ITEM NO.	QTY	TECHNICAL SPECIFICATIONS
1	1	**LEVEL FLOW PROCESS CONTROL TRAINING SYSTEM** **(i) MAIN OBJECTIVES** This item is a scaled-down industrial water process plant system, with industrial process instrumentation developed to teach/train the principles, applications, calibration, tuning, operation, trouble-shooting and maintenance of a liquid level-flow process and its control and instrumentation. The design and construction shall permit process and control loop flexibility to study PID **single loop level** and **flow** controls as well as level-flow **cascade** controls. Furthermore, the level process must be **Self Regulating** and **Non-Self Regulating** and the level measurement must be of an **Open** and **Closed** tank. Two different principles of flow and level measurement/detection must be illustrated. The Supplier shall be fully responsible for the process design, test the required Experiments and document the full experiment procedures, test results and the interpretation of the appropriate theories so as to provide effective teaching of the subject. Training in the Operation of the equipment and in the underlying Theories of the subject must be provided. **(ii) MINIMUM EXPERIMENTS REQUIRED IN THE EXPERIMENT MANUAL** **The item supplied is considered non-performing if any of the experiments specified below is not formally documented and proven in the Experiment Manual or is not able to successfully illustrate the underlying theories intended. The underlying theories of each experiment must be authoritatively stated in the Experiment Manual to support the observed responses.** **The Experiment Manual must provide the detailed procedures and the supplier actual test results for the following experiments. For each experiment, the observed responses must be interpretated with the theories for compliance and all these must be recorded as part of the Experiment Manual. Two or more sets of controller tuning parameters (in PID etc.) that provide acceptable responses, must always be presented for every loop tuning test mentioned below. The control response is considered acceptable here only if the response is critically damped to 1/4-amplitude damped, with no offset, at any chosen process conditions within the normal operating range.** **a) include experiments with test procedures and the supplier's actual test results to illustrate the level as a Non-Self Regulating and Self Regulating process using an Open tank. Perform similar test for flow. For the level experiments, the tests must be repeated with the tank Closed.** **b) include experiments similarly to study flow control in PID single loop.** **c) include experiments similarly to study level control from ON/OFF to PID single loop and PID level-flow cascade controls.** **The PID level controls must be experimented at an Open tank and at a Closed tank, with the level process Self Regulating and Non-Self Regulating.** **The Experiment Manual for the PID tuning of the flow loop, level loop and level-flow cascade loop using P, PI and PID modes, with comments of the observed responses and their compliance with the theories.** **The Experiment Manual must include all the cases of level experiments stated above.** **d) include experiments similarly to study the application of a valve positioner at the control valve installed in the process pipeline. Experiments and test procedures to tune the temperature loop in single and cascade modes must be included.**

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		e) include an experiment with full test procedures and the supplier's actual test results to study how the liquid volumetric flowrate in pipeline can be measured using the pressure drop (DP) across an orifice, at various flowrates, over the entire calibrated range. The measured flowrate must be verified against one other pipeline installed flowmeter. **The above list of experiments represents the minimum knowledge content required of this training system.** **Tenderers are to state their track record and conclusion (if any) for each of these listed experiments. Otherwise, they will be evaluated as having inadequate or no such previous experiment experience.** **Site acceptance will NOT be granted if all above tests are unable to show conclusively the intent of the Experiment.** **<u>(iii) SPECIFICATIONS OF THE PHYSICAL PLANT</u>** The model plant shall be self-contained (requiring only the connection of the utilities) and skidded on a steel checker plate platform with castor wheels. Its overall dimensions is about 2000 x 1600 x 1600 mm HWD. The following are <u>MANDATORY</u> specifications that must be complied with, without exception or deviation. • The model plant must be a scaled-down industrial process plant operating at commercial or industrial production flow rates in stainless steel process piping (**NOT TUBING**) of nominal sizes 1" to 2", using industrial process type and class of equipment and instrumentation, and constructed to such standards and practices, with conformance to local safety codes. • The hardware of the control system shall be consist of a mix of pneumatic, electronic and microprocessor-based instruments of manufacturers that are already widely installed in the local process and chemical industries. • The **supplier's guaranteed** level (mm) and flow (m^3/Hr) operating ranges for this proposed model plant must be clearly stated in the tender submission. • The level tank must be made from stainless steel material. • Water reservoir shall be of stainless steel with flat walls and suitable reinforcement. The following are the minimum requirements that must be included: • centrifugal pump to deliver inflow water through the associated 1" piping (not tubing) into the level tank from the water reservoir. • level measurement of an **Open/Closed tank** by differential pressure (DP) method, span 800mm. The measured level must be verified against a level gauge in millimeter. • level detection shall be by one other commonly used level monitoring principle. • orifice plate-differential pressure (DP) with 3-valve manifold. Transmission shall be 4-20mA, minimum span 3 m^3/Hr. • variable area flowmeter to measure normal product throughput 2m^3/Hr. Min. scale 0-3m^3/Hr. • 1 inch globe control valve with current-to-air (I/P) converter (4-20mA to 3-15psig) and positioner with by-passed switch. • temperature gauge (bimetal). AISI 304SS case/ring, 5" dial size, dual ranges °C/°F. • two or more pressure gauges (bourdon). AISI 304SS case/bezel, 4" dial size, dual ranges psi/bar.

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		• continuous trend chart recorder, with two inputs of 4 to 20mA to record key variables including Level and Flowrate. Multiple chart speed. • panel-mount microprocessor PID controller. The controller must have the required PID, analog 4 to 20mA inputs and outputs, digital inputs, digital outputs, computer serial interface (RS 485 or equivalent) and be fully tested to meet the stated experiments and requirements. Maximum 2 PID loops in the controller. • changeover between PID single loop / cascade is implemented by simple switching • a control panel for the panel instruments, annunciators, electrical start-stop and controls etc. The Plant control panel must be constructed in two separate compartments, where the electronic instrumentation must be separated from the electricals/power. • two Annunciator windows with Test/Acknowledge buttons must be included. • facility for Instructors to simulate three common faults during plant operation for fault-finding must be included. • chart paper, recorder pens and other consumables to be included for 1 year operation. • the proposed model plant must be ready to be operated and similarly controlled from the industrial Distributed Control System (DCS) operator stations, in SCADA or DCS mode for the same controls to be performed. **(iv) EXPERIMENT MANUAL AND DOCUMENTATION** Please submit the specified number of copies of the following customized Experiment Manuals specially prepared for this project. • two (2) copies of custom-written supplier's Experiment Manuals detailing the Operation of the physical plant and complete with full procedures and typical test results for the **'Minimum Experiments Required in the Experiment Manual'**. The Experiment Manual shall be written in sufficient details so that the students can independently conduct the various experiments with minimum instruction and supervision, by following step by step procedures for the Experiments. The Experiment Manual shall be verified together with the proposed physical plant during the experiment Testing and Training, prior to the Site Acceptance. • two (2) copies of Standard Instrument Manuals containing General Specification, Technical Information, Installation, Configuration and Maintenance Instruction Manuals and Spare Parts List of the individual equipment and instruments must be provided. • one (1) copy of panel wiring diagram of the model plant • one (1) copy of equipment/instrument certificates and default parameter settings. • training course notes shall be handed out during the training. The copyright status of the documentation above, including that of translation from English language to another language shall be stated. **(v) SITE INSTALLATION AND COMMISSIONING** The supplier shall install the physical plant at the designated location and connect the necessary facilities as follows: • power supply to the physical plant (electrical works) • air distribution system from the isolation valve provided at the air supply pipeline to the physical plant (piping works) • water supply to and drain from the physical plant (piping works) Tenderers can arrange a site visit to estimate the amount and extent of installation works and materials required. Commissioning shall proceed immediately to have the physical plant operating and ready for Training and Site Acceptance.

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		(vi) TRAINING AT SITE (2 DAYS) The Training for the Instructors and Lecturers shall include: • Classroom lectures on the theory of Process Control Instrumentation as applied to the Experiments. • Operation training must be conducted, which include the hands-on experiment training with the start-up, operation and shut-down of the physical Plant. The training shall include instructions on how to use the Experiment Manuals by running the relevant experiments in the Experiment Manuals. The **'Minimum Experiments Required in the Experiment Manual'** that are stated in this Tender Specifications shall serve as the Training check-list. The duration of the training at site shall be 2 days. * Tenderers shall submit their training resume, including the resume of their training and support engineers. In particular state the institutions where they have conducted the above training program. * A tentative **training proposal** must be submitted for evaluation. **(vii) SITE ACCEPTANCE TEST (SAT) FOR THE EQUIPMENT AND EXPERIMENTS** The purpose of the SAT is to certify that the Training System delivered and installed have met the requirements of the Tender Specifications. It requires witness test runs of the various Experiments and checking the control system dynamics etc to confirm if the Experiments are performing, i.e. if the underlying theories and principles intended for the Experiments have been successfully demonstrated in following the supplier's **Experiment Manuals**. Insufficient or non-performing Experiments will be considered non-performing and Site Acceptance will NOT be certified. The only terms of reference shall be the Tender Specifications in which the **'Minimum Experiments Required in the Experiment Manual'** are detailed in the Tender Specifications. The compliance to the Tender Specifications shall be strictly enforced for the issuance of the final Site Acceptance Test certification. Furthermore, the supplier shall continue to remain liable for the compliance to the Tender Specifications for a period of two (2) years after the issuance of the Site Acceptance Test certificate. The training system should be able to operate without any difficulty after it has been installed and commissioned and it is expected to do so as warranted by the manufacturer/tenderer's guarantee. The Purchaser shall reserve the right to recover from the supplier, the cost of engaging their own Specialists or Consultants, if it is ascertained that any of the Experiments, equipment or services have defaulted against the Tender Specifications. •

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		(viii) OTHER SUBMISSION For further tender evaluation, the tenderers must submit the following: • P & I Diagram of the physical plant • process description of the training system • list of all educational institutions where the supplier has designed and installed this proposed level-flow training system and documented its Experiment Manual, for cross-checking and visitation. For this purpose, please submit a list of the Experiments that were provided for in the Experiment Manuals for these institutions. Submit a sample copy of the customized Experiment Manual. • "Certificate of Guarantee" by the manufacturer/supplier to meet the intent of the Experiments as detailed in the **'Minimum Experiments Required in the Experiment Manual'** in this Tender Specifications. • their earliest possible delivery and site commissioning date. In addition, the tenderer must submit a detail work of schedule showing how the project is going to be executed to meet the stipulated time frame. However, the purchaser reserves the right to determine the date of installation of the training system. • the tenderer must justify their competency for executing this project successfully. Please submit the past/previous experience for handling similar project. **(ix) WARRANTY PERIOD** • The tenderers shall state the warranty period of all equipment supplied. • The warranty period must **not be less than one (1) year** from the date of complete handling over. Any equipment / material defects or faulty operation due to manufacturer or installation shall be the responsibility of the supplier who shall immediately make good and / or replace any such defect or faulty components. • All labour and material needed during the warranty period shall be supplied free of charge. Any exclusion shall be clearly specified in the tender.