# การทดสอบระบบงาน

# Quality Assurance and Testing

## Quality Assurance Program

### The Contractor shall employ documented and rigorous Quality Assurance (QA) techniques and practices throughout this project.

### ผู้รับจ้างต้องดำเนินการทดสอบเพื่อการประกันคุณภาพอย่างเข้มงวดและจัดทำเอกสารประกอบการทดสอบ

### The QA program shall cover the preparation of all Project deliverables, including documentation, hardware, software, and support as they align with PEA’s requirements.

### การทดสอบ/ทบทวนเพื่อการประกันคุณภาพต้องดำเนินการให้ครอบคลุมระบบงานที่ส่งมอบทั้งหมด รวมทั้งเอกสาร ฮาร์ดแวร์ ซอฟต์แวร์ ระบบงานและระบบสนับสนุนอื่นๆ ที่เกี่ยวข้อง

### The QA program shall provide for the minimization of defects, the early detection of actual or potential deficiencies, timely and effective corrective action, and a method to track all such deficiencies.

กระบวนการประกันคุณภาพดังกล่าวเป็นไปเพื่อลดข้อบกพร่องของระบบงาน เพื่อประเมินความบกพร่องหรือความไม่เพียงพอของทรัพยากร เพื่อให้สามารถป้องกันความบกพร่องที่อาจเกิดขึ้นได้อย่างทันกาลและมีประสิทธิภาพ และเพื่อกำหนดวิธีการในการติดตามและแจ้งเตือนข้อบกพร่องที่อาจเกิดขึ้นได้ในอนาคต

### Contractor shall provide PEA with their documented quality assurance standards, policies, and procedures at the start of the project.

ผู้รับจ้างต้องเสนอแนวทางวิธีการ มาตรฐาน และกระบวนการ ที่ใช้ในการประกันคุณภาพของการพัฒนาระบบงาน ตั้งแต่เริ่มต้นโครงการ

## Inspection

การเข้าตรวจสอบการดำเนินการ

### PEA shall be allowed access to the Contractor’s facilities during component design, system design, manufacturing, and testing and to any facility where hardware or software is being produced that will be delivered as part of this project.

ผู้รับจ้างต้องยอมให้ กฟภ เข้าถึงระบบคอมพิวเตอร์ ทั้งฮาร์ดแวร์และซอฟต์แวร์ที่เกี่ยวข้องทั้งหมด ในระหว่างการพัฒนาซึ่งจะต้องส่งมอบให้กับ กฟภ.ในโครงการ

### The Contractor shall provide office facilities, equipment, and documentation necessary to complete all inspections and to verify that the product is being fabricated and maintained in accordance with the Specification.

ผู้รับจ้างต้องจัดเตรียมสิ่งอำนวยความสะดวก อุปกรณ์ และเอกสารที่จำเป็นในการดำเนินการตรวจสอบการดำเนินการทั้งหมดทั้งนี้เพื่อตรวจสอบความถูกต้องตรงตามข้อกำหนดโครงการ

### PEA shall be allowed to review, verify, and visit any of the Contractor’s products, designs, facilities, or locations as well as any subcontractor’s products, designs, facilities, or locations with minimal (7 days) notice and at any time during the project schedule.

กฟภ. สามารถเข้าเยี่ยมชม และตรวจสอบ ผลิตภัณฑ์ การออกแบบ ระบบงาน หรือสถานที่ดำเนินการของผู้รับจ้าง ได้ภายในระยะเวลาตามสัญญา โดยจะแจ้งล่วงหน้า ไม่น้อยกว่า 7 วัน ทั้งนี้รวมถึงผู้รับจ้างช่วง(subcontractor) ด้วย

### PEA shall be allowed to review and verify the functional implementation of software informally at the Contractor’s facilities and/or a subcontractor’s facilities in conjunction with scheduled project meetings at no additional cost to PEA.

กฟภ. สามารถเข้าเยี่ยมชมและตรวจสอบ การพัฒนาซอฟต์แวร์ได้ ภายในระยะเวลาตามสัญญา ทั้งนี้รวมถึงผู้รับจ้างช่วง(subcontractor) ด้วย

### Mutually agreed to agendas, goals, and predicted outcomes shall be delivered to PEA prior to each demonstration, and the results shall be recorded as part of the project documentation.

### PEA shall be allowed to witness any component testing and/or system testing prior to the formal Factory Acceptance Test.

กฟภ.สามารถเข้าร่วมกระบวนการทดสอบรายหน่วย (component/unit testing) การทดสอบเชิงระบบ (system test) ก่อนที่จะถึงกระบวนการทดสอบเพื่อการยอมรับ (Factory Acceptance Test)

### PEA shall be allowed to inspect and/or audit the Contractor’s hardware and software quality assurance standards, procedures, and records. Documents identified in the approved software quality assurance plan will be inspected to verify that the Contractor has performed the required quality assurance activities.

กฟภ. สามารถเข้าตรวจสอบ

### The inspection rights shall apply to any subcontractors developing new hardware and/or software for inclusion in the project, as well as those subcontractors providing customized hardware and/or software. These requirements shall not apply to subcontractors supplying standard computer or peripheral equipment and standard, off-the-shelf products.

## Test Responsibilities

### Both PEA and the Contractor shall designate, in writing and prior to the start of the factory test, the test coordinators.

### Each coordinator, i.e. PEA and Contractor, shall be responsible for ensuring that the tests are conducted in accordance with PEA’s requirements and the approved Test Plans.

### The coordinators shall each have the authority to make binding commitments for their employer such as approvals of test results and scheduling for variance corrections or, as a minimum, to cause such commitments to be expeditiously made.

### The Contractor shall be responsible for all structured factory tests unless otherwise stated in this Specification document, including the conduct of the tests and all record keeping and document production.

### The Contractor shall support factory and Site testing by supplying staff and documentation to assist with test setup and configuration as required to meet the project Test Plans.

### PEA shall support the factory testing by supplying staff to execute the structured test procedures as well as performing the unstructured testing under the Contractor's supervision.

### The unstructured testing shall be performed by PEA throughout the factory testing period, and shall not be limited by the functional areas being tested or the setup or data requirements for the tests.

### Contractor shall submit the test plan and test procedures to PEA for approval.

### Contractor shall perform all tests and document all test results and record all issues and track their resolutions for PEA review and approval.

### PEA reserves the right to witness or perform any or all structured and unstructured site tests. Contractor shall document the test results even when PEA performs the tests.

### The Contractor shall support the Site testing by supplying staff to monitor the tests.

### The Contractor shall provide at least one relevant subject matter expert (per functional area being tested) from their staff to be on-site during these structured and unstructured Site tests.

### The Contractor shall be responsible for all maintenance (hardware and software supplied by the Contractor) throughout all of the testing periods.

## Test Documents

### Test Documents General Requirements

#### The Contractor shall provide test plans, procedures, and records for all tests for contractually required features and functionality.

#### The Contractor shall ensure that each test is comprehensive and verifies the proper performance of the features and functionality under test.

#### All requirements in the Specification shall be subject of a test to assess whether the requirement has been delivered in accordance with the Specification.

#### The test plans and test procedures shall emphasize the testing of each functional requirement by cross referencing the test plans and procedures to the specific requirements in the Specification, by the checking of error conditions, by documenting the simulation techniques used, and by stating the acceptance criteria for each test.

#### The test plans and test procedures shall be modular to allow individual test segments to be repeated as necessary.

#### All test plans and test procedures for standard, modified standard, and custom functions shall be submitted to PEA for review no later than two months prior to the preliminary factory test.

#### All the test documents shall be subject to the document review and approval process as required by PEA.

#### PEA shall approve test plans and test procedures no later than two weeks prior to the preliminary factory test.

#### PEA shall develop any additional test plans and procedures for the unstructured testing performed during factory testing and during site testing.

#### The Contractor shall recommend, and approved by PEA, bug-tracking tools for managing test cases and test results, documenting defects and for source code configuration and versioning.

### Test Plans

#### Contractor shall develop the test plans, with advice from PEA as needed, and submit the plans to PEA for approval.

#### The test plans shall include (1) The schedule for each set of tests to be conducted.

#### The test plans shall include (2) The responsibilities of the Contractor, and PEA personnel to conduct each set of tests, including the assignments of personnel to perform and record the tests, the provision of test equipment and data, and reporting of the test results.

#### The test plans shall include (3) Any forms to be completed as part of the tests and the instructions for completing the forms.

#### The test plans shall include (4) Procedures for monitoring, correcting, and testing variances.

#### The test plans shall include (5) Procedures for controlling and documenting all changes made to the hardware and software after the start of testing, including regression testing methodology.

#### The test plans shall include (6) Block diagrams of the hardware test configuration, including the Contractor- and the PEA-supplied equipment, external communication channels, and any test or simulation hardware.

#### The test plans shall include (7) Identification of automation tools and scripts used for testing. The Contractor shall deliver these tools and scripts together with their user manual documentations to PEA as a project deliverable.

#### The test plans shall include (8) The goal and expected results of the set of tests, as they relate to the requirements.

#### The test plan shall describe all temporary hardware and/or simulations to be employed for each test.

#### Test plans shall be provided for the preliminary Factory Acceptance Test (pre-FAT).

#### Test plans shall be provided for the Factory Acceptance Test (FAT).

#### Test plans shall be provided for the Full Functional Test (FFT).

#### Test plans shall be provided for the Site Acceptance Test (SAT).

### Test Procedures

#### The test procedures shall describe the methods and processes to be followed in testing the system.

#### The test procedures shall be modularized, such that individual functions can be independently tested and so that the testing proceeds in a logical manner.

#### The test procedures shall include (1) The name of the function to be tested.

#### The test procedures shall include (2) A list of test segments to be performed and a description of the purpose of each test segment.

#### The test procedures shall include (3) The set-up and conditions for each segment, including descriptions of the hardware and software being tested, the test equipment required for monitoring and/or simulation, and the data to be supplied by the Contractor and by PEA.

#### The test procedures shall include (4) Descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment.

#### The test procedures shall include (5) Descriptions, listings, and instructions for all test software tools, scripts, and displays required for the procedure.

#### The test procedures shall include (6) Step-by-step descriptions of each test segment, including the inputs and user actions for each test step.

#### The test procedures shall include (7) The expected results for each segment, including the pass/fail criteria.

#### The test procedures shall include (8) Forms for the recording of test results, including pass/fail status and observations made by the personnel conducting the test.

### Test Records

#### Complete records of all test procedures performed, including the results of each test shall be maintained by the Contractor and provided to PEA upon acceptance of the test.

#### Contractor shall maintain a test completion log with PASS/FAIL and approval signatures.

#### The records shall be keyed to the test procedures.

#### The test records shall include (1) Reference to the appropriate test procedures.

#### The test records shall include (2) Date(s) of the test and the test duration.

#### The test records shall include (3) Description of any test conditions, input date, or user actions differing from that described in the test procedure.

#### The test records shall include (4) Test results for each test segment including a passed/failed indication and a record that each step was performed, including copies of any displays used to adequately demonstrate the test results. All information recorded during the test such as measurements, calculations, and times shall be included in the test results.

#### The test records shall include (5) Identification and signature of the representatives of PEA and the Contractor who performed and witnessed the test.

#### The test records shall include (6) Provision for comments by PEA 's representatives.

#### The test records shall include (7) References to all variance reports generated.

#### The test records shall include (8) Copies of reports, display copies, and any other softcopy or hardcopy generated as part of the test.

## Variance (Findings/Defects) Recording and Resolution

### Variance Records

#### The record of each variance shall include (1) The time and date of the initial discovery of the variance.

#### The record of each variance shall include (2) A variance number – a unique, sequential number assigned when the variance is entered into the tracking system.

#### The record of each variance shall include (3) An identification of the person submitting the variance and the names of any other witnesses or knowledgeable Contractor or PEA staff.

#### The record of each variance shall include (4) An identification of the system component, such as a hardware item or software function, including version or build number, against which the variance is being written.

#### The record of each variance shall include (5) An identification of the test plan and/or procedure, as applicable. The stage or step of the plan or procedure where the variance occurred shall be identified.

#### The record of each variance shall include (6) An overview of the variance suitable for use in keyword searches.

#### The record of each variance shall include (7) A detailed description of the variance, including a print-screen hardcopy wherever possible.

#### The record of each variance shall include (8) Responsibility for resolution of the variance (Contractor or PEA).

#### The record of each variance shall include (9) Identification of progress through the appropriate variance state(s):

#### a) Open (recorded but not scheduled for further action)

#### b) Assigned (scheduled for further action)

#### c) Pending (the variance has been resolved but not tested)

#### d) Closed (PEA has accepted the resolution)

#### e) Cancelled (not a variance, not repeatable, etc.)

#### f) Deferred (will be addressed or fixed in next product release by the Contractor)

#### The record of each variance shall include (10) The date of assignment and/or change of a variance into each variance state.

#### The record of each variance shall include (11) A mutually agreeable variance severity level assignment.

#### The Contractor shall incorporate the use of the severity level definitions by PEA on this project.

#### The record of each variance shall include (12) A description of the variance resolution, including identification of all hardware, software, and documents modified or otherwise changed, plus the names of the Contractor and/or PEA staff involved with the resolution.

#### The record of each variance shall include (13) A record of all testing performed.

#### The record of each variance shall include (14) Identification of PEA staff accepting the variance resolution and the date of acceptance.

### Schedule for Variance Correction

#### The Contractor and PEA shall meet as necessary to review the variance list.

#### Each new variance opened since the previous meeting shall be scheduled for correction at the meeting.

#### For Severity 1 defects, Contractor will provide PEA updates (email and/or teleconference) at least every 4 hours, until a mutually agreeable plan for resolution, including temporary workaround if any, has been approved by PEA. The awarded Contractor will discuss and agree upon these details with PEA before the start of the project.

#### For Severity 2 defects, Contractor will provide PEA access to a ticketing system and reports with up to date defect status. Outstanding defects will be discussed during structured project reviews, to occur no less frequently than once per quarter. Remediation timelines, or other disposition (such as upgrading/downgrading severity level), will be determined as part of this process. The awarded Contractor will discuss and agree upon these details with PEA before the start of the project.

#### For Severity 3 defects, Contractor will provide PEA access to a ticketing system and reports with up to date defect status. Outstanding defects will be discussed during structured project reviews, to occur no less frequently than once per two quarters. Remediation timelines, or other disposition (such as upgrading/downgrading severity level), will be determined as part of this process. The awarded Contractor will discuss and agree upon these details with PEA before the start of the project.

### Variance Resolution

#### A variance shall be deemed resolved only upon written acceptance of the correction by PEA.

#### Prior to submitting the corrected variance for acceptance by PEA, the Contractor shall take all reasonable steps to verify that the correction has resolved the variance and the Contractor shall update the variance record to reflect the corrective action taken.

#### PEA shall then schedule any testing to be performed in conjunction with the Contractor.

#### A variance shall be deemed accepted only after PEA has tested the corrected variance to its satisfaction.

#### The Contractor shall support any and all testing deemed necessary by PEA to verify the corrections.

## Test Schedule

### General Test Schedule Requirements

#### The Contractor shall provide a detailed test schedule for the testing of the system (may include unit testing, but not limited to, preliminary Factory Acceptance Test, Factory Acceptance Test, Full Functional Test, and Site Test) that is consistent with the overall project schedule.

#### The test schedule shall allow sufficient time throughout the testing period for unstructured testing by PEA.

#### The time reserved for unstructured test for each functional module shall be included in the test plan.

#### Unstructured testing opportunities shall be made available to PEA on request. This time may be used by PEA to perform additional tests that are needed to investigate potential problems detected during structured testing.

#### The test schedule shall cover the testing of all aspects and components of the system, including interfaces to other systems and to components supplied by PEA, and shall be subject to PEA approval.

### Test Initiation

#### The Contractor shall provide all plans and procedures for the test to PEA for approval prior to the beginning of each testing period.

#### The Contractor shall provide all relevant documentation, including project documents, to PEA for review or approve prior to the beginning of each testing period.

#### A copy of all relevant documentation including design and maintenance documents, user manuals, test plans, and test procedures shall be located in the test floor staging area prior to the beginning of each testing period.

#### Before any test, all operating system parameters, files, and configuration information shall be saved to archive media so that the system operating environment can be recreated.

#### Before any test, all database, display, and report definitions shall be saved to archive media so that the databases, displays, and reports can be recreated if necessary.

#### Before any test, all source code libraries shall be saved to archive media so that software can be regenerated if necessary.

#### Before starting the Factory Acceptance Test, the preliminary Factory Acceptance Test shall have been successfully completed, and the Contractor shall have submitted to PEA written certification that the preliminary Factory Acceptance Test was successfully completed.

#### Before starting the Full Functional Test (FFT), all Severity Level 1, 2, and 3 variances shall have been corrected and verified to the satisfaction of PEA.

#### PEA shall retain the right to disapprove initiation of a testing period if the proper documentation is not provided by the Contractor and/or PEA determines that variances have not been fully integrated and tested by the Contractor.

### Test Completion

#### A test shall be deemed to be successfully completed only when all of the following items have occurred:

#### 1) The predicted test outcome has been successfully demonstrated

#### 2) All variances have been resolved to the satisfaction of PEA, or a mutually agreeable mitigation plan has been defined.

#### 3) All test records have been transmitted to PEA.

#### 4) PEA acknowledges, in writing, successful completion of the test.

### Test Supervision

#### If PEA believes, at any time, that the quantity or severity of variances warrants suspension of any or all testing, the test shall be halted, remedial work shall be performed, and the test shall be repeated at no additional cost to PEA.

#### The repeat of the test shall be scheduled for a date and time mutually agreed upon by both the Contractor and PEA.

## Modifications During Testing

### No changes shall be made to the system after Full Functional Test (FFT) has started without the express authorization of PEA. (This requirement does not apply to pre-FAT and FAT.)

### The Contractor shall carefully control the test environment so that all changes can be readily identified and so that any changes installed for any purpose can be removed and the previous test environment restored.

### PEA shall have the right to suspend testing, to revert to a previous version of any software or hardware, and to restart any testing previously performed if, in its opinion, changes have been made to the system under test without authorization or that the changes made were deemed to impact on previously completed tests.

### The Contractor shall establish and document a formal change control and configuration management process for identification, control, and reporting of any changes made to hardware, software, and documentation at any time during the project, including after shipment to PEA’s site.

## Preliminary Factory Acceptance Testing

### The preliminary Factory Acceptance Test (pre-FAT) is a complete dry run of the FAT, following the approved test plans and procedures.

### The Contractor shall use the pre-FAT to detect and resolve any design, integration, database, display, and performance problems prior to the FAT.

### The Contractor's project manager shall sign off on each test.

### The completed test results shall be sent to PEA for inspection before PEA 's personnel travel to the Contractor's facilities for the FAT.

### All tests shall be conducted using the PEA-specific databases unless PEA authorizes the Contractor to use a test database.

### The Contractor shall notify PEA at least thirty days prior to the start of the pre-FAT, and PEA shall have the option to witness all or parts of it.

### The Contractor shall notify PEA when the pre-FAT has been successfully completed and system is ready for FAT.

### The Contractor shall provide a certificate of successful completion of the pre-FAT that is signed by its executive management stating that pre-FAT test was successfully completed and the system is ready for Factory Acceptance Test (FAT).

## Factory Acceptance Test

### General Factory Acceptance Tests Requirements

#### The Factory Acceptance Test (FAT) shall be tested and conducted at the awarded Contractor’s manufacturer/supplier/sub-contractor factories located in Country of Origin described in the Price Schedule section and/or PEA’s defined locations, e.g. PEA Data Centre, both based on the approval of PEA.

#### The Factory Acceptance Test (FAT) shall include, but not be limited to: (1) Functional test and (2) Unstructured test, of the AMI system based on the approval of PEA.

#### The Contractor shall perform comprehensive functional testing.

#### The Contractor shall provide interfaces to or simulation of devices and interfaces that are not available for factory acceptance test.

#### The PEA-supplied field equipment that may be in operational service cannot be used for factory acceptance test and shall be realistically simulated in a test environment by the Contractor during formal Factory Acceptance Test (FAT).

#### The simulation software for FAT shall be provided and delivered to PEA as a project deliverable upon successful completion of the Factory Acceptance Testing.

### Functional Test

#### The test procedures shall take into account all additional test equipment and shall ensure that the additional equipment does not create false test results.

#### The functional test shall rigorously exercise all functions and devices, both individually and collectively, and shall verify the correct functional operation of all software.

#### The functional test shall include (1) Verification of all required functionalities of the AMI system, based on the approval of PEA.

#### The functional test shall include (2) Verification of proper acquisition, processing, and storage of data from appropriate sources, and verification of protocol and data exchanges with all external systems that will interface with the system, based on the approval of PEA. Where necessary, the Contractor shall provide appropriate simulations of the external systems; such simulations must themselves be verified before being used.

#### The functional test shall include (3) Verification of user interface functions, based on the approval of PEA.

#### The functional test shall include (4) Demonstration of the security, based on the approval of PEA.

### Unstructured Test

#### The unstructured tests shall be performed during the functional test period in the factory at the discretion of PEA.

#### The Contractor shall assist PEA in unstructured tests as required by PEA; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, assisting with monitoring tools, and explaining all unexpected results.

## Full Functional Test

### Full Functional Test General Requirements

Once the winner of the Contractor is selected, the awarded Contractor shall prepare for the Full Function Testing (FFT) before the actual implementation and deployment of the system. The awarded Contractor shall pass the FFT before proceeding with any field work of the project. PEA shall define the guideline of full functional test for the first lot of meter installation. In the FFT test, the Contractor shall prepare at least 15 sets of smart meters with 5 sets for each smart meter brand, in which the amount of CT-operated smart meters is 3 sets and CT-VT operated meters is 2 sets. The Contractor shall also prepare at least 15 sets of 4G/3G modems, in which the amount of the first 4G/3G modem brand is 8 sets, and the second 4G/3G modem brand is 7 sets.

#### The Full Functional Test (FFT) shall be tested and conducted at PEA’s defined locations, e.g. PEA Data Centre or Contractor’s facility, based on the approval of PEA. The testing site of FFT shall represent an overall environment of the project deployment areas.

#### The Full Functional Test (FFT) shall include, but not be limited to: (1) Equipment test, (2) Functional and Interface test, (3) Performance test, (4) Stability test, (5) Cyber Security Test and Audit, and (6) Unstructured test, based on the approval of PEA.

#### The Contractor shall perform comprehensive functional testing and realistic performance, response, and system stability testing.

#### The Contractor shall provide interfaces to or simulation of all devices and interfaces that are not available for factory acceptance test. This includes hardware ultimately to be provided by PEA (e.g., workstations, network equipment, firewalls, etc.), or hardware previously shipped to PEA as part of this project.

#### The PEA-supplied field equipment that may be in operational service cannot be used for full functional test and shall be realistically simulated for all aspects of testing in staging and/or test environment, including functionality, performance response and stability, by the Contractor during Full Functional Test (FFT).

#### The temporary hardware and/or simulation devices and/or software shall be provided and delivered, as a discretion of PEA, to PEA as a project deliverable upon successful completion of the Full Functional Test (FFT).

#### The FFT shall allow PEA to test the proposed solutions and capabilities that are essential to mitigate possible barriers or problems in the fields.

#### All key functionalities shall be included in the FFT system setup.

#### PEA shall identify the FFT testing site at the time of project award.

#### The FFT shall be tested in the Staging (preferred) or Development/Training (alternative) environment.

#### From a theoretical perspective, the FFT should include all data exchanges and functions that will be in the final installation. The best FFT would be an entire staging system; however, it may be impractical. It is the selected Contractor’s responsibility to investigate the site and provide comments to PEA if any concern.

### Equipment Test

#### The equipment test shall verify that the Contractor’s solution includes all required equipment, that the equipment is properly configured, and that the equipment can successfully execute the diagnostic programs provided.

#### The equipment tests shall include a visual inspection for proper workmanship, including cables, connectors, serial numbers, and labelling.

#### The assembly drawings and configuration drawings shall be verified during equipment test.

#### The equipment tests shall verify that the specified capacity and expansion requirements have been satisfied.

### Functional and Interface Test

#### The test procedures shall take into account all additional test equipment and shall ensure that the additional equipment does not create false test results.

#### The functional and interface tests shall rigorously exercise all functions and devices, both individually and collectively, and shall verify the correct functional operation of all hardware and software.

#### The functional and interface tests shall include (1) Verification of all required functionality of the system, including, at least but not limited to, the HES, MDMS, NMS, MOMS, Customer Energy Portal systems, and ESB, based on the approval of PEA.

#### The functional and interface tests shall include (2) Verification that all software has been correctly sized and meets PEA’s capacity requirements, based on the approval of PEA.

#### The functional and interface tests shall include (3) Verification of proper acquisition, processing, and storage of data from appropriate sources, and verification of protocol and data exchanges with all external systems that will interface with the system, based on the approval of PEA. Where necessary, the Contractor shall provide appropriate simulations of the external systems; such simulations must themselves be verified before being used.

#### The functional and interface tests shall include (4) Verification of all user interface functions, based on the approval of PEA.

#### The functional and interface tests shall include (5) Verification of the proper operation of local and wide area network devices, including routers, gateways, switches, and the network as a whole by monitoring network traffic using diagnostic procedures and reconfiguration tests, based on the approval of PEA.

#### The functional and interface tests shall include (6) Verification of communications maintenance capabilities including diagnostics, communications maintenance and exception management, based on the approval of PEA.

#### The functional and interface tests shall include (7) Verification of all hardware maintenance capabilities, based on the approval of PEA.

#### The functional and interface tests shall include (8) Verification of the redundancy and failure recovery schemes of the system, based on the approval of PEA.

#### The functional and interface tests shall include (9) Verification of the proper response of the system to at least the following abnormal situations, based on the approval of PEA:

#### (a) Loss and restoration of processors and servers

#### (b) Loss and restoration of user interface equipment

#### (c) Loss and restoration of archive storage devices

#### (d) Loss and restoration of external subsystems

#### (e) Loss and restoration of input power

#### (f) Loss and restoration of communication network processors

#### (g) Loss and restoration of any other peripheral devices

#### (h) Loss and restoration of local and wide-area network elements

#### (I) Detection of and recovery from communication errors (simulated by Contractor)

#### The functional and interface tests shall include (10) Demonstration of the security of the entire system from unauthorized access, based on the approval of PEA.

#### The functional and interface tests shall include (11) Verification that changes of system time will not prevent the system from operating properly and that the system can correctly handle the beginning of a new day, month, and year; leap years, leap seconds and the change in century and decade; and changes to and from Daylight Savings Time, based on the approval of PEA.

#### The functional and interface tests shall include (12) Documentation verification that will verify that all documentation to be delivered with the system is present and meets the requirements, based on the approval of PEA.

### Performance Test

#### The performance test shall verify that the specified performance requirements are met, based on the approval of PEA.

#### Simulation shall be provided by the Contractor, where necessary, to create the conditions for the specified performance scenarios, i.e., base conditions, steady state, normal activity, high activity state (typical disturbance), and “worst-case” catastrophic state scenario, based on the approval of PEA.

#### The simulations shall include realistically simulating communications bandwidth and path delays between PEA sites.

#### The simulations shall be documented in the test plan and tested first to verify that the desired activity is being simulated.

#### Execution of the performance tests shall be automated as much as possible so that test runs can be reproduced.

#### The simulation tools, applications, and documentation used by the Contractor to create the simulated environments shall be provided and delivered to PEA as a project deliverable for use in development of subsequent simulation environments for additional testing.

### Stability Test

#### A 200-hour continuous run of the system (under various PEA load scenarios) shall be performed after successful completion of the functional and performance tests, based on the approval of PEA.

#### No hardware or software changes, patches, or modifications shall be allowed during the stability test.

#### The duration of the stability test shall cover any daily and/or weekly changes that may occur during normal operation.

#### All chronological time sensitive functions shall be initiated during the stability test.

#### The stability test will be considered successful if no critical function ceases to perform for any period of time, no major hardware failure occurs, no failover occurs, and no restarts occur within the test period, based on the approval of PEA.

#### Major hardware failure is defined for the purpose of this test as the loss of network, hardware such as a server, disk, user workstation, etc. Non-repetitive device failures of printers, monitors, etc., are not considered major failures.

#### During stability test, the Contractor shall exercise the system (with simulated inputs, events, and conditions) in a manner that approximates an operational environment under various PEA load scenarios, based on the approval of PEA.

#### PEA shall augment the simulated activity with unstructured user actions during this test, based on the approval of PEA.

#### PEA shall not purposely cause any hardware or software failure, that is, failover and restart testing will not be done during this test.

### Cyber Security Testing and Audit

#### The Contractor shall perform a cyber-security audition per functional requirements by a professional audition company or organization, by which the Contractor shall solely bear all expenses related to such cyber-security audition, and be approved and witnessed by PEA.

#### It shall be verified that, for all system assets, security event monitoring is enabled and functioning per functional requirements.

#### It shall be verified that network ports not required for operation have been disabled.

#### A virus and malware scan of the system shall be performed to verify that all virus and malware scanning tools are enabled and using the most up-to-date virus signature patterns.

#### It shall be verified that all software not required for operation has been removed or disabled.

#### All signature files used by the software integrity schema shall be regenerated.

#### It shall be verified that all software not required for operation has been removed or disabled.

#### The use of shared accounts shall be minimized and that all users with access to a shared account be documented.

#### PEA shall reserve the right to audit the Contractor’s cyber security training and background checks for all Contractor staff to be sent to PEA’s site and all staff remaining at the Contractor’s facility who have access or will work on the system.

#### Access privileges assigned to user accounts shall be restricted to those needed to perform the user's tasks and be approved by management

#### All users shall receive security awareness and acceptable use training prior to being allowed physical and electronic access to system assets.

#### All users shall receive and passed security background checks prior to being allowed physical and electronic access to system assets.

#### All data flows within the system, including communications paths and protocols shall be documented.

### Unstructured Test

#### The unstructured tests shall be performed during the functional and performance test periods as well as during the stability test at the discretion of PEA.

#### The Contractor shall assist PEA in unstructured tests as required by PEA; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, assisting with monitoring tools, and explaining all unexpected results.

## Site Acceptance Test

### Site Acceptance Test General Requirements

#### The Site Acceptance Tests shall include, but not limited to the installation test, the functional test, the performance test, and the unstructured test.

#### The Site Acceptance Tests shall be conducted at PEA after shipment and installation of the system, based on the approval of PEA.

### Installation Test

#### The installation test shall be conducted by the Contractor

#### The installation test shall include a repetition of the equipment test performed in the factory, but performed in the field and interfacing with actual field equipment and devices.

#### The Contractor shall load MOMS and other field operation software and start the system in the PEA test environment.

#### At the option of PEA, all MOMS and other field operation software shall be recompiled from the source or distribution media.

#### In cooperation with PEA, the Contractor shall attach the MOMS and other field operation software to communications facilities for all data sources and other systems that interface with the AMI system.

#### The Contractor shall provide initialization, configuration, and preliminary tuning of MOMS and other field operation software.

### Functional Tests

#### The site functional tests shall be comprised of a subset of the functional tests performed in FFT.

#### The functional tests to be performed shall be proposed by the Contractor and approved by PEA.

#### These tests shall be extended as necessary to test functions simulated during the FAT and FFT, such as communications with all field devices and all other systems that interface with the system. In this case, Contractor shall work with PEA to plan for the extended tests.

#### Unstructured tests shall also be employed, as necessary, to verify overall operation of the system under actual field conditions.

### Performance Tests

#### The site performance tests shall be comprised of the performance tests performed in FFT, but interfacing with actual field equipment that may not have been available during FFT testing.

#### The performance tests to be performed shall be proposed by the Contractor and approved by PEA.

#### Execution of the performance tests shall be automated as much as possible so that test runs can be reproduced.

#### The simulation tools, applications, and documentation used by the Contractor to create the simulated environments shall be provided and delivered to PEA as a project deliverable for use in development of subsequent simulation environments for additional testing

### Stability Test

#### A 200-hour continuous run of the system (under various PEA load scenarios) shall be performed after successful completion of the functional and performance tests, similar to those conducted during FFT.

#### The Contractor shall assist PEA in stability test as required by PEA; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, assisting with monitoring tools, and explaining all unexpected results.

### Unstructured Tests

#### The unstructured tests shall be performed during both the functional and performance test periods.

#### The Contractor shall assist PEA in unstructured tests as required by PEA.

## System Performance Test

### Performance Tests

#### The site performance tests shall be comprised of the performance tests performed in SAT with the achievement of the system performance requirements in section 1.8.2 of Book 2 AMI System, but interfacing with actual field equipment that may not have been available during SAT testing.

#### The performance tests to be performed shall be proposed by the Contractor and approved by PEA.

#### Execution of the performance tests shall be automated as much as possible so that test runs can be reproduced.

#### The simulation tools, applications, and documentation used by the Contractor to create the simulated environments shall be provided and delivered to PEA as a project deliverable for use in development of subsequent simulation environments for additional testing

### Stability Test

#### A 200-hour continuous run of the system (under various PEA load scenarios) shall be performed after successful completion of the functional and performance tests, similar to those conducted during SAT.

#### The Contractor shall assist PEA in stability test as required by PEA; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, assisting with monitoring tools, and explaining all unexpected results.

# Training Requirements

## Training Requirements Framework

### Contractor shall prepare and deliver a comprehensive training program on the operation and maintenance of the project.

### Contractor shall present its methodology for training development and delivery for each impacted PEA audience.

### Contractor shall present its approach on flexibility, expandability, and scalability of the training product.

### Contractor shall present its methodology for the delivery of incremental training for future changes to the AMI for C&I Systems product and its associated components (i.e. firmware upgrades, integration of new functions, etc.)

### Contractor shall furnish training document for system operating, programming, and troubleshooting documents.

### Contractor-supplied documentation and training materials shall enable PEA to carry out its own training as it requires after the initial Contractor training round.

## Scope of Training

### General Scope

#### The training curriculum shall comprehensively train PEA's staff on all hardware and software to be provided.

#### This training shall cover the theory of design and operation, use-cases, maintenance, and installation of upgrades or new releases of these products. The Contractor shall provide extensions to all subcontractor-provided training that covers how these products are used, the specific features of these products implemented, and features that cannot be used if any.

### Self-Study Courses

#### PEA prefers classroom style courses for all training. Self-study training using books and video-based training may be used as supplementary training only. A copy of any books and video files used in training shall be provided to PEA as part of the training documents.

### Recording of Courses

#### PEA shall be permitted to make video and audio recordings of all training classes. PEA will use these recordings solely for internal instruction purposes and will not release the recordings to third parties.

## Training Documents

### Training Documents General Requirements

#### The Contractor shall provide a detailed training plan for PEA’s approval that supports the implementation and phasing of the project and considers the knowledge required by PEA’s own project team to facilitate their participation in the Project.

#### The Contractor shall be responsible for the preparation and production of all course materials.

#### Training documents shall be subject to PEA's Documentation Review and Approval process.

### Training Plan

#### The training plan shall be prepared in cooperation with PEA such that it supports the project implementation schedule and phasing of the project deliverables.

#### The training plan shall consider the availability of PEA personnel.

#### A logical sequence of courses shall be arranged.

#### The training plan shall list each course to be taken, the dates for the course, and the expected number of students to attend.

#### Training plan shall be scheduled to minimize the loss of knowledge through lack of use.

#### Training shall be scheduled so that there will not be long periods of time between training and the use of the training.

#### The training plan shall be constructed such that some training can be completed prior to the start of Full Functional Test (FFT), based on the approval of PEA.

#### The Contractor and PEA shall conduct a Training Needs Analysis during the design phase to develop a best fit training plan for the PEA team. This will enable the Contractor to work with PEA to design a training plan that leverages the PEA team's existing knowledge and skill-set and focuses primarily on new, upgraded, and specific content.

### Course Descriptions

#### The Contractor shall provide a description of all courses offered by the Contractor and its Sub-contractors for PEA’s approval.

#### The course descriptions shall include (1) the course name (and number if applicable).

#### The course descriptions shall include (2) a brief description of the course.

#### The course descriptions shall include (3) a description of the intended audience for the course.

#### The course descriptions shall include (4) a description of the relation of the course to others in the training plan.

#### The course descriptions shall include (5) the duration of the course.

#### The course descriptions shall include (6) a breakdown of the course schedule, identifying classroom, laboratory, and hands-on periods.

#### The course descriptions shall include (7) a list of the training materials to be supplied.

#### The course descriptions shall include (8) a list of reference material to be used in the course.

#### The course descriptions shall include (9) a list of any prerequisite training or experience expected of the students.

#### All the course descriptions shall be included in the training plan.

### Course Material

#### Contractor shall provide all necessary training materials, including course manuals and reference materials.

#### Individual copies of the training materials shall be provided to each trainee.

#### One set of the training materials shall be provided for PEA archives.

#### Class materials, including documents sent before the training classes and class handouts, shall become the property of PEA.

#### Contractor shall permit unrestricted reproduction of the material by PEA for internal use.

#### All course materials shall be distributed to the students at least two weeks prior to the course.

## Instructor Qualifications

### Course instructors shall have demonstrated technical competence in the subject and previous instructing experience.

### The Contractor shall submit the qualification of the instructors as per training course in the training plan for PEA’s approval.

### PEA prefers instructors who are subject matter experts with experience in presenting the course material (as opposed to hardware or software developers who have never presented courses).

### The Contractor may use the developer as the instructor for project elements produced specifically for this contract. The developer shall use appropriate training staff as resources when developing the training course and materials.

### Contractor shall have the OEM-provided training on their products directly.

### Contractor shall remain responsible for selecting OEM-provided courses, coordinating their delivery, and ensuring that all training objectives are met.

### In addition to the above, if the course instructor is not proficient in the Thai language, PEA would prefer that the Contractor also provides an interpreter, with relevant technical background, to help the instructor deliver his presentation as efficiently and effectively as possible.

## Training Curriculum

The training curriculum presented in this clause is intended to describe the contents of the training when viewed as a whole. The subjects covered by individual courses may differ as long as the overall objectives are satisfied.

### Seminar

#### **Two types of Seminar shall be given, referred to herein as the Seminar for Technical Support Group and the Seminar for Executives.**

#### **Seminar for Technical Support Group**

##### This Seminar shall be the very first course in the training sequence. The seminar shall constitute an introductory class for PEA personnel who typically will participate in the project as members of the project team or as managers with a special interest in the project.

##### Most of the attendees will also attend The Contractor’s subsequent training courses. Thus, the Seminar for Technical Support Group shall present not only a general overview of the project, but also details related to understanding the architecture, its functions and technology, the project schedule and its various phases, how the project will be implemented, the role to be played by PEA personnel, and the training they will receive.

#### **Seminar for Executives**

##### In contrast to the Seminar for Technical Support Group, the Seminar for Executives shall not be scheduled until the Site Acceptance Test has been performed.

##### The seminar shall provide ample opportunity for free interchange between The Contractor and PEA personnel. Many of the attendees will include managers concerned with system operations. Thus, the seminar shall provide a high level overview of the functions and technology with particular emphasis on the project’s objectives, the results achieved, and how the system should be operated and managed.

### Database and Display Building

#### The database and display building courses shall be scheduled to coincide with the delivery of the Development Systems.

#### The courses shall teach trainees how to prepare the input data to define the operating environment, to build the database and displays, and to prepare the database administrator to maintain and modify the database and its structures.

#### The courses shall include classroom instruction reinforced by hands-on-training in the form of workshops making full use of the Development System facilities.

#### The workshops shall be used to bridge the gap between understanding the conceptual and theoretical aspects of building databases and displays and being able to actually build such databases and displays. These workshops shall utilize PEA’s actual data, displays, and models to ensure that PEA is properly engaged in database and display building activities.

### Information Management

#### The Information Management courses shall be designed to train PEA personnel in the use of the Information Management capabilities, including selections of items to be archived, calculations associated with historical data, and report building features.

#### These courses shall be especially oriented for those of PEA personnel who develop and maintain displays, reports, and calculations relating to Information Management data and for those PEA personnel who maintain the system as an enterprise-wide resource.

### System Administration and Programming

#### The System Administration and Programming course shall consist of several components in order to train PEA personnel, as software engineers, to perform all system administration tasks as well as to maintain the system from both an administration and detailed programming perspective.

#### Administration at System Level: This component shall familiarize the trainees with the procedures necessary to operate the system as an integrated entity, to recognize and respond to system malfunctions, and to perform system level maintenance functions.

#### Administration at Operating System Level: This component shall prepare the trainees to manage and maintain the system at the operating system level.

### Communications Software

#### The Contractor shall provide training on the communications between data sources, the communications network software used within the context of its local area network (LAN), wide area networks (WAN), and on the interfaces or communications links with external subsystems and networks.

#### Training shall be provided for both Contractor and subcontractor supplied software and communications products.

### Application Software

#### The Contractor shall provide training on application software. Each application course shall be organized to be responsive to PEA's specific requirements and shall be regarded as an extension to the standard courses that are provided.

### Portable Devices

#### This course shall cover the operation of the portable devices that PEA personnel will use.

### Hardware Maintenance

#### This course shall teach the trainees the basic theory and operation of each hardware component and the essential knowledge and skills required to maintain and troubleshoot.

#### The course shall include entry-level training in the use of operating system skills, an introduction to the critical directories and files that drive the operating system, and a discussion of the related software, system boot process, networking concepts, and terminology for computer hardware.

#### The level of training shall be commensurate with PEA’s intent to keep the system in continuous working order using its own staff following acceptance of the system. The training shall be provided on actual equipment or on similarly configured systems.

#### The course shall be designed for the hardware maintenance technician, who has computer maintenance experience, but no detailed knowledge of the specific hardware.

### On-the-Job Training

#### To supplement formal training, PEA will locate staff at the factory site as well as at PEA project sites to participate in an on-the-job training (OJT) program. In this respect, The Contractor propose a comprehensive OJT program where the main objective is to train PEA personnel in system integration and development, hardware maintenance, database and display generation (including system data import and export capabilities), and all details concerning the software.

#### Final details of the OJT program shall be agreed upon prior to contract signing, based on PEA’s approval.

# Documentation

## General Documentation Requirements

### Documentation shall be provided for all equipment and functions provided by the Contractor as part of this procurement.

### All documentation shall be in Thai or English depending on the type of documentation. In general, user manuals and design documents shall be in Thai or English.

### The documentation shall describe the AMI for C&I systems, including all of its hardware, software, and interfaces, and shall cover functionality, design, testing, configuration, installation, system startup, operations, and maintenance.

### The Contractor shall provide documentation to enable PEA to have complete operational and maintenance knowledge of the AMI for C&I systems so that after the system has been installed and accepted, PEA’s technical staff may use, modify, and maintain the system with minimal assistance from the Contractor.

## Document Delivery

### Product documentation shall be provided on CD-ROM or electronic media in PDF and native format such as MS Word, AutoCAD, etc.

### Contractor shall allow PEA to make further copies, electronic or hardcopy of product documentation as required for their own use.

### Custom documents shall be provided in Microsoft Word format, during the review process.

### Custom documents shall be provided in both Microsoft Word and PDF formats when finalized.

### Documents shall be delivered in two phases: (1) Approval documents, submitted for PEA’s review and approval, and (2) Final documents.

### Contractor shall provide documents to PEA as softcopy on magnetic or electronic media or by electronic transfer (for example, electronic mail or ftp).

### Final documents shall be delivered on hardcopy, on-line on the development environment, and on softcopy on CD-ROM or DVD or Flash Drive.

## Document Review and Approval

### General Document Review and Approval Requirements

#### All documents provided pursuant to this contract shall be subject to review and approval by PEA.

#### All system designs, implementation plans, test plans and test procedures, and training plans shall be approved by PEA.

### Scope of Reviews and Approvals

#### The acceptance or approval of any documents by PEA shall not relieve the Contractor of the responsibility to meet all of the requirements of the contract or of the responsibility for the correction of the documents.

#### The Contractor shall have no claim for additional costs or extension of time on account of delays due to revisions of the documents that may be necessary for ensuring compliance with the contract.

#### All deliverable documentation shall be revised by the Contractor to reflect the delivered AMI and other systems.

#### Any modifications resulting from the Factory Acceptance Test (FAT), Full Functional Test (FFT), Site Acceptance Test (SAT), and System Performance Test shall be incorporated in this documentation.

## System Requirements Matrix

### Contractor shall assist PEA when PEA is unable to clearly identify the traceability within the Requirements Matrix.

## Hardware Documentation

### List of Deliverable Hardware

#### The list shall itemize each hardware item and include equipment configuration information.

#### The configuration information shall be sufficient so that PEA can procure an identical item from the manufacturer.

#### The list shall include network names and addresses (or these shall be included in the network configuration diagram).

#### The list shall include a space for PEA to enter equipment identification for their own purpose.

### Equipment Configuration Diagram

#### The equipment configuration diagram shall depict the logical interconnection of all of the Contractor-supplied equipment and its connection to the PEA-supplied equipment.

#### The equipment configuration diagram shall use the same terminology as the list of deliverable hardware so that the correspondence between the two can be readily determined.

### Network Configuration Diagram

#### The network configuration diagram shall show the design of the local and wide area networks designed by the Contractor as well as the communications network supplied by PEA.

#### Both logical and physical depictions shall be provided for the network supplied by the Contractor. Only a logical depiction is required for the network supplied by PEA.

### Interconnection List

#### In the interconnection list, the physical interconnections among the AMI for C&I systems components, other than those shown on the network configuration diagram, shall be depicted.

#### In the interconnection list, each cable shall be identified, along with its terminations.

### Site Installation Drawings and Procedures

#### The site drawings shall depict the physical arrangement of the AMI for C&I systems components.

#### The drawings and procedures shall include (1) Equipment physical drawings showing dimensions, cabinet internal arrangements, and the size and weight of each enclosure.

#### The drawings and procedures shall include (2) Unpacking, moving, handling, and other installation details.

#### The drawings and procedures shall include (3) The location of external connections including types and sizes of connectors.

#### The drawings and procedures shall include (4) Input power and grounding requirements.

#### The drawings and procedures shall include (5) Environmental requirements.

#### Cabinet drawings showing required cabinet internal layout shall be provided

#### OEM documentation shall be provided.

### Hardware Maintenance Manual

#### The hardware maintenance manual shall describe the preventive maintenance and restorative procedures required to maintain the equipment in good operating condition.

## Software Documentation

### Software Documentation General Requirements

#### The Contractor shall provide PEA with user documentation for all third party software components of the AMI for C&I systems.

### List of Deliverable Software

#### The list of deliverable software shall itemize each software item and include version and license information.

#### The distribution media for each software item shall be identified.

#### The list of deliverable software shall indicate for each item whether source code is supplied.

#### An interoperability report consisting of Contractor supported software versions versus 3rd party software and OS versions versus hardware versions shall be provided.

#### An interoperability report shall note supported patch levels of 3rd party products that are supported.

### User Manual and/or Guide

#### A user manual or user guide shall describe the use of the functions of the software.

#### The user manual shall include screen shots and/or block diagrams designed to help the user navigate the functions of the software.

#### The user manual shall include troubleshooting hints and an introduction or overview of the main functions.

#### For third party software, the Contractor shall provide the standard user manual normally supplied with the software.

#### For software produced for the AMI for C&I systems project such as MOMS, Customer Energy Portal, etc., the Contractor shall supply a user manual.

### Upgrade and Patch Management Plan

#### For third party software, the Contractor shall deliver an upgrade and patch management plan describing the OEM’s recommended practice for obtaining and installing upgrades and patches.

### Software Development Standards

#### The Contractor shall document the development standards used to develop the AMI for C&I systems and other related software.

#### The standards used to develop any PEA custom software shall be described as appropriate, e.g. CMMI level 3 for MOMS and Customer Energy Portal.

### Database Definition

#### The database definition shall identify the characteristics of all AMI for C&I systems and other related systems’ databases.

#### The database definition shall include (1) The name or identification of the database.

#### The database definition shall include (2) A description of the intended use of the database, including backup and recovery, archiving, data security, file and file layouts. If the database is specific to a single application, the application shall be identified.

#### The database definition shall include (3) A description of the organization of the database (the database schema or model, including type, size and possible values for each field, relationship, index, procedure, function, trigger, etc.)

#### The database definition shall include (4) A description of each field of each data item.

#### The database definition shall include (5) Instructions for generating and populating the database.

#### The database definition shall include (6) Details of programming interfaces. This shall encompass access methods, address schemes, and read, write, and modify actions.

#### The database definition shall include (7) Initialization description – How or by what software is the data initialized and to what value(s).

#### The database definition shall include (8) Details of maintenance actions.

### Software Functional Description

#### The software functional description shall describe the functions to be performed by each software module from the standpoint of a user. (Software functional descriptions are also referred to as user guides.)

#### The software functional description of the AMI for C&I systems and other related software shall be clearly described so that it can be understood without understanding the detailed operation of each software module.

#### Software functional descriptions shall be used as the first step in the design of a custom (for example, new functionality).

#### It shall have sufficient information for PEA to determine that the new functionality will meet the requirements of the contract.

#### The software functional description shall include (1) Functional description.

#### The software functional description shall include (2) Performance requirements.

#### The software functional description shall include (3) Resource requirement.

#### The software functional description shall include (4) User interface.

#### The software functional description shall include (5) Software interface requirements.

#### The software functional description shall include (6) Data requirements.

#### The software functional description shall include (7) Error messages.

#### The software functional description shall include (8) Diagnostic messages.

#### The software functional description shall include (9) Maintenance and expansion procedures.

#### 1) Functional description – A narrative description of each program. Where appropriate, solution algorithms shall be described

#### 2) Performance requirements – The execution periodicity, processing capacity, and tuning and execution parameters that control or limit the capabilities of the software

#### 3) Resource requirement – The expected minimum requirements for main memory, auxiliary memory, processor capacity, and other resources required by the software

#### 4) User interface – A description of the interface used to control the software, including all user inputs and program responses

#### 5) Software interface requirements – A description of the logic interfaces with other programs

#### 6) Data requirements – A description of all data models, data and databases accessed by the software, including execution parameters

#### 7) Error messages – A concise description of all error messages and possible corrective actions

#### 8) Diagnostic messages – Where the software generates a record of its internal operations, the messages shall be described

#### 9) Maintenance and expansion procedures – A description of either maintenance procedures or expansion procedures that is relevant to maintenance of the program or expansion of the program.

#### It is PEA's strong preference that software functional descriptions are provided as a soft copy and on-line documentation.

### Detailed Design Document

#### The detailed design documents are a second level of detail to the software functional descriptions.

#### For customized software, i.e. MOMS, Customer Energy Portal, etc., the Contractor shall first deliver a software functional description for approval by PEA.

#### After approval of software functional description, the Contractor shall produce a detailed design document for approval by PEA.

#### Production of the software shall proceed after approval of the detailed design document.

#### A detailed design document shall relate to a single software functional description.

#### The detailed design documentation shall include the precise design information needed for planning, analysis, and implementation of the software.

#### The detailed design documentation shall include (1) the divisions of the software design entities.

#### The detailed design documentation shall include (2) a dependency description specifying the dependent entities, their coupling and required resources, an interface description providing details of external and internal interfaces not provided in the software functional description.

#### The detailed design documentation shall include (3) a detailed design description containing the internal details of each design entity.

#### The detailed design documentation shall provide a detailed description of how the software will support the functions described in the software functional description.

#### The detailed design documentation shall include a diagram of the software indicating major modules and an overview of the operation of each module.

#### The detailed design documentation shall describe data structures and flow, and a diagram or description of the manner in which the modules interface with other modules.

#### For each software module, the detailed design documentation shall include the following items (1) Program abstract.

#### For each software module, the detailed design documentation shall include the following items (2) General technical description of the module.

#### For each software module, the detailed design documentation shall include the following items (3) The module logic, documented by standard diagramming conventions based on the Unified Modelling Language (UML).

#### For each software module, the detailed design documentation shall include the following items (4) External interfaces to the program including applicable calling sequences.

#### For each software module, the detailed design documentation shall include the following items (5) Initialization considerations.

#### For each software module, the detailed design documentation shall include the following items (6) Identification of any databases referenced or modified.

#### For each software module, the detailed design documentation shall include the following items (7) Error codes and error handling processes.

#### Each program module, including subroutines, shall be sufficiently documented to allow an experienced programmer (with supervision of the designer) to perform the coding of the module, as well as allow PEA personnel to maintain such software in the future.

#### All job control files (batch or make files) required for compilation, assembly, and linking of each program shall be documented in detail as part of the detailed design documentation.

## System Maintenance Manual

### The System Maintenance Manual shall describe all user procedures necessary to build and maintain the software system of the AMI for C&I systems and other related software.

### The System Maintenance Manual shall include complete instructions on performing a system generation from sources for all processors.

### The System Maintenance Manual shall provide information on optimizing system performance.

### The System Maintenance Manual shall describe the hierarchy of disk directories used by AMI for C&I systems and other related software, and the location of all categories of files: including executable programs, displays, databases, sources, build files, etc.

### The System Maintenance Manual shall describe the procedures to configure the computer system of AMI for C&I systems and other related software, and backup the system.

### The System Maintenance Manual shall include documentation of the distributed system software supporting the configuration control function, data integrity, startup, restart, and the network management subsystem.

### The System Maintenance Manual shall provide a list of the Internet Protocol (IP) addresses of all devices in a manner compatible with PEA’s security standards and shall describe the procedures for upgrading or adding additional servers, loggers, storage devices, and other peripheral devices.

### The System Maintenance Manual shall include detailed user information on all supported tools and utilities supplied with the system to assist in diagnosing internal system issues and integrity as well as interface and communication troubleshooting tools.

### The System Maintenance Manual shall provide detailed information on troubleshooting all processors and processes of the AMI for C&I systems and other related software.

### The System Maintenance Manual shall describe the use of error logs, the meaning of all program-generated error or informational messages, and the recommended response to these messages.

### The System Maintenance Manual shall explain what the user should do to save information after a processor or process failure, and shall describe the procedures to gather this information to allow the user to communicate in an informed manner with maintenance personnel.

### The System Maintenance Manual shall include a description of the procedures to restore normal operation after a failure of the AMI for C&I systems and other related software.

## User Manual

### General User Manual Requirements

#### The user manuals shall be organized for quick access to each detailed description of the user procedures that are used to interact with the AMI for C&I systems and other related software functions.

#### The user manuals shall present in a clear and concise manner all information that a user needs to know to understand and operate the AMI for C&I systems and other related software satisfactorily.

#### The user manuals shall make abundant use of screen snapshots to illustrate the various procedures.

### Database Editor’s Manual

#### The Database Editor’s Manual shall describe the procedures to define, build, edit, extract, archive, load and expand all the databases of the AMI for C&I systems and other related software.

#### The Database Editor process shall be covered by training guides.

#### The database software description guide shall contain information describing how an administrator may define and add new attributes to an existing database entity.

#### The database software description guide shall describe how to restore any database to a previously saved version if the database had been corrupted.

### Display Editor’s Manual

#### (if applicable) The Display Editor’s Manual shall describe and fully illustrate the capabilities of the Display Editor, including procedures to auto-generate and edit single-line displays for the AMI for C&I systems and other related software and to link display fields with entities in the database of the AMI for C&I systems and other related software.

#### (if applicable) The Display Editor’s Manual shall describe how to generate new device symbols.

#### (if applicable) The Display Editor’s Manual shall present a clear description of the principles behind zooming and decluttering, and shall explain how the user can assign declutter levels to display elements in order to achieve a satisfactory decluttering upon zooming.

#### The Contractor shall furnish (1) System operating, programming, and troubleshooting document.

#### The Contractor shall furnish (2) Component documentation – hardware units.

#### The Contractor shall furnish (3) Documentation of software and operating system (OS) components including application programming interface (API) documentation that is approved by PEA before system delivery.

#### The Contractor shall furnish (4) Documentation of panel and system wiring and connections.

#### The Contractor shall furnish (5) Data flow diagrams showing message types and paths.

#### The Contractor shall furnish (6) Source code for Contractor-supplied programs shall be supplied, or maintained in an escrow arrangement that assures PEA access to source code if the Contractor is no longer able or willing to support or modify the code.