# Guidelines for Performing the Conformance Tester Audit

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## Executive Summary

One of the tasks of the UCAIug Testing Committee is the verification of conformance testers. This verification is performed by auditing a specimen test (or series of tests) performed by the testing company. The tester is accredited by UCAIug after it has proven competence to perform the test (actually, when incompetence cannot be proven). This report details the process used to perform the audit.

The intended audience for this document is partcipants of the audit task force. A secondary audience is for vendors and testers to assist them in the determination of the expectations of Conformance tested devices.

## Overview of the Accreditation Process

The process begins with the submission of a "Qualification Request" by a tester for accreditation by UCAIug. The request form is extracted from an Annex in the Accreditation Procedures document (presently Annex B) where the vendor declares requested level, test type, and test capabilities. At the time of this writing (October 2009), only one vendor has sought Level A certification. Both Server and Client testers have been certified using this process.

Upon receipt of the accreditation request from a member of the UCAIug, the accreditation process begins. UCAIug requests documents from the tester to show competence to perform testing in general and then supplies the materials from a sample test. These materials are scrutinized for mistakes and a formal report is issued to the tester indicating the areas needing further improvement. It should be stressed that NO tester has ever passed this initial audit step without concerns being raised.

For each concern raised by the auditor, the tester may either comply with the auditor's request, or it can write a rebuttal to the auditor indicating why they feel that the auditor is mistaken. The auditor and tester negotiate the changes until the auditor is satisfied that the tester has demonstrated competence to perform a test on the sample equipment.

The auditor then informs the UCAIug testing secretary of the testing results. The secretary then requests that the tester complete and sign a "Tester Qualification Agreement" which is extracted from an Annex of the Accreditation Procedures document (presently Annex A). The secretary will then sign that document and return it along with a signed "Qualification Form", which is extracted from an Annex of the Accreditation Procedures document (presently Annex C). The secretary will also post a copy of the "Qualification Form" on the UCAIug web site. This posting is the formal notice to the UCAIug community that the tester is qualified to issue UCAIug-endorsed Conformance Certificates.

## Tester Inspection

The first step in the audit procedure is the inspection of documents which are independent of the device-under-test. These documents include the "Qualification Request", the ISO 17025 (or ISO 9000) certificate and the "testing procedures inclusion" document (see below).

The "Qualification Request" document is checked to ensure that all fields are completed and no ambiguities exist. The auditor should inspect this document for any extra "notes" and request clarification from the tester if needed. Also, the auditor should verify that ISO 17025/9000 claims agree with the presence of supplied documentation.

ISO documents should be inspected for both legitimacy and expiration dates. The expiry of these ISO certificates must be at least 1 year later than the time of the audit.

The "testing procedures inclusion" documents are then inspected. The Conformance Test Quality Plan (if supplied) and/or the Test and Inspection Plan is then inspected to ensure that a company officer has signed-off on the test plans. Note that at least one of these two documents must be supplied by the tester, per the rules in the Accreditation Procedure.

Any other documents specified on the Qualification Request should be checked for relevance. If the documents are irrelevant to testing then they should be removed from the Accreditation Request (for example, a blatant advertising document should not be permitted to be included in the request).

The proposed Certificate is then inspected. Although all testers to date have used the format shown in an Annex of Accreditation Procedure (presently Annex D), there is no requirement for this. The certificate does, however, have a lengthy list of requirements which appear in the same Annex as the sample certificate. The proposed certificate must have all of the required information. The detailed contents of the certificate are checked later in the audit process.

## Inspection of Vendor Documents

The next step is the inspection of documents which accompany the Unit-Under-Test (UUT). These documents include the conformance statements (PICS, MICS, PIXIT, and TICS) as well as the SCL file and the TPCL file.

The PICS document is first checked to ensure that all items listed in PICS Annex of 61850-7-2 appear on the customer PICS. All items marked mandatory in 61850-7-2 must also be marked "Yes" or "M" in the customer PICS. A check should be made for consistency of the PICS (for example, if the Reporting Model is declared without any Reporting Services then the PICS is in error). The Control and File transfer sections deserve specific attention because it is a common source of errors by vendors. Also the Time Synchronization section should be checked for consistency and format (for example, the values for T1 and T3 should be integers between 9 and 23).

The MICS document should be inspected to ensure that all non-standard Data Objects have well-defined semantics. Because of the wide variability in the MICS statements, the only further tests are for "just does not look right".

The PIXIT document should be inspected to ensure that the format is similar to that specified on the UCAIug site. Each item should have a clear value or explanation.

The TICS document must state that all mandatory (inter-operability) issues are implemented. Green Tissues from http://tissues.iec61850.com may be marked as implemented. Issues marked Yellow or Red or White should not be listed as implemented since these do not yet have an agreed solution.

The SCL file is provided by the vendor, which is ultimately responsible for its content. However, the tester must verify the contents of the ICD file (for servers) and verify that valid SCD files can be used by clients. The tester might prepare additional files, but these are not audited.

For all SCL files, auditors should verify the following items:

- SCL element refers to 2003 schema
- Header attribute "nameStructure" is "IEDName"
- Verify that the elements within "Services" element (within "IED" element) match the declarations in the PICS and PIXIT documents.
- Verify that the SCL file passes full XML validation against version 1.4 schema. Do NOT use any vendor-supplied schemas for this testing.
- Pass the file through the Siemens validator (at http://www.61850.com) as well as the SEL AcSELerator Architect software (http://www.selinc.com/SEL-5032). Both of these public-domain tools perform checking beyond XML validation.
- Looks for content which "just does not look right"

For ICD files, auditors should verify the following items:

- If “Substation” section exists, its name attribute is “TEMPLATE” (note that the presence of a substation section is probably an error since it only exists for pre-configured IEDs, which is NOT the normal case)
- If a “Communication” section exists, then the “ConnectedAP” element should only reference the IED named in the IED section.
- In the “Communication” section “Address” section, verify that the IP (IP, subnet, and gateway) as well as the OSI selectors (TSEL, SSEL, and PSEL) information is present if the PIXIT specified fixed required values.
- Verify that the Name attribute of the Communication section is “TEMPLATE”
- Inspect the file for “odd” “Val” elements and specifically scrutinize the valKind attributes. For example, “Val” element for MX Functional Constraints are probably an error.
- Verify that all enumerations mentioned in the ICD file exist in the DataTypeTemplates section

For SCD files, auditors should verify the following items:

- Verify that the substation name is other than “TEMPLATE” (there is actually no strict requirement for this)
- Verify that none of the IEDs name is “TEMPLATE” (again, there is no strict prohibition on this name)
- Verify that every IED in the communication section has at least an IP and subnet address. For most system, a gateway address should also be specified, but there are no strict rules for this.
- (more checks ???)

The TPCL (Test Procedures Conformance List) specifies deviations of the device from the “IEC version of the standard”. These include technical issues which are based upon TISSUEs located at http://tissues.iec61850.com/default.mspx. Only solved (Green) Tissues may appear in the list and the “mandatory” issues (from http://www.ucaiug.org/org/TechnicalO/Testing/Shared%20Documents/IEC61850TICSTemplatev0.2.doc) must be included. The TPCL may also include items that clarify how the most recently approved UCAIug IEC 61850 Test Procedures are applied. That is, there may be clarifications that are not technical but apply only to the test procedures. Since the UCAIug Testing QAP provides for a one year grace period before testers are required to use a more recent approved version; the TPCL tracks pending changes that that are needed to properly test a given device at a given time.

## Inspection of Output Documents

The output documents from the test include the Conformance Certificate, the network trace files, and optionally the vendor test report.

The Conformance certificate inspection is actually a very difficult step. The list of conformance blocks should be checked against the qualification request because the tester MUST have actually proved competence for all claimed blocks and the only (simple) way to claim competence is the production of a test report. However, the tester can also claim competence by producing additional network trace files beyond those displayed on the specimen certificate. For each listed conformance block, every mandatory test from the test procedures must be shown in the "Mandatory" test column. The "Conditional" test column must list all tests which are required based upon the PICS and PIXIT and TICS documents. Every conditional test should be checked against the other documents and removal of tests which seem required should be addressed by the vendor. Lastly, the test counts on the front of the Certificate should be checked.

The network trace files inspection is probably the most important part of the audit. These traces provide concrete:

- proof of competence to generate the correct stimulus messages
- the IED response which should have been checked by the tester

These traces also provide valuable "hidden" information such as activity of time synchronization. The first step in the trace inspection is to verify that every test specified on the certificate which should result in network traffic is actually reflected on a network trace. Approximately 5-10% of the traces should be carefully inspected to ensure that the test was correctly executed. Special attention should be paid to the Ass1 and Ass2 tests because any abnormal disconnects may be difficult to see among the thousands of individual traces. The Ass1 and Ass2 traces often contain time synchronization packets which can be used to gauge time sync accuracy and resolution. For example, if the outgoing SNTP (client) requests are always on 5 millisecond boundaries but the vendor claims 1 millisecond resolution, then this is a clear test failure. Also, if the observed clock offset is far greater that that specified in the PICS, then this indicates that the tester missed requesting clarification from the vendor. The sync attempts also show the resolution and accuracy of the tester's clock source (fields within the SNTP clock response). If the tester's clock source is not better than the vendor's claimed accuracy, then the tester should not be able to claim competence to verify to that level. Similarly, traces containing time stamped data can indicate the accuracy claim of the vendor's clock (excessive accuracy claims, such as 60 nanoseconds, should be justified by the vendor). As the auditor gains experience with the trace files, more information can be gleaned from these records.

The report from the tester to the vendor is sometimes included in the audit package. If it is included, the auditor can help the tester by reviewing that package. The package should clearly state the following items:

- exactly what was tested
- test equipment (analog test sets, digital test sets, timing analysers, etc.)
- specific tests that were executed

- pass/fail status of each of the tests (or perhaps a blanket statement that all pass
- observations of the tester (there should always be some observations!)

## Additional actions for Annual Tester Audits

Re-auditing of testers occurs on an annual basis. After the initial audit, testers are required to maintain proper records, issue trouble reports, and issue correct certificates.

During these subsequent audits, the following items should be checked:

- Are the certificates issued since the last audit still substantially correct (this involves only a visual scan of the certificates)
- Has the tester submitted any testing issue trouble reports? Have these been timely and accurate?
- Has the tester clearly indicated to its clients (the UUT vendors) that the project feedback process from the QAP must be followed?
- Has the tester maintained proper test records? These records should include all materials submitted by the UUT vendors, the test report of each test (including failed tests), and at least one sample of any ICD/SCD files which were created during the test.

## Summary of (auditor) tester correction report

The auditor's report must contain the following information:

- Executive summary – did the auditor uncover any concerns?
- Basic description of the audit process (high-level : what was done)
- Detailed finding of the auditor. Quote sections of test/standard as needed
- "Other observations by the auditor" (incidental finding that do not affect the tester pass/fail but might be otherwise of interest to the tester or vendor)
- Summary of corrective actions – what does tester need to do before they become accredited?)

## Re-inspection procedure

After tester responds to all concerns, verify documents. If you see additional concerns based on the new materials, then raise these as additional concerns. However, if new concerns are found on previously submitted materials, these can be brought to the attention of the tester but should not considered a new cause of failure. The auditor must exercise judgement in this area recognizing that the audit is a sampling process and not an exhaustive verification of the competence of the tester. However if, in the judgement of the auditor, the severity of the new concern raises serious questions of tester competence, then this may be considered a new cause of failure.

Another auditor report is generated at this point, but it can be much less formal because it should include only a few misunderstandings between the re-submission materials and the original issue. The auditor should issue this report as quickly as possible because the tester is probably very anxious to begin issuing certificates.

The reply by the tester to the second report should fulfill all of the requirements of the auditor. If the auditor is not satisfied at this point, then the remainder of the audit committee should be consulted for “next steps” (perhaps the tester is actually not competent to execute the UCAIug tests after all!)

## Final comments on the audit procedure

The testers have already expended considerable resources toward 61850 testing. They have undergone dozens of hours of formal training and possibly hundreds of hours of self-paced learning. The auditor should, however, not assume detailed section-by-section knowledge of the standard and associated test procedures by the testers. The language used in test reports and written communications should never belittle the tester. Simply point out the specific sections that need to be reviewed and possibly indicate similar relevant sections that might have escaped their scrutiny.

Keep a positive attitude with the tester on the assumption that they will eventually become an Accredited Tester. You will need to work with these testers every year and mutual trust will be needed for that partnership.