alarm signal shall be indicated to the Local Panel and the ECCR.

(e) Under-Excitation Limit

The regulator shall have an under-excitation limiter to prevent operation of the generator while under AVR control. The limiter shall operate smoothly, and without causing hunting. The alarm signal shall be indicated to the Local Panel and the ECCR.

(4) Supplementary Protection

The following supplementary protections and alarms shall be provided.

(a) Fuse Failure Protection for measuring transformer

The excitation control system shall incorporate means of detecting generator voltage transformer fuse failure. If such a failure is associated with the Duty Channel, an alarm shall be raised and shall be automatically change over to the Standby Channel. If failure is associated with the Standby Channel, an alarm shall be raised and standby

automatic control shall be excluded from the normal control transfer sequence. This facility shall not operate for low terminal voltage conditions arising from a fault on the system.

If fuses associated with both channels fail, control shall be transferred to manual.

(b) Rotor Over-Current Protection

Even the control channels are operating in Duty and Standby mode, their protection shall operate when the over current is detected.

(c) Over-voltage Protection

Protection shall be provided against stator over-voltage.

(d) Under-excitation Protection

If with the duty channel in automatic control, its under-excitation limiter fails to operate as designed to prevent from damage in pole slipping, a protective function shall operate. If subsequently, with the standby channel in automatic control, its under-excitation limiter also fails to operate, a protective function shall operate.

(5) Manual Excitation Control

The manual control shall meet the following additional requirements:

(a) Follow-up/Tracking

Equipment shall be provided to cause the manual excitation control to match the excitation level determined by the in-service automatic control, after a suitable time delay to avoid hunting, etc. This is to ensure that a changeover from automatic to manual control, under steady state conditions, will generally take place without perceptible transients while operating in the generator capability range where manual control is stable.

(b) Manual Restrictive Limit

(i) A facility shall be provided to prevent the manual controller operating point from following the in-service automatic controller operating point beyond a characteristic

line known as the Manual Restrictive Limit, which will be advised by the Purchaser in the form of a locus of points on the MW versus MVAR capability diagram. If protective transfer from automatic to manual control occurs while automatic is operating beyond the characteristic curve, it is acceptable that there be an immediate increase in excitation current and hence MVAR lagging output to bring the operating point with the characteristic curve.

- (ii) A facility shall be provided to prevent an operator reducing excitation current using a manual excitation controller beyond the characteristic curve described in (i). Further, if excitation is under manual control and the MW output is increased, a facility shall be provided to ensure the manual operating point remains within the characteristic curve.

(6) Test and Monitoring Facilities

- (a) To facilitate performance testing of the AVR and for future investigations, quantities shall be made available for measurement at the excitation cubicle. The quantities shall include the following and may taken the form of analogue signals or outputs from the digital software:

- Generator stator voltage and current
- Generator three-phase real and reactive generator power output
- Generator rotor voltage and current
- Any other signal used by the Supplier as a feedback in the AVR
- Intermediate signals at key points in the AVR block diagram
- Test and monitoring devices for recording

- (b) Analogue transducers (if any) required for processing primary signals shall be mounted in the excitation cubicle and have a time constant (lag) of less than 20 milliseconds.

(7) Sources for Generator Voltage Signals and Current Signal

The generator voltage and current signals for each AVR Channel shall be derived from two (2) physically separate V.T.s and one (1) existing C.T.. Each V.T. and C.T., which is separately connected to the phase-isolated bus bars and secondary wired with separate cables, will be used to the existing equipment and adapted to the respective AVR

channels to minimize the possibility of a single event crippling both automatic regulators. Further existing V.T.s and C.T are specified (see Table TS-4-03 and 04).

(8) Performance Data

- (a) The Supplier shall provide the complete block diagram so that it shows the gains, time constants, delays, limits and saturation of the excitation system as designed. Where these can be varied, ranges and recommended values are to be shown. Frequency response curves of each block with the recommended settings are required. The Supplier shall at appropriate times resubmit the block diagram amended during the test to show the parameters and limits and again to show those which apply to the excitation system after it has been commissioned.

11.5.4 Panel Specifications

All elements of the control panels for excitation system shall mounted in self standing, metal enclosed, floor mounted cubicles. The equipment shall have easy access for maintenance and all wiring are terminated on molded terminal blocks, except for power cables, which terminate at the equipment terminals in the cubicles.

The table below shows the minimum technical requirements for all panels.

Table TS-4-06 Panel Specifications

ITEM		SPECIFICATION	
Construction	Panel thickness	Front door	3.2 mm
		Rear cover	
		Side panel	
	Front door	Inner panels	2.3 mm
		Roof cover	
	Front door	Handle	With key
	Dust proofing		IP 20
Painting *1)	Outside surface		Munsell 5Y7/1
	Inside surface		
	Instrument frame		Munsell N1.5
Wiring	Wire size	Control circuit	$\geq 1.25 \text{ mm}^2$
		Power circuit	$\geq 5.5 \text{ mm}^2$
	Terminals		Compression type
	Wiring mark	Type	Sleeve type tube
Withstand voltage	Control circuit		2000V 1minute (to earth)

Note) *1 : All metal surface shall be cleaned, phosphate and given two (2) coats of rust-resistant primer followed by two (2) coats of finish paint.

11.5.5 Power and Control Cables

- (1) All power and control cable shall be complying with ICEA, ASTM and IEC Standards and with the recommendation of the National Electrical Code, ANSI C1.
- (2) Conductors in vertical runs shall be supported with non-conducting material.
- (3) All terminations shall use 2-hole type lugs for cables larger than #4/0 AWG (or equivalent SI).

Insulation shall be suitable for wet and dry locations, and it shall conform to Part 3, Paragraph 3.8, ICEA S.61-402. In general, low voltage cables shall be suitable for a continuous conductor temperature of 75°C. Medium voltage cables shall be suitable for a continuous conductor temperature of 90°C. The table below shows the minimum technical requirements for wire and cable for the power station.

Table TS-1- 03: The Minimum Technical Requirements for Wire and Cable

Voltage Class Rating	Type/No. of Cond./Material	Insulation/Jacket	Application	Minimum Size (or equivalent SI)
300V/105°C	PLTC/Single, Triad, or Multi-Pair/Copper	PVC/PVC	Instrumentation	Minimum Size (or equivalent SI)
300V/105°C	PLTC/Single or Multi-pair/ Copper	PVC/PVC	Thermocouple	#20.w #20 drain wire
300V/105°C	PLTC/Copper	PVC	75 Ohm. Coaxial Cable	#16.w #20 drain wire
300V/200°C	PLTC/Single, Triad, or Multi-pair/Copper	FEP	Instrumentation	#20.RG-59/U
300V/200°C	PLTC/Single or Multi-pair/ Copper	FEP	Thermocouple	#16.w/#18 drain wire
600V/75°C	TC/Single or Multi-conductor/ Copper	XLP/PVC	Power and Control Circuits	#12
5.15kV/90°C 7.2kV/90°C	Single or Multi-conductor/ Copper	XLPE/PVC or EPR/CPE or CSPE(133% Insulation)	Medium Voltage Power and Distribution Circuit	
Ground Wire	Single/Copper	Bare or Green Insulation	Grounding	
Static and Messenger Wire	High Strength Steel	Bare	Lightning Protection and Cable Messenger	
<p>Note) For the purpose of the isolation from noise and line surge caused by radio noise, thunderbolt, induced voltage and etc, following control cables will be used:</p> <ul style="list-style-type: none"> - compensation cable - optical cable - coaxial cable - sealed or screening cable 				

12. SCOPE OF THE GOODS

12.1 General

The Goods shall fully satisfy the Purchaser's demand. The Supplier shall be deemed to have satisfied himself on and taken account in his Bid all the conditions and circumstances affecting the Contract Price and the detailed design requirements for the purposes of rehabilitation of the Project. The Supplier shall be solely responsible for the design of the Goods in quality, quantity, dimensions, shape and such other necessary elements as required by this rehabilitation Project, with particular attention to the existing facilities and equipment, whether left in use or removed.

12.2 Scope of Supply

The static excitation system shall be equipped with the following components.

The Supplier shall supply:

- (1) one (1) set of power unit which shall consist of the required thyristor bridges complete with the necessary controls and protections for each unit (Unit #1 to #4).
- (2) one (1) set of measuring voltage transformer with terminal connection for each unit (Unit #1 to #4)
- (3) one (1) set of regulating equipment for each unit (Unit #1 to #4).

The system shall consist mainly of the following components:

- (a) Voltage regulator with adjusting and control of the voltage of generator
 - (b) Current regulator
 - (c) Electronic operational amplifier
 - (d) Under excitation and over excitation limit devices
 - (e) Pulse generator
 - (f) D.C. power supply unit which shall energize the regulation circuits
 - (g) Isolation units
- (4) one (1) set of field circuit breaker unit with protection and monitoring accessories, which shall be adapted to the existing field flashing unit and existing back-up exciter's circuit breaker for each unit (Unit #1 to #4).

- (5) one (1) set of control, protection and monitoring instruments for each unit (Unit #1 to #4).
- (6) one (1) set of excitation transformer for each unit (Unit #1 to #4).
- (7) one (1) set of AVR control patch panel which shall be installed in a existing turbine/generator control desk for each unit (Unit #1 to #4).
- (8) all power and control cables with terminal connections for each unit (Unit #1 to #4).
- (9) all necessary cable conduits and cable trays with accessories for each unit (Unit #1 to #4).
- (9) one (1) set of tool for commissioning and maintenance with hardware, software, interface module and cable.
- (10) following spare parts for each unit (Unit #1 to #4).
 - (a) one (1) set of AVR controller for four (4) units* (**total : one (1) set)
 - (b) three (3) quantity of thyristors
 - (c) two (2) quantity of fan for the thyristor ventilation (if required)
 - (d) six (6) quantity of thyristor fuses
 - (e) one (1) set of power supply unit
 - (f) one (1) set of interface unit
 - (g) one (1) set of analogue I/O unit
 - (h) one (1) set of digital I/O unit
 - (i) one (1) quantity of measuring voltage transformer
- (11) other necessary spare parts for three (3) years.

12.3 Test and Inspection

12.3.1 Visual Inspection before Designing

The Supplier shall perform the visual inspection at the Site before designing to clarify the terminal points of the connection, installation space, panel layout, interface and/or interlock to the existing equipment and the ECCR. The Supplier shall inform his result of the inspection to the Purchaser. Further the Purchaser will cooperate for the performing of this inspection.

12.3.2 Test and Inspection at Workshop

(1) General

Where no specific test is specified then the various items of plant, materials and equipment shall be tested in accordance with the applicable standard, acceptable to the Purchaser. Where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice, subject to the prior approval of the Purchaser. In all cases, the tests shall include electrical and mechanical tests.

if considered necessary by the Purchaser, any multi-part assemblies shall be fully erected in the Works prior to packing and dispatch to the Site.

(2) Excitation System

The Supplier shall provide a list of excitation system tests result conducted at the workshop. The list shall include following items.

(a) Thyristor Bridge

Tests shall be carried out on the thyristor bridge as required by IEC 134.

With reference to the temperature rise test, the temperature rise must remain within limits for a duty cycle no less than that specified in this Clause.

(b) Excitation Power Transformer

The Supplier shall carry out temperature rise tests at the Works, using a higher than rated current to prove that in-service rated temperature rises will not be exceeded. The test current shall take into account the extra losses due to harmonics and shall be determined by reference to ANSI/IEEE C57.110. The Supplier shall execute all other necessary tests for Excitation power transformer.

(3) Complete Excitation System

The Supplier shall perform the following tests.

- (a) A Transfer Function Test shall be carried out on the excitation system for the determination of all time constants, gains, input/output limits and frequency response curves.
 - (b) An Excitation System Nominal Response Test shall be carried out to determine the excitation system nominal response V_E . The voltage error step to be used in the test is 10% of rated voltage.
 - (c) Checks shall be carried out on the operational features of the automatic excitation regulator; including automatic changeover from one controller to another; and to manual operation of limiters, follow-up controls and alarms.
 - (d) All other test as necessary shall be carried out to prove compliance of the excitation system with the specified requirements.
- (4) Further the Supplier shall perform the following witness tests in the presence of the Purchaser's engineers who dispatched to the Workshop, but not limited to. The Supplier shall provide all necessary assistance for these visits, witness tests and give all the information requested.

Expenses needed for these Purchaser's personnel, related the following witness tests shall be included in his Bids.

Static excitation system : two (2) engineers , one (1) time

(If the excitation power transformer is manufactured separately in other manufacturer and directly to the Site, two (2) engineers will witness the test at other manufacturer's workshop.)

- Routine test of the excitation power transformer for each unit
- AVR unit static characteristic test
- Measurement of insulation, resistance, dielectric test and current test of thyristor unit for each unit
- Operation test of control devices for each unit
- Visual & dimensional check and sequence check of control panels for each unit

13. COMMISSIONING

13.1 General

Upon completion of the erection work of the Goods by an erection Contractor the Supplies shall commence Commissioning of the Goods.

Commissioning includes adjustment, performance, no-load and load test. The details are specified hereunder, but not limited to.

The Supplier shall prepare all necessities for commissioning.

If incorrect erection work is found during the Commissioning period, modification work shall be done by the erection Contractor upon a notice of the Supplier through the Purchaser.

13.2 Commissioning

- (1) The Supplier shall submit to the Purchaser the Commissioning procedures including time schedules one (1) month prior to start of the Commissioning.
- (2) The procedures shall include adjustment and test procedures, evaluation criteria of adjusted and tested machines, instruments, control apparatus, systems etc. and forms of records.

Commissioning test is divided into the following stages.

13.2.1 Loop Check and Tuning

After completion of the erection work, the Supplier shall perform the following tests.

- Wiring continuity tests
- Alignment of equipment
- Calibration of C&I equipment
- Checking and testing electrical relays, and instrument transmitters and other all devices
- Setting protective devices
- High Voltage test (Insulation test) relevant equipment
- Loop test

- System sequential test
- Control system adjustment, setting and tuning
- Interlock test

13.2.2 Excitation System

- (1) Tests shall be carried out to prove that the stability and damping of the automatic excitation regulator (AVR) complies with the specified requirements. Tests with the stabilizing signals connected and disconnected shall be carried out to demonstrate the effect of all stabilizing signals used in the AVR. The tests shall be carried out with the generator no-load operating on open circuit and rated voltage (no-load operation).
- (2) With the generator on open circuit and under AVR control, the generator terminal voltage shall be measured at speeds corresponding to 48, 50 and 52 Hz without changing the voltage set point.
- (3) The voltage drop compensation shall be proved effective. The Purchaser will arrange for variations in system voltage to permit reasonable reactive load changes to be made on the generator. The Supplier will make electrical measurements to confirm the degree of compensation.
- (4) The control system for co-ordinating reactive power loading of each generator shall be proved to be able to carry out its function by in-service test. The Purchaser will arrange for variations in reactive power demand on the generators for this test.
- (5) With the generator on open circuit and under AVR control, changeover of the AVR from one control function to another (i.e. auto-auto, auto-manual) shall be proven for each fault condition.
- (6) All necessary tests shall be carried out to check the excitation system transfer function block diagram.
- (7) Further the Supplier shall perform the following witness tests in the presence of the Purchaser's engineers.
 - Measurement of insulation and resistance of panels for each unit.

- Visual & dimensional check and sequence check of control panels for each unit.
- AVR voltage build-up test at no-load for each unit.
- AVR step response test at no-load.
- Synchronization operation at rated voltage for each unit.
- Load up operation to maximum load at rated voltage for each unit.
- Load down operation to minimum load at rated voltage for each unit.
- Reactive power control test in parallel operation of the Generators.
- Measurement of generator voltage, generator current, generator field current, generator field voltage, and excitation transformer temperature and current.

13.3 Completion of Commissioning

The Supplier shall give a notice of completion of the Commissioning.

Upon the notice of the completion of the Commissioning if the Purchaser duly judges that the Commissioning is fully completed and the specified performances of the Goods are proved well, the Purchaser shall give a certificate of completion of commissioning.

14. TRIAL RUN

The Supplier shall carry out the Trial Run according to the prepared program in presence of the Purchaser. The Supplier shall execute following test for the Trial Run for each unit. Trial run shall be continued not less than five (5) days during following conditions:

- Load operation at rated voltage for each unit

Note)

When all the Works completed (it should be the date of Provisional Acceptance for the final unit), the Supplier shall remove from the Site all temporary facilities and office provided by the Supplier.

15. SUPERVISION SERVICES

15.1 General

- (1) The Supplier shall provide qualified and competent supervisors for the erection work of the Goods. The erection work of the Goods will be carried out by an erection Contractor under the control and direction of the Purchaser.
- (2) The Supplier shall propose the dispatching schedule of the supervisors, that includes period, man-month and duties of each supervisor and/or skilled worker, in the technical schedule.
- (3) The Supplier shall supply the instructions for erection work as specified in Clause 5.2.4 (6).
- (4) The Supplier shall take full responsibility for the safety, protection and security of his supervisors.

15.2 Duties of Supervisor

The supervisor for the erection work shall have the following duties:

- to cooperate with the Purchaser in executing his duties.
 - explanation of the erection instruction to the erection Contractor.
 - to give correct instructions necessary for the erection work to the erection Contractor upon request of the Purchaser or the erection Contractor.
 - to observe progress of the erection work and to give advice to the Purchaser when he acknowledged any delay in the progress.
 - to evaluate the quality of each activities of the erection work and to give advice to the Purchaser when he acknowledged any defect in any activity.
 - observation and dimension control of the equipment foundation.
 - observation of cable work.
 - to measure critical dimensions of essential components.
 - to judge whether erection work may proceed to further erection milestone or not.
 - to evaluate quality of the whole erection work and to give his comments on the results to the Purchaser upon completion of the erection work.
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16. TRAINING OF PURCHASER'S PERSONNEL

16.1 General

The Supplier shall provide to the Purchaser as the transfer of technology and developing expertise in the area of engineering, operation and maintenance of the Goods.

The number of man-days of training as detailed below shall be included in the Bid.

The Supplier shall be responsible for the development of the training module and program Schedule, which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to training procedures/ methodology, module content instructional materials such as audio visual materials, tapes and slides, and manuals for each trainee.

During the conduct of the training program the Supplier shall employ qualified English speaking instructors.

16.2 Training at Supplier's Home Country

The Supplier shall train Purchaser's engineers for operation and maintenance. All expenses related to the training shall be borne by the Supplier and shall include but not be limited to travel expenses (international and in-land fares), lodging and per diems, travel and medical insurance, instructors fee, program and miscellaneous cost to be incurred during the training.

The training shall generally be divided on the following basis, subject to the approval of the Purchaser:

- Maintenance : Two (2) Engineers two (2) weeks
- Operation : 1 (one) Engineer two (2) weeks

The cost of such training shall be included in the respective commercial schedule.

16.3 Operation and Maintenance Training at the Site

The Supplier shall provide a comprehensive training program related to design application, operation and maintenance, including trouble shooting of the Goods at the Site during erection work and Commissioning.

The content of the training program shall include but not be limited to:

- Operation and maintenance of Excitation system
- Maintenance covering electrical, mechanical, control and instrumentation

The training programs shall be submitted to the Purchaser for approval.

16.4 On the Job Training

The Purchaser shall provide operation and maintenance personnel to the Supplier for training under the direction of the Supplier for the purpose of on the job training.

All instructions shall be in English language.

17. MATERIALS AND SERVICES TO BE PROVIDED BY THE PURCHASER

The Purchaser will provide the followings to the Supplier :

- (1) Operational personnel
- (2) Electricity and water needed for execution of the Contract
- (3) Internal Tele-communication line