ARMENIA NUCLEAR POWER PLANT

TECHNICAL SPECIFICATION NO. 7660-01

DIESEL GENERATOR

LOAD SEQUENCER

WITH OPTIONAL

CONTROL UPGRADE

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TECHNICAL SPECIFICATION

DIESEL GENERATOR LOAD SEQUENCER WITH OPTIONAL CONTROL UPGRADE

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SPECIFICATION 7660-01

DIESEL GENERATOR LOAD SEQUENCER WITH DIGITAL CONTROL UPGREADE

1 SCOPE

This Specification covers the design, manufacture, shop testing, packaging, storage and handling, technical direction of installation, and nuclear qualification of a Diesel Generator Load Sequencer (DGLS).

Two new Class 1E Diesel Generator Load Sequencers will be installed at the Nuclear Power Plant in Armenia (ANPP). Microprocessor-based systems will replace obsolete diesel generator load sequencers.

The DGLS shall include all hardware, software and equipment needed to perform diesel generator load sequencing. All major components of the system shall be capable of communicating with each other and with external digital control systems through appropriate data links.

2 GENERAL REQUIREMENTS

2.1 WORK PROVIDED BY CONTRACTOR

The Contractor shall complete the following work, as required by the Contract Documents and as specified herein:

- Design, manufacture and assemble the DGLS.
- Provide licensed operating system, application, communications, diagnostics, operator interface, data storage and archival, programming, display building, and report generation software
- Perform functional hardware and communications shop testing.
- Package the DGLS.
- Provide technical assistance to the Purchaser for the installation, programming and field testing of the DGLS.
- Furnish system technical and qualification documentation
- Conduct training program for plant personnel.
- Spare parts list

2.2 WORK PROVIDED BY PURCHASER

The following work will be provided by the Purchaser:
Woodward type EGB13P governor

- Logic diagrams for load sequencers
- Installation of DGLS at job site
- Field Wiring.

- Engineering workstation with printers required for operator interface, programming, testing and reporting.

2.3 APPLICABLE CODES AND STANDARDS

The latest edition and addenda of the following publications in effect on the date of Contract Award are a part of this Specification and, where referenced by title or basic designation only, are applicable to the extent indicated by the specific reference. Use of alternate codes and standards is acceptable when comparability to the listed codes and standards can be demonstrated.

ANSI/ISA S50.1 - Compatibility of Analog Signals for Electronic Industrial Processes
ANSI/ISA- Standards Group 88 - Batch Control
ICS1 - Industrial Control and Systems: General Requirements
NFPA 70 - National Electric Code
IEEE 7-4.3.2-1993, " Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations"
IEEE 323-2003, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
IEEE 338-1987, "Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems"
IEEE 344- 1987, 'Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations"
IEEE 379-2000, 'Standard Application of the Single-Failure Criterion to Nuclear Power Generating Safety Systems"
IEEE 384-1992, 'Standard Criteria for Independence of Class 1E Equipment and Circuits"
IEEE 828-1998 "Standard for Software Configuration Management Plans"
IEEE 829-1998, 'Standard for Software Test Documentation"
IEEE 830-1998, "Recommended Practice for Software Requirements Specifications"
IEEE 1012-1998, "Standard for Software Verification and Validation"
IEEE 1016-1993, " Guide to Software Design Descriptions"
IEEE 1028-1998, "Standard for Software Reviews and Audits"
NEMA ICS-6, "Enclosures for Industrial Controls and Systems"
EIA RS-232-D, "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange"
EIA RS-422, "Electrical Characteristics of Balanced Voltage Digital Interface Circuits"
EIA RS-485, "Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems"
IEC-1000-4-1 (1992), "Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 1: Overview of Immunity Tests"
IEC-1000-4-2 (1995), "Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 2: Electrostatic Discharge Immunity Test"
IEC-1000-4-3 (1995), "Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 3: Radiated, Radio-Frequency, Electromagnetic Field Immunity Test"
IEC-1000-4-4 (1995), "Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 4: Electrical Fast Transient/Burst Immunity Test"

Regulatory Guide 1.97, Revision 3, "Instrumentation for Light-Water-Cooled Nuclear Plants to Assess Plant and Environs Conditions During and Following an Accident"
Regulatory Guide 1.152, " Criteria for Programmable Digital Computer System Software in Safety Related Systems of Nuclear Power Plans".
ISA RP 55.1 "Recommended Practices for Hardware Testing of Digital Process Computers"
ASME NQA-1-1994, "Quality Assurance Program Requirements for Nuclear Facility Applications"
ASME NQA-1-1994, Subpart 2.2, "Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Facility Applications"
ASME NQA-1-1994, Subpart 2.7, "Quality Assurance Requirements of Computer Software for Nuclear Facility Applications"
10CFR50, Appendix B. "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants".
Federal Regulations 830.122 (10CFR830.122) "Quality assurance criteria".

Other recognized standards shall be utilized, as required, to serve as design, fabrication and construction guidelines.

The latest edition of the above Codes and Standards, in effect at the time of Contract Award, shall be followed. Should Codes or Standards be revised after Contract Award, Contractor shall inform the Purchaser immediately upon receipt of such information. Before adopting any subsequent issue, addendum, or case ruling, Contractor shall discuss the effect of such requirements with the Purchaser and proceed with material and/or fabrication changes only after Purchaser's approval.

3 DETAILED REQUIREMENTS

3.1 DESCRIPTION OF DISEL GENERATOR LOAD SEQUENSER

Modernization of Armenian nuclear power plant 6kV safety system will result in providing two redundant Class 1E safety trains:

- Train 1 will include 6kV switchgear section 3PB-2, diesel generator 1DG-1, and diesel generator 1DG-2
- Train 2 will include 6kV switchgear section 4PB-2, diesel generator 2DG-1 and diesel generator 2DG-2

Each safety train will be equipped with a Class 1E diesel generator load sequencer covered by this Specification. This is the first phase of diesel generators modernization.

DGLS is common for two diesel generators of the same safety train. DGLS shall detect the "initiate load sequencing" signal, start diesel generators, close diesel generators breakers, trip and sequentially close required 6 kV and 380V breaker safety related loads in accordance with the Purchaser provided algorithm.

The Class 1E microprocessor based DGLS shall be comprised of components and auxiliary devices capable of performing sequencing functions in accordance with Purchaser's provided algorithms. The

system controllers and I/O necessary to perform diesel generator load sequencing will be located in the electronic equipment rooms, elevations 0.00 and 9.6.

DGLS should include all necessary operator interface software required for load sequencing , data acquisition, communications, logging, historical storage retrieval, printing, reporting, alarming and for systems diagnostics through multi-colored interactive graphic displays.

The Contractor shall provide all application and non-application specific programming tools required to supply a functioning system. All system components shall be properly addressed and ready to communicate prior to shipment to jobsite.

3.2 INTEGRATED DIESEL GENERATOR CONTROL SYSTEM

The diesel generator load sequencer hardware and software will be upgraded to an Integrated Diesel Generator Control System (IDGCS) capable of performing the following functions:

- Load sequencing (phase one).
- Diesel generator load sharing (Contractor's algorithm. One for each diesel generator) shall allow two diesel generators of the same safety train to run in parallel and share common loads.
- Diesel generator voltage regulation (Contractor's algorithm. One for each diesel generator) shall control the diesel generator output voltage via electronic signals to the static excitation system.
- Diesel generator speed control (Contractor's algorithm. One for each diesel generator) shall provide the electronic speed sensing and speed control via the electronic signals to Woodward type EGB13P governor. The accuracy shall be within ± 1%.
- Diesel generator static excitation (One for each diesel generator) shall replace an obsolete 80V, 370A rotary exciter.
- Diesel generator automatic auxiliaries control (Purchaser's algorithm. One for each diesel generator) shall control diesel generator operation in accordance with algorithm.

IDGCS shall be designed to control two 1600 KW, 6300 V, 0.8 power factor, 0.95 efficiency diesel generators of the same safety train.

The diesel generator 1DG-1 and diesel generator 1DG-2 are located in section 1 of the DG building. The diesel generator 2DG-1 and diesel generator 2DG-2 are located in section 2 of the DG building. The distance between the location of DGLS equipment and the diesel generators location will not exceed 1500 feet.

Contractor shall clearly indicate in his proposal how the proposed Class 1E microprocessor based Diesel Generator Load Sequencer (DGLS) can be upgraded to the Class 1E microprocessor based Integrated Diesel Generator Control System with the above listed functions. The technical characteristics of the proposed IDGCS shall be included in the proposal. All protective functions, regulating and limiting characteristics of the IDGCS shall be listed. Contractor shall state in the proposal if any of the above listed functions will be implemented in a separate, stand alone device. If any additional

equipment, such as sensors, transmitters, limit switches, is required for the upgrade, the Contractor shall list the required devices in the proposal.

The IDGCS software shall be properly partitioned. Each diesel generator control software and load sequencing software shall be completely independent. The failure of one program shall not compromise the function of the others.

The I/O information for diesel generator auxiliaries' automatic control is provided in the Table 2

Contractor shall define the I/O data required for the DG control (regulations, excitation, protection) and provide the list of I/O with detailed information in the proposal.

3.3 ENVIRONMENTAL REQUIREMENTS

The DGLS is a Class 1E safety related system and shall be environmentally qualified in accordance with IEEE standard 323-2003
The equipment making up the DGLS shall be able to operate and meet their functional requirements under the range of environmental conditions found to exist in the plant areas where the DGLS equipment is located. The expected range of environmental conditions is shown in the Table below.

Table. Range of Environmental Conditions

	Normal Operation Conditions With Plant in Service	
Temperature	-18 ° C Min	+25 ° C Max
Relative Humidity	65 % Min	80 % Max
Radiation (20 Years TID)	0 mR/hr Min	0 mR/hr Max
	Normal Operation Conditions With Plant Shutdown	
Temperature	-18 ° C Min	+25 ° C Max
Relative Humidity (Max)	65 % Min	80 % Max
Radiation (20 Years TID)	0 mR/hr Min	0 mR/hr Max
	Emergency Conditions With Environmental equipment not available	
Temperature	-10 ° C Min	+55 ° C Max
Relative Humidity (Max)	65 % Min	80 % Max
Radiation (20 Years TID)	0 mR/hr Min	$2x10^3$ mR/hr Max

3.4 SEISMIC QUALIFICATION

DGLS and all its components shall be seismically qualified in accordance with IEEE standard 344-1987 and Regulatory Guide 1.100. Qualification test shall be by test or analysis. If the test method is used, the Test Response Spectra (TRS) for DGLS shall envelope the Required Response Spectra (RRS) of the respective elevations provided in Attachment of this Specification. DGLS shall be qualified to a Safe Shutdown Earthquake (SSE) and Operational Basis Earthquake (OBE). OBE acceleration, when not available shall be taken as 50% of the SSE acceleration. Damping values shall be 2% for OBE and 4% for SSE.

3.4.1 SEISMIC QUALIFICATION REPORT

Contractor shall submit to Purchaser a Seismic Qualification Report which shall confirm to IEEE standard 344-1987, section 10, “documentation”. The Seismic Qualification Report shall include a Certificate of Compliance.

3.5 SOFTWARE VERIFICATION AND VALIDATION

Verification and Validation of firmware and software shall be performed in accordance with IEEE Standard 7-4.3.2.

3.6 EMI/RFI CERTIFICATION

Digital equipment qualification shall be in accordance with EPRI TR-102ss.

3.7 ELECTROMAGNETIC COMPATIBILITY TESTS (EMC)

The data acquisition system shall be tested in accordance with IEC 1000-4-1, Part 4, Section 1; IEC 1000-4-2, Part 4, Section 2; IEC 1000-4-3, Part 4, Section 3; and IEC 1000-4-4, Part 4, Section 4, or equivalent standard.

3.8 PERFORMANCE REQUIREMENTS

The DGCS shall be capable, as a minimum, of performing the following specific tasks:

- Diesel generator load sequencing
- Provide real time indication of all specified electrical parameters in engineering units.
- Record, display, and print out real time historical trends of all specified inputs, outputs and calculation results.
- Record and print out time-stamped sequential events for alarms and trips.
- Interface with third party controls for status using TCP/IP protocol and Ethernet interface.

Contractor shall have complete responsibility for performance, design, and selection of components for the DGLS. The design criteria as specified hereinafter are minimum guidelines.

3.9 HARDWARE

DGLS hardware shall include, but not be limited, to the following equipment:

- Processors
- I/O Equipment
- Communications Equipment
- Cabinets and Enclosures

3.9.1 DIGITAL CONTROLLERS

Controllers shall be configurable using Contractor's standard software/firmware algorithms, to execute regulatory, computational and logical functions required for performing of the load sequencing functions.
The system shall be designed to meet Class 1E requirements. Redundant controllers shall be provided such that the backup controller will automatically and immediately assume control upon failure of the primary. The failure of any DGLS component shall be alarmed. The backup controller or controllers shall be configured identically to the primary and shall continuously monitor inputs and execute control strategies. The output of the failed controller shall not be directed to the I/O interface system.

In the event of controller communication failure, each output shall be capable of either holding its last value or being forced into a desired fail-safe condition.

Fully programmed controllers shall have at least 20% spare processing capacity as defined in section 7.2.

All data links to the controllers shall be redundant.

3.9.2 I/O EQUIPMENT

Redundant Class 1E I/O shall be properly partitioned into separate I/O modules to minimize common mode failure. I/O associated with partitioned program shall be grouped separately to avoid common mode failure.

The system shall be able to scan, process and update all analog I/O at 2 times/sec or faster..

The system shall be able to scan and update all digital I/O at 10 times/second.

I/O modules shall have individual over-current protection to prevent damage to the chassis, other modules or power supplies.

The Purchaser will provide a detailed I/O list after contract award.

The I/O requirements by type are listed in TABLE 1.

3.9.3 ANALOG INPUTS

The system shall scan, process, and store each analog input continuously.

Analog inputs shall be 0-5 mA DC current signals (AI), for 2.5 ±0.5 kê load, thermocouples (TC) or Resistance Temperature Detectors (RTD).

The system shall provide validity checking for all analog inputs. If an input is out of range, it shall be automatically tagged as bad and logged. Power for inputs will, in general, be provided from the DGCS; however, the system shall be capable of accepting externally powered signals.

3.9.4 DIGITAL INPUTS (DI)

The system shall scan contact inputs for status change or alarm conditions. Normal state of any contact input shall be definable as open or closed. Digital inputs shall be filtered to reject contact bounce or noise before using them for process control or monitoring. The system shall accept dry (voltage free) contact inputs at 110 VAC and DC. The system shall provide the power required to sense the inputs. Contact inputs shall be individually fused using manufacturer's standard termination units.

3.9.5 ANALOG OUTPUTS (AO)

Analog outputs to control elements shall be 4-20 mADC current signals powered by the control system. They shall be capable of driving up to 600 ohms total loop resistance. Control transfer shall be bumpless from manual to automatic and vice-versa on all control loops. Control loop shall automatically transfer to manual upon detection of a malfunction of the output loop.

3.9.6 DIGITAL OUTPUTS (DO)

Digital outputs shall be individually selectable as maintained or momentary type, as required by the application, and shall be individually selectable as normally open or normally closed.

1 Amp minimum rated relay contact outputs shall be supplied from the DGCS for the control of 220 VAC 50 HZ or 220VDC electrically operated devices.
0.5 Amp minimum rated relay contact outputs shall be supplied for 110 VDC output signals.
220 VAC, 220 VDC and 110 VDC control power will be supplied from the actuated device or from Purchaser's power distribution panels. The power feed to each device shall be individually protected.

The DGCS shall not be used to directly control devices operating at greater than 220 VAC or 48 VDC. In such cases, the controlled devices shall be equipped with suitable interposing relays.

3.9.7 COMMUNICATIONS EQUIPMENT

Communications between the I/O and controllers shall be redundant and dedicated.

The Contractor shall supply all required communications equipment housed in system cabinets and enclosures including but not limited to communications cards, network hubs, routers, gateways and switches. The Contractor shall provide manufacturer model numbers for all communications equipment for Purchaser review and approval.

Communication of data shall be via redundant media. Field-run communications cables will be furnished by the Purchaser.

3.9.8 CABINETS AND ENCLOSURES

Systems Class 1E cabinets shall be suitable for the installed environment as defined in this Specification. Cabinets shall contain required ventilation equipment and filtered louvers to dissipate the heat generated if required. The maximum heat load of each cabinet assembly shall be specified in the proposal.

Cabinets shall be arranged for bottom entry of field wiring. Termination points and wiring within the cabinet shall be separated according to signal level and safety qualification. Low level signals and 220 VAC signals shall be separated. Each cabinet shall have a minimum of 20% installed spare points of each type of I/O used.

Cabinet dimensions shall not exceed:

Height - 2360 mm
Width - 800 mm
Depth - 550 mm.

Cabinet design shall have a provision for the bolted or welded to floor connection. There are existing I-beams imbedded in the concrete for the cabinets installation at the site. The distance between two parallel I-beams is 550 mm.

The enclosures shall be sized to accommodate the required installed spares quantities of each type of I/O.

3.10 ELECTRICAL REQUIREMENTS

3.10.1 POWER SUPPLY AND GROUNDING

The control system shall be designed to operate on 220 VAC +10%, -15%, 50 HZ, ±3%, fluctuation 12%. Purchaser will provide two separate power circuits to each controller cabinet and I/O enclosure. Contractor shall implement the connection of these feeds in such a manner that they remain isolated from one another and either one can power the entire system. The system shall automatically revert the power to the backup supply upon loss of the primary. The power shall be transferred back to the primary source when it restored. I/O enclosures may require additional primary power circuits for powered outputs.

Contractor’s DC power supplies shall convert Purchaser primary feeds to the required voltages for each system device.

Contractor's DC power supply loading shall not exceed 80 percent of maximum current rating with the cabinets served by the supply fully loaded. Each DC power supply shall be backed up by a redundant supply so that loss of an individual power supply shall not alter system performance. Each supply shall be capable of supplying the full load of the connected devices. Normally both supplies shall be on line, sharing the load. Redundant DC power supplies shall be suitably isolated from one another to prevent the failure of one supply from adversely affecting the other.

Purchaser will supply separate 220 VAC feeds for powered outputs.

For low power (50 watts and less), Contractor shall provide power wiring inside his termination cabinet. No more than 8 circuits shall be powered from a single circuit breaker. The line-side output terminals shall be individually fused.

For higher wattage (more than 50 watts) 220 VAC electrically operated devices, control power will be supplied from the dedicated Purchaser supplied feed circuits.

Contractor shall identify, in his proposal, the number and location of primary power circuits required by the system. For all supplies except that feeding powered field devices, Contractor shall furnish maximum load required. This information shall be provided as connected load in KVA and power factor, and maximum operating load and power factor.

Contractor shall specify in his proposal all signal, power and safety grounding requirements for his system. Purchaser will provide ground connections, as required.

Contractor shall provide recommendations for conducting a power and grounding survey before the system is powered in the field to assure that transients or inadequate grounding will not affect the integrity of the signals or the system.

3.10.2 WIRING AND CONNECTIONS

3.10.2.1 AC SERVICE

Each cabinet or device requiring a separate ac power feed shall be provided with an approved field wiring termination suitable for the service. The Contractor shall provide a definition of all service wiring requirements with his quotation.

Power feed wiring screw terminals shall be capable of terminating ring tongue lugs with 12 AWG wire. Field I/O terminations shall be compression type terminal blocks, suitable for terminating up to 14 AWG wire.

3.10.2.2 INTERCONNECTION WIRING

Contractor furnished wiring, required to interconnect cabinets or other system components, shall be in the form of plug-in cables, to the maximum extent possible. PVC insulation shall not be used.

3.10.2.3 CABINET INTERNAL WIRING

Cabling shall be furnished for connecting termination panels to system electronics modules. The cable shall be provided with plug connectors at both ends.

All wiring required for internal power distribution, grounding etc., shall be factory installed by Contractor. Terminals on external terminal blocks for powered outputs shall be arranged so that Purchaser's field wires for the field device will land on adjacent terminals.

3.10.2.4 Field Wiring

Contractor's recommendations for Purchaser's field wiring shall be included in his proposal. Any mandatory requirements for system performance shall be so stated. Any requirements that will affect the installed cost of the system such as the requirement for shielding of digital input wiring, shall be clearly stated. If such requirements are dependent on factors such as circuit length, voltage level and proximity to other voltage level wiring, these criteria shall be defined in sufficient detail to permit Purchaser's evaluation of their applicability to the specific installation.

3.11 DATA COMMUNICATIONS

Contractor shall identify in his proposal the specific type of cable recommended for each control and I/O. A suggested manufacturer's cable type and number shall be included with the proposal. Contractor shall provide a cost per foot for him to supply the cable.

The Contractor shall provide all hardware including connectors, adapters and termination devices, required to terminate the highway cable to the system, regardless of who ultimately furnishes the cable.

4 PACKING, HANDLING AND PRESERVATION

All openings shall be protected for shipment and storage from dirt, dust and moisture in accordance with ASME NQA-1 Subpart 2.2. All surfaces that may be subjected to corrosion or oxidation shall be protected in accordance with Contractor's standard methods.

Following award of a contract, the Contractor shall provide a description of the intended method of packaging, handling, and preservation, for Purchaser approval. This approval is required before shipment.

5 QUALITY ASSURANCE

DGLS shall be classified as Safety Class 1E. The design, manufacture and testing of these portions must be covered by a Quality Assurance Program (QAP) in full compliance with ISO 9000, ASME NQA-1 or 10CFR50, Appendix B. The QAP should indicate compliance with the quality assurance criteria of Title 10 Code of Federal Regulations 830.122 (10CFR830.122)
The Contractor shall be responsible for Verification and Validation (V&V) of the DGLS in accordance with the requirements of ASME NQA-1, Subpart 2.7.
Organizational independence between personnel performing the design and implementation of the DGLS and the V&V personnel shall be provided.

Following system acceptance test, the Contractor shall incorporate all system modifications, both hardware and software, into as-built system drawings and documentation at no additional cost to the Purchaser.

6 INSTALLATION, FIELD SERVICES AND TRAINING

6.1 INSTALLATION

The DGCS will be installed by Purchaser. Contractor shall ship the equipment pre-assembled in a minimum number of components or sections ready for installation. Contractor shall provide the services of a competent engineer to provide technical direction for the proper installation of the equipment (if required) at rates quoted in proposal.

6.2 FIELD SERVICES

Contractor shall provide field services if required at rates quoted in proposal. Included in these services are:

- Inspection and checkout of the installed system for proper power, grounding and communications prior to system energization
- Software loading and field services prior to loop checks and functional testing

.

6.3 TRAINING

Contractor shall provide training if required at the project site for plant operations, engineering and maintenance staff, so that they may become familiar with all aspects of operating and maintaining the equipment. The training program shall cover all details of operation, maintenance, replacement and checking of components and circuits and shall include troubleshooting. Training shall include printed materials.
Contractor's proposal shall contain a complete description of the training program, the educational level considered necessary for personnel to do the maintenance work, and estimated length of time needed to impart thorough training.

7 TESTING

7.1 FACTORY ACCEPTANCE TEST (FAT)

An FAT shall be performed by the Contractor at the Contractor's assembly location and will be witnessed by the Purchaser.

The FAT shall verify the operability of all DGCS hardware, communications and software.

The FAT shall be conducted after all hardware has been assembled and all communications and software has been downloaded into the system.

The Contractor shall demonstrate, to the satisfaction of the Purchaser, conformance with the requirements of this specification for all aspects of operation of the system.

The Contractor shall provide all hardware, software, diagnostic programs, test equipment, power, personnel, etc., necessary to complete the test.

A means to simulate inputs and monitor all outputs shall be connected to the I/O prior to the start of the test.

Included in the system test shall be the capability to perform recovery from power loss, diagnostics, and any other tests deemed necessary by the Contractor to prove the integrity of the system.

The Contractor shall prepare and submit for Purchaser approval a detailed FAT procedure prior to the test. Purchaser will review the procedure and provide required modifications. After Purchaser final acceptance, this document shall be the basis for conducting the FAT.

Contractor shall promptly correct any deficiencies or faulty conditions determined during these tests at no cost to Purchaser, after which additional tests shall be run to confirm satisfactory equipment operation. Contractor shall bear costs of additional tests.

7.2 SITE ACCEPTANCE TESTS (SAT)

SAT will be conducted on site with completed systems connected and energized. The tests will be a normal part of startup and shakedown processes. The SAT will include Full Loop Checks, Performance Tests, and Stress Tests and to assure that FAT problem reports have been resolved correctly.

Full Loop Checks will verify the proper operation of the field equipment and its interaction with the DGCS.

The Performance Test will test the Control System under a normal process load for a period of time no less than 48 hours. The performance testing shall also encompass integration testing of hardware and software components.

The Stress Test will test the control system under maximum load for a period of time no less than 24 hours. Maximum load shall be defined as approximately 20% above normal process load.

Any deficiencies or faulty conditions of the control system hardware or non-application specific software determined during these tests shall be promptly corrected by Contractor at no cost to Purchaser, after which additional tests will be run to confirm satisfactory equipment operation.

SAT testing is by the Purchaser.

8 INFORMATION TO BE SUBMITTED

Unless specifically noted in the Contractor’s proposal and listed in the attached Schedule A “Technical Exceptions and Clarifications”, the equipment and services furnished by the Contractor shall be in

complete technical compliance with this Specification, its attachments and all purchasing documents. Any exception or deviation from the specification must receive prior written approval from the Purchaser before proceeding with implementation.

8.1 WITH PROPOSAL

Contractor shall furnish with the proposal all documentation required by the Request for Proposal (RFP) documents, including:

- Complete description of project approach
- Detailed block diagram of the system, including redundancy features
- Details of all proposed equipment including preliminary Bill of Materials with manufacturer model numbers, Product Bulletins and data sheets
- Equipment Weights and Dimensions
- Grounding and Field Wiring Recommendations
- Power requirements at each supply connection (Watts and VA)
- Supplied equipment approximate heat dissipated to the surroundings in BTU/Hr.
- Add/delete price per I/O module type.
- Maintenance schedule
- Spares required for scheduled maintenance
- Priced Recommended Spare Parts List
- Quality Assurance Program
- Class 1E qualification documentation.

Contractor shall finish the above documents for both the Diesel Generator Load Sequencer and Integrated Diesel Generator Control System. Integrated Diesel Generator Control System documentation shall also include add/delete price per control function. If necessary, the functions may be grouped as follows:

- Diesel Generator Governor, Speed Control and Load Sharing
- Diesel Generator Voltage Regulation and Static Excitation System
- Diesel Generator Synchronization
- Diesel Generator Protection
- Diesel Generator Automatic Auxiliaries control.

8.2 AFTER AWARD

The information, data and documents below shall be submitted for approval or for information in accordance with the timing specified in TABLE A, "Information to be Submitted" of this specification.

8.3 SCHEDULES FOR APPROVAL

- Contractor shall submit and maintain a schedule that includes the following:
- Need dates for Purchaser supplied information
- Submittal date of each Contractor document

- Fabrication and assembly dates for major system components
- Date for Factory Acceptance Testing
- Equipment shipment dates

9 LIST OF DOCUMENTS TO BE SUBMITTED FOR APPROVAL

- Shop drawings showing the outline of equipment and overall dimensions indicating clearance distances required for maintenance, equipment removal or other functions and showing location of mounting/anchoring provisions.
- Enclosure arrangements of internal hardware, wiring terminal blocks and cable connections for external power wiring and grounding.
- Bill of materials directly identifiable to each device or component and shown on Contractor's drawings.
- Testing procedures
- Data for Information
- Control Logic Development Programs and Manuals
- Overall system interconnection drawing
- External connection diagrams showing all field wiring terminals and connections for communications networks, pre-fabricated cabling, system interconnecting wiring and data link connections.
- Certified Shop Tests Reports
- Operating and Maintenance Manuals – 5 sets
- Complete Parts List
- Packing, Handling, Preservation and Shipment Procedures

10 PURCHASER PROVIDED INFORMATION AFTER AWARD

- Finalized scope of work
- Algorithms
- Detailed I/O list with signal tags and assignment
- List of required alarms and indications.

11 GENERAL TECHNICAL REQUIREMENTS

11.1 TESTING

11.1.1 TEST PLAN

The Supplier will submit a Test Plan to Purchaser for approval. This Test Plan will cover the burn-in test, Factory Acceptance Test (FAT) and Site Acceptance Test (SAT).
The Test Plan shall explain the basic testing methodology and the purpose of each test, and define acceptance criteria.
The Test Plan will be implemented through detailed Test Procedures.

11.2 INITIAL HARDWARE TESTS

11.2.1 MANUFACTURER'S QA TESTING

As specified in the individual manufacturer's QA Plans, tests shall be performed at the component, assembly, cabinet and system levels to verify proper equipment operation before shipment to the integration facility.

11.2.2 BURN-IN TEST

All electronic equipment shall be subjected to a burn-in of at least 100 hours without failure.
Records of the burn-in shall be available for the Purchaser to review prior to the Factory Acceptance Test.
The Purchaser shall be notified in writing two weeks in advance of these tests and reserves the right to witness these tests.

11.3 PROGRESS INSPECTION

The Purchaser and Owner shall have the right to witness or inspect any part of fabrication or testing of the system hardware or software.
Such inspection shall not relieve the Supplier from providing equipment in accordance with this Conformed Specification.
The right of inspection also applies to Supplier subcontractors and shall be free of cost to the Purchaser.

11.4 INTEGRATED SYSTEM TESTS

11.4.1 FACTORY ACCEPTANCE TEST (FAT)

The FAT will be to perform to test the system software and hardware. The purpose of this test is to demonstrate that the DGLS system (factory integrated hardware and software) meets the specification requirements. FAT shall be conducted on the DGLS prior to shipment to ANPP. No substituted equipment or cables shall be used in the system for testing purposes except as approved as part of the Test Plan or Test Procedures.
All hardware and software changes shall be included in the system prior to FAT. The Supplier shall provide all software necessary to demonstrate acceptable operation of the system.
The FAT shall include a fully integrated system test. The test shall include, but is not limited to, the following:

- Exercising of devices
- Demonstrating proper operation of hardware
- Demonstrating proper operation of software
- Demonstrating compliance to this specification
- Demonstrating all system functions
- Simulating data highway failure
- Simulating equipment failure and recovery
- Demonstrating spare capacity
- Demonstrating the use of diagnostics

The FAT shall be conducted at the Supplier's facility.
The Purchaser and/or Owner's engineering, operations and quality assurance representatives may participate in the FAT.

Prior to the start of FAT, the following shall be performed:

- All FAT plans, procedures and acceptance criteria shall be submitted to the Purchaser for review and approval at least four weeks prior to the start of FAT.
- The equipment under test shall be configured at the factory, to the extent possible, in the configuration it will be in at the site.
- The Supplier shall have supplied any test equipment, hardware and/or test software required.
- The Purchaser shall be notified three weeks in advance of the test and given the opportunity to participate and/or witness.
- The Supplier will certify all test results for tests not witnessed by the Purchaser in writing.
- All discrepancies discovered in the performance of the FAT shall be formally recorded in discrepancy reports, and their subsequent resolution shall, in turn, be documented.
- Following FAT, the Supplier shall incorporate all system modifications, both hardware and software, into the system drawings and instruction manuals at no additional cost to the Purchaser.
- A written copy of the Owner's acceptance of the FAT results is required prior to shipment.
- Successful completion of the FAT shall not constitute Final Acceptance of the system; Final Acceptance occurs after successful completion of SAT.

The Supplier shall maintain complete records of the FAT. As a minimum, the records shall include:

- References to the appropriate Test Procedures
- Descriptions of special test conditions
- Results
- Name of test personnel and witnesses
- Date of test

11.4.2 <u>SITE ACCEPTANCE TEST (SAT)</u>

Site acceptance testing will be focused on the functions that cannot be adequately tested in the factory (e.g., alarm signalization system, integration with the on-site equipment, etc.).
The site acceptance tests will demonstrate that after installation at the plant, the system performs as well as in factory and the system functions correctly when connected to the existing plant equipment.
Once installed, a Site Acceptance Test (SAT) of the system shall be performed at the site using written test procedures that have been approved by the Purchaser. All SAT plans, procedures and acceptance criteria shall be submitted to the Purchaser for review four weeks prior to the start of the SAT.
SAT should not proceed without the approval of the Purchaser.

SAT procedures shall test the following in the site environment to the fullest extent possible:

- Hardware functioning
- Test data highways

- Test process inputs
- Test integrated system

SAT shall be conducted at the site on the integrated system that includes all items delivered. Full functionality of the system and all hardware supplied shall be demonstrated during the SAT.
All inputs and outputs and their realization from the terminal blocks on through the database shall be demonstrated using actual data from plant equipment. All other external connections, such as peripherals and data links, shall also be tested.
Any discrepancies discovered, as well as their resolution and verification, shall be reported and documented through the use of discrepancy reports.
Successful completion of SAT, including implementation of corrective actions resulting from discrepancy reports, shall constitute Final Acceptance of the DGLS by the Owner.
The Supplier shall maintain complete records of the SAT. As a minimum, the records shall include:

- References to the appropriate Test Procedures
- Descriptions of special test conditions
- Results
- Name of test personnel and witnesses
- Date of test
- SAT Strategy

Upon completion of SAT, a report documenting the testing activities and results will be provided.

11.5 ADDITIONAL TESTS

11.5.1 ISOLATION TESTS

All inputs and outputs of the DGLS system shall be capable of being connected to a 400-VAC 50-Hz power line without damage to other parts of the system, other than the faulted I/O channel or I/O board.
Duration of the applied voltage during the test shall be sufficient to demonstrate that continued application of the fault voltage would cause no further damage.

11.5.2 ELECTROMAGNETIC COMPATIBILITY TESTS (EMC)

The system shall be tested in accordance with IEC 1000-4-1, Part 4, Section 1; IEC 1000-4-2, Part 4, Section 2; IEC 1000-4-3, Part 4, Section 3; and IEC 1000-4-4, Part 4, Section 4, or equivalent standard.

12 ADMINISTRATIVE REQUIREMENTS DOCUMENTATION

Documentation shall consist of drawings, technical descriptions, specifications, theory of operation, test plans, test results and reports and other documents described herein or requested by the Purchaser.

12.1 DRAWINGS AND DOCUMENTATION FOR REVIEW

All drawings and documentation are subject to review and comment by the Purchaser.

Purchaser reserves the right to have others review drawings and documentation. .

12.2 DOCUMENT AND DRAWING REQUIREMENTS

The Supplier shall certify the accuracy of all documentation required for installation, operation and maintenance.
The following document and drawing conventions apply:

Type of material:		Hard copy and electronic
Format:		
-	Text:	Microsoft Word Windows
-	Spreadsheet:	Microsoft Excel Windows
-	Design Drawings:	AutoCAD

Size and configuration:	Text: U.S. letter (8½ x 11 inches)
	Design Drawings: U.S. 11 x 17 inches

Drawing transmittal:

- One hardcopy of all manuals and one reproducible
- Two prints of each drawing are required.
- User's Manuals, Maintenance Manuals, Installation Manuals, Test Plan, Test Procedures and drawings shall be supplied in both English and Russian languages.

Documentation to be supplied should include, as a minimum, System Description, Software User, Operator's User's, Hardware Description and Maintenance, Installation, Test and Start-up Manuals.

Dimensions shown on drawings and in documentation shall be based on the (SI) metric units of measurement.

12.3 LANGUGE REQUIREMENTS

All documentation shall be supplied in both English and Russian languages.

13 PROJECT STATUS REPORTING

Following contract award, a Project Status Report and schedule to the Purchasr by the tenth day of each quarter.
The quarterly Project Status Report should describe overall progress, design, manufacturing and test status, percentage of task completion, problems impacting delivery and planned or required corrective action, informational needs and other topics identified during preparation of the Conformed Specification or during the implementation of the project.

14 INFORMATION TO BE SUBMITTED

After review by Purchaser and award of Contract, the technical data in the DFLS proposal shall become part of the Conformed Specification.

List of Drawings to be submitted for Review:

- Shop drawings showing the outline of equipment and overall dimensions indicating the clearance distances required for maintenance, equipment removal, or other functions
- Cabinet arrangement of internal hardware, wiring terminal blocks and cable connections for external power wiring and grounding
- External connection diagrams showing all field wiring terminals and connections, prefabricated cabling, system interconnecting wiring and data communication interface connections
- Overall system interconnection/overview drawing

14.1 BILL OF MATERIALS:

Bill of materials (BOM) directly identifiable to each device or component and shown on Supplier's drawings.

14.2 MANUALS:

Supplier shall supply all installation, operating and maintenance manuals in accordance with this Specification. A preliminary set of operating and maintenance manual(s) covering the exact material furnished shall be submitted before equipment is factory tested. After factory test, the final manual(s) shall be issued for review.

Portions of the manual covering the installation of field-mounted equipment shall be submitted by Supplier ahead of the arrival of equipment on the job site so that preparation may be made by others for their installation.

Data for Information:

- Recommendations on Interconnection Wiring
- Factory Acceptance Test Report
- Instrument Calibration Report

TABLE 1

LIST OF INPUT AND OUTPUT SIGNALS FOR TWO REDUNDANT DGLS

DESCRIPTION	CHARACTERICTICS	Q-TY	Remarks
Digital input	110 VAC	50	
Analog input	0-5 mA	8	
Digital output	220 VDC, 220VAC	200	
Digital output	110 VDC	8	

TABLE 2

LIST OF INPUT AND OUTPUT SIGNALS FOR FOUR DIESEL GENERATOR CONTROL SYSTEMS (EXCLUDING I/O FOR EXCITATION, SPEED AND VOLTAGE CONTROL, LOAD SHARING AND PROTECTION)

DESCRIPTION	CHARAC-TERICTICS	Q-TY	Remarks
Digital input	110 VAC	200	
Digital output	220 V	100	

TABLE 3

TECHNICAL DATA TO BE SUBMITTED

FOR SPECIFICATION NO. 7660-01

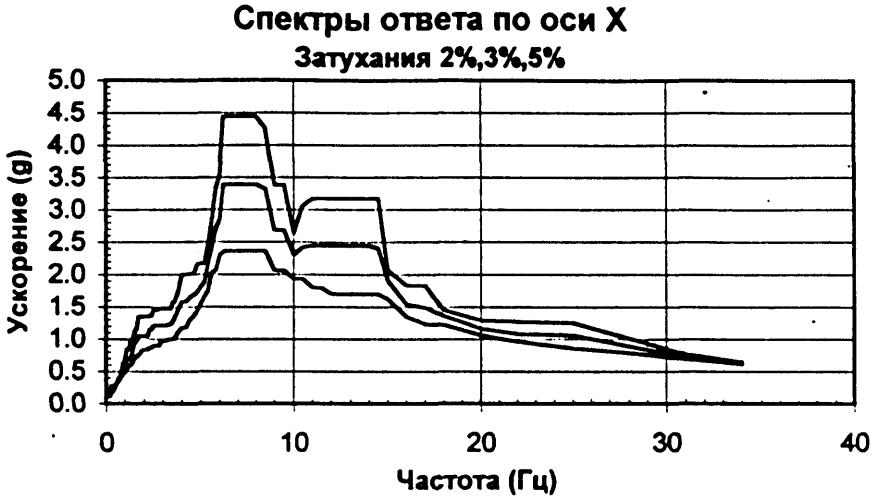
Contractor shall submit the following:

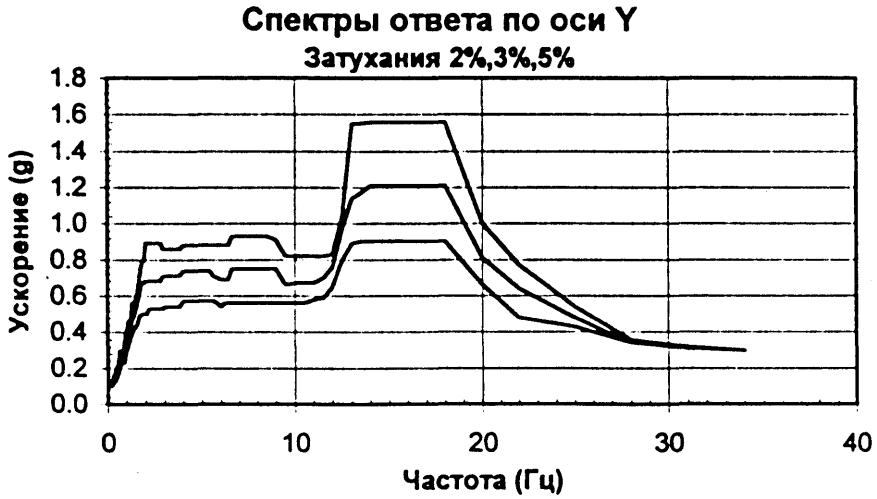
FUNCTION	PROVIDED Yes/No	Value	Remarks
Watchdog Timer			
Loss of Field			
Under Excitation Limitation			
Volt per Hertz Limitation			
Field Overvoltage Protection			
Field Overcurrent Protection			
Generator Undervoltage Protection			
Generator Overvoltage Protection			
Voltage Regulation (over the load range) +/- %			
Voltage Regulation: Response Time +/- %			

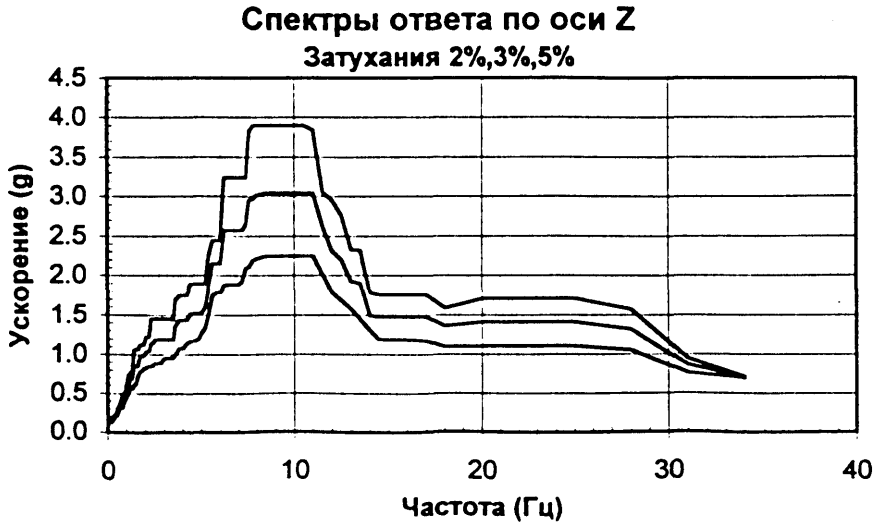
ATTACHMENT

Elevation 9.6 meters
Floor response spectra

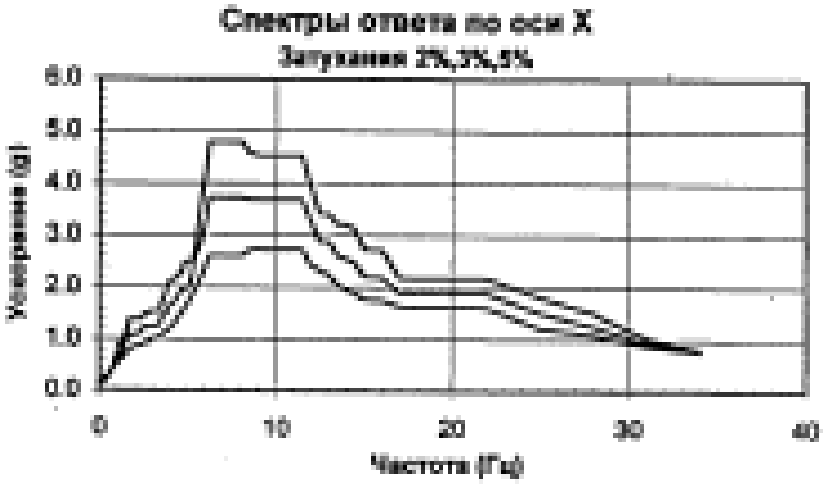
Отметка 9.6 . Узел № 648







Отметка 9.6 . Узел № 796



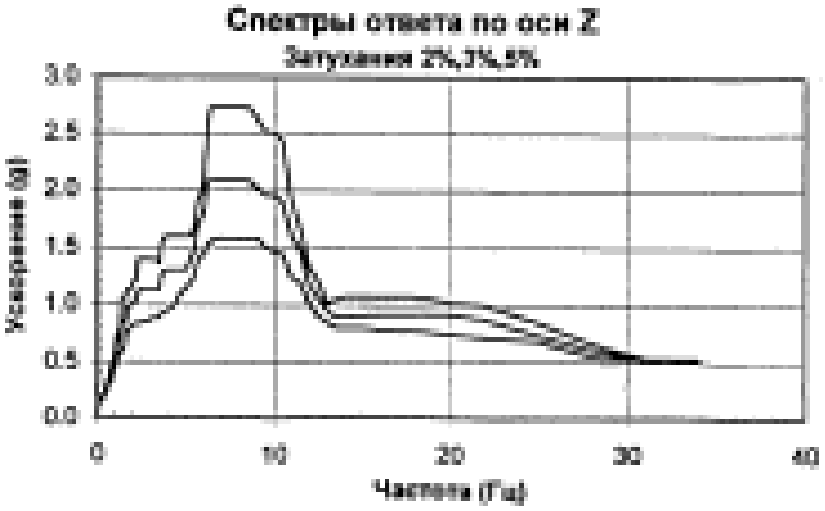


TABLE A

TABLE A

INFORMATION TO BE SUBMITTED

FOR SPECIFICATION NO. 169010

Contractor shall submit the following:

Submittal	Described in Sec.	Submit for	Submit By	Remarks
Schedule of Work	8.3	A	15 DAAC	
Schedule of Submittals	8.3	A	15 DAAC	
Delivery Schedule	8.3	I	15 DAAC	
Bill of Materials	8.1	A	15 DAAC	
Cabinet Arrangements	9	A	45 DAAC	
Control Logic Development Programs and Manuals	9	I	30 DAAC	
External Connection Diagrams	9	A	45 DAAC	
System Interconnect Diagrams	9	A	45 DAAC	
Test Procedures	11	A	30 DPT	
Packing, Handling, Preservation and Shipment Procedures	9	A	45 DPS	
Manuals	14.2	I	45 DPS	
Spare Parts List	9	I	15 DAAC	
Nuclear Qualification	3	A	15 DAAC	
Quality Assurance Plan	5	A	15 DAAC	

LEGEND FOR TABLE A (Days identified are calendar days)

A – Submit for Approval
I - Submit for Information

DAAC Days after award of Contract
DPRF Days prior to release for Fabrication
DPT Days prior to test
DPS Days prior to shipment
DATC Days after test completion
UCW Upon completion of work