California ISO

Your Link to Power

New Remote Intelligent Gateway and Secure Socket Layer Validation Procedure

REVISION HISTORY

REVCAISON NO.	DATE	DESCRIPTION
1.0	12/5/2001	Initial release of document
2.0	5/25/2007	Revised Security Requirements
3.3	11/4/2008	Revised Validation and Security Requirements
4.1	11/13/08	Final Edits
4.2	8/14/2013	Updated RIG Contacts
4.3	12/16/2015	

ABSTRACT

This Remote Intelligence Gateway (RIG) Validation Procedure provides vendors or device owners with guidelines to configure and test a device for validation and use by the California Independent System Operator Corporation (CAISO) participant providing real time telemetry. The following Procedure outlines the responsibilities of vendors or device owners, and the CAISO staff in configuring, scheduling, and performing testing. To request the testing and device validation vendors must fill out the validation request form in Appendix A. Vendors and device owners should also read through the validation procedure in its entirety and list any exceptions to this Procedure on the request form.

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1 INTRODUCTION

The tests outlined in this Procedure will be performed with the active participation of California Independent System Operation Corporation (CAISO) personnel, but all costs and responsibilities (aside from providing CAISO personnel) shall be at the sole cost of the vendor or device owners. CAISO does not assume any liability resulting from or arising out of any tests conducted pursuant to this Procedure, unless due to the gross negligence or willful misconduct of CAISO personnel. By requesting the tests outlined below such a vendor or device owner expressly consents to the Procedure and agrees to the terms herein. Further, vendor and/or device owner agree to hold CAISO harmless from all liability, except as provided herein.

1.1 TEST PREREQUISITES

The reference to 'Owner' in this testing and validation procedure represents the RIG Owner or representative.
The following prerequisites are required before testing can begin:

- ❑ Names and phone numbers of all test personnel (if testing remotely)
- ❑ Test database spreadsheet
- ❑ Signed ECN connection form if testing remotely
- ❑ RTU IP address, DNS and Gateway addresses

1.2 METHODOLOGY

In order to run a successful test, it is necessary to establish the methods and general procedures which will be followed throughout the test. It is important that these rules and procedures be agreed to, and followed, by all parties during the test. In those cases where either methods or procedures are violated or changed, all parties shall acknowledge the change, reach a mutually agreeable resolution and document the results. This resolution may involve mutually agreed to changes being made to the test procedure or resumption of the previously agreed to methods and procedures. This document will provide the framework for the methods and procedures required to successfully validate the Owner's RIG solution. Related documents shall be referenced and attached to this document where applicable.

The Owner and the CAISO will each appoint a Test Supervisor that is solely responsible for representing their respective companies during testing. The Test Supervisors will be responsible for approving the tests, approving any departure from the procedure, and documenting errors or omissions. The individuals from the CAISO and the Owner conducting each series of tests will sign off on each test procedure section.

The Test Supervisors may add or delete items from the test, redirect the test, skip sections, or review sections at any time during the test provided such changes are agreed to by both the Owner and the CAISO, are consistent with the terms of the Technical Standard and do not result in equipment damage.

The tests are designed to run in the sequence given in this document except where noted. Proper sequencing of tests is necessary because of set up procedures that may have occurred in previous tests. However, it is recognized that circumstances often require that the sequence be interrupted.

Such an interruption or rescheduling requires both Test Supervisors to agree, the impact of the sequence interruption be recognized, and said interruption or rescheduling be documented.

Successful testing involves the active participation and understanding of test functions by both parties. This will provide the CAISO with the opportunity to observe the test results. Upon successful completion of each section, the Test Supervisors will sign off that section as complete and accepted. When testing the RIG from a remote location the CAISO Test Supervisor will maintain the master Validation Procedure and upon completion of the validation testing will send a copy of the signed procedure to the Owner. This original copy shall be signed by the Owner's Test Supervisor in the appropriate locations and returned to the CAISO Test Supervisor.

1.3 DISCREPANCY REPORTS

There may be cases where test results are not satisfactory. Appendix B contains a Discrepancy Report (DR) form where all unsatisfactory results are to be recorded. Discrepancy reports will also be used to document any outstanding issues arising from the tests.

1.4 LOGISTICS

The test period will begin with an orientation meeting (or conference call) of all personnel involved in the testing. The purpose of this meeting is to review testing procedures and to set forth what is to be accomplished by the end of the test period. The test period will conclude with a review meeting (or conference call). In the case where unsatisfactory test results are obtained, this meeting will be used to mutually determine the proper course of action to obtain satisfactory results.

1.5 UNAVAILABILITY AND EXCEPTIONS

Any items or features of the Owner's RIG that are not available or not functional at the time of the tests must be documented on the Discrepancy Report (DR) form located in Appendix B. Exception will be reviewed and an agreement will be reached with the Owner on how each issue is resolved.

1.6 RIG OWNER RESPONSIBILITY

The Owner is responsible for all configuration and development of the RIG device being tested. When the Owner's solution is ready to test the Owner will schedule the test with the CAISO Test Supervisor.

1.7 CAISO RESPONSIBILITY

The CAISO test supervisor is responsible to ensure the RIG Owner's request aligns with the RTU Specification and that the specifics of the test plan will be possible within the given test environment.

The CAISO expressly reserves the right to modify, or withdraw from, the process initiated and described herein at its sole discretion without any liability to vendor or device owners. No rights or licenses shall be vested or granted in any party, individual or entity by virtue of its preparation to participate in, or its participation in, such process. The CAISO expressly reserves the right to modify, for any reason, the test procedures and any provision contained herein. No binding commitment shall arise between the CAISO and an Owner hereunder unless the parties sign documents of agreement that become effective in accordance with their terms. The Owners are advised that this is a CAISO Document and hence CAISO ADR Procedures apply to any dispute arising hereunder in accordance with Article 13 of the CAISO Tariff.

2. SYSTEM SETUP

This section will provide the Owner the basic network and hardware requirements for the RIG to be certified for real-time data acquisition for CAISO. A sample database, with calculations, is posted in Appendix C for reference.

The Owner may use supplementary devices such as PLCs with their RIG to add functionality if the RIG is unable to comply directly with CAISO technical standards. The use of supplementary devices is acceptable, but will be noted as an exception.

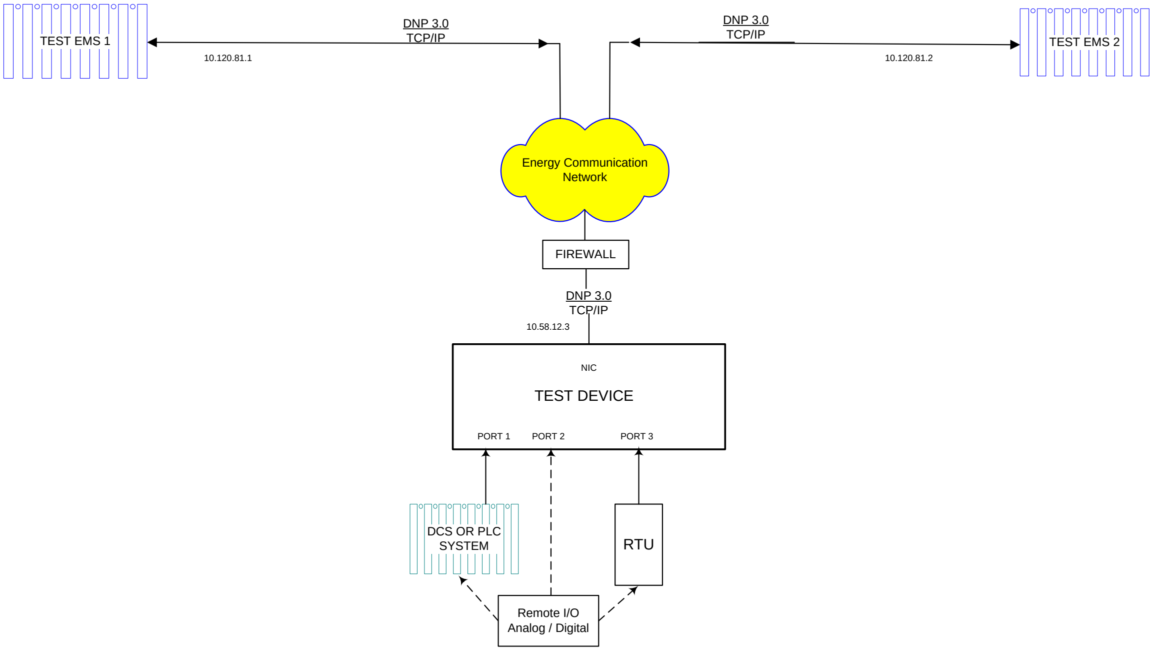
2.1 DNP / IP CONNECTION

2.1.1 Network Agreement

If an Owner chooses to test remotely, then they must have the CAISO Network Agreement submitted before connecting to the CAISO ECN and testing their device. The CAISO Network Agreement outlines the Information Security policy, standards, and guidelines for CAISO Connected Subscribers (CS) which is available at http://www.caiso.com/docs/2001/09/26/2001092611012525611.pdf. Connected Subscribers (CS) utilize the dedicated shared, high-reliability, and high bandwidth communications network established by the CAISO, called the Energy Communications Network (ECN), for CS to CAISO connectivity as well as CS to CS connectivity. All entities that access the ECN are required to sign this agreement.

2.1.2 Block Diagram

The Owner must provide a communication block diagram of the physical RIG configuration. The Block diagram should indicate all external devices, and how they are connected to the RIG. Each port must be labeled and identified, indicating the type of device connected. The diagram should be submitted no later than two weeks prior to testing. A sample block diagram is provided below



Block Diagram Example

2.1.3 IP Addresses

IP addresses will be provided by CAISO if the RIG is tested at the CAISO test center. IP addresses of the CAISO master will be provided by the CAISO.

2.1.4 DNP Master and Slave Address

The RIG must be configured to allow two DNP master addresses (provided by the CAISO) and the RIG DNP slave device set to address 1.

2.1.5 Test Database

CAISO will provide a test database to the Owner in .CSV format. The Test Database will have a minimum of 10 analog inputs, and 10 digital inputs. To be certified for AGC use, a RIG shall be capable of accepting at least 2 analog outputs. It will be configured to the sample database listed in Appendix C.

3. TEST PROCEDURE

The validation test will be conducted by CAISO and the Owner. The Owner may choose to perform validation testing remotely, if so, they must order a CAISO Energy Communication Network AT&T circuit. Owners must provide CAISO with the IP address of the circuit. Testing can also be performed at CAISO, where CAISO will provide the Owner with an IP address.

Owners are expected to have all setup procedures, and DNP certifications completed or provide DNP driver exceptions one week before the testing and validations date

CAISO engineers have the responsibility to track, analyze, and amend any test procedures as they see fit, to test the functionality and reliability of the test device.

3.1 ANALOG INPUTS (TO CAISO)

The RIG must be able to reply with 15 bit plus sign data. Analog inputs shall have the option to be configured either 0 to 32767 or -32767 to 32767. An example of a 0 to 32767 point may be voltage and -32767 to 32767 point may be MW line flow. All analog inputs are expected to respond accurately and update within 4 seconds.

3.1.1 Heartbeat

The RIG must be able to generate an internal heartbeat, or have a supplementary device generate the heartbeat for the RIG. The heartbeat must increment one count per second, from 1 to 100 in a continuous loop. CAISO will verify that the heartbeat counter generates a DNP analog event.

3.1.2 Scaling

For testing the Owner must manually enter each analog input point. Any reasonable method for inputting an analog value may be used. The CAISO will verify that the correct value and mapping is displayed at the CAISO SCADA Interface workstation in EMS. Scaling for each analog input will be tested at zero, minimum, mid scale and maximum scale for accuracy.

3.1.3 Deadband

The maximum deadband must not exceed 2 counts.

3.1.4 Summing

The RIG must be able to perform summing of two or more analog input points. Summing should include the adding and/or subtracting of any number of analog inputs.

3.1.5 Scale

Analog inputs must be able to read all values from minimum to full scale. Each data point must have the option to be configured either 0 to 32767 and or +- 32767.

3.1.6 Data Quality / Alarming

The RIG shall be able to send CAISO a data quality indication. The RIG shall provide a DNP ONLINE / OFFLINE quality flag on a per point basis. CAISO will fail and re-establish the communication to the external device.

The use of DNP ONLINE / OFFLINE quality flag is required for all analog points. When communication is lost with any external device the analog data associated with that device should indicate an OFFLINE status. The use of the DNP ONLINE / OFFLINE quality flag shall be set from within the RIG.

For example:
If there are two serial communication ports ‘A’ and ‘B’ connected to the RIG device and port ‘A’ fails, those points associated with port ‘A’ alone have their DNP data quality flags set to OFFLINE internally to the RIG. While port ‘B’ data points DNP remain set to ONLINE.

If external points are connected to a network LAN device and the LAN fails to communicate only those points associated to that LAN port have their DNP quality flags set to OFFLINE.

3.1.7 RIG Heartbeat

When communication fails between the CAISO and the RIG, CAISO will see the RIG heartbeat stop. When communication is restored between the two systems the heartbeat in the RIG shall continue to increment. The heartbeat in the RIG should continue to increment at all times whether the CAISO is connected or not.

3.1.8 Calculations

All calculations indicated on the test database will be checked for accuracy and timing by CAISO personnel.

The RIG at a minimum must be capable of performing all calculations in section 3. If the RIG lacks functionality to perform the calculations, the use supplementary devices, such a PLC to perform calculations is acceptable; however, exceptions will be noted.

3.1.9 Bumpless Transfer (Used for AGC control)

The RIG may have the option to set up a Bumpless transfer method for AGC control, to track SETPOINT when generating units are off AGC control. A calculated SETPOINT will be stored in the RIG continually updating the set point with the current MW value of the generator. When the generator transfers to CAISO AGC control the generator should not “bump” to a different MW output until a new CAISO MW set point is received at the RIG.

Section Complete **RIG Owner______________** **Date______________**

CAISO_________________ **Date______________**

Comments:____
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3.2 DIGITAL INPUTS

3.2.1 Digital Input State

CAISO will verify that the correct digital events are displayed at the SCADA interface workstation, and generating a binary input event in the DNP traffic when toggled

3.2.2 Data Quality/ Alarming

The RIG must demonstrate the ability to send CAISO a data quality indication for each point. It shall provide either a DNP ONLINE / OFFLINE quality flag on a per point basis and a digital port alarm for each communication port.

The use of DNP ONLINE / OFFLINE quality flag is required. DNP ONLINE / OFFLINE quality flags will be tested by monitoring DNP traffic between the RIG and the CAISO EMS.

The RIG shall indicate an OFFLINE data quality for all data associated with an external device if communication is lost with that device. A DNP ONLINE / OFFLINE quality flag shall be set from within the RIG.

3.2.3 Digital Communication Port Alarming

Each communication port shall have a digital point Port Alarm that indicates the port status.

The Port Alarm shall be set to TRUE when the communications between the external device(s) and the RIG has failed communicating. When this event occurs the RIG will set all associated digital and analog point quality flags to OFFLINE status, until the port is communicating correctly with the external device(s). All other digital or analog points not associated with that port will have the quality flags remain in the ONLINE status.

When a failed communication port has returned to normal status those associated digital and analog points will have the quality flags set to ONLINE.

3.2.4 10 Data Points

The RIG must be capable of providing a minimum of 10 Digital Input points to CAISO.

3.2.5 Calculations

The RIG must be able to perform basic logic functions internally. If the RIG lacks functionality to perform the calculations, the use of supplementary devices, such as a PLC to perform calculations is acceptable; however, this exception will be noted.

- **LOGIC**

  At a minimum, the RIG must be able to perform basic logic calculations, such as AND, OR, and basic compare statements or functions. The RIG shall perform a calculation that requires a digital point and an analog point logically compared to represent a Unit Connected (UCON) status. The calculation shall be a digital point (Unit Breaker) and an analog point (Unit Mega Watts) greater than 1Mega Watt (MW).

The following is an example of a typical UCON calculation.
UCON = (Digital Point = True) and (Unit MW > 1).

Calculating multiple digital together using digital operands of OR, AND logic will be tested

Summing multiple analog points together with operands of Add, Subtraction, Multiplication, and Division will also be tested.

Section Complete **RIG Owner______________** **Date______________**

CAISO_________________ **Date______________**

Comments:____

3.3 ANALOG OUTPUTS (SETPOINT) (SENT FROM CAISO EMS)

CAISO well send the test device multiple SETPOINT for AGC control, and test the time it will take the RIG to accept and retransmit the SETPOINT.

Section Complete **RIG Owner______________** **Date______________**

CAISO_________________ **Date______________**

Comments:____
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3.4 COMMUNICATION TESTING

3.4.1 Loss of Power

The RIG will have its power supply terminated to simulate power failure. After the power is restored to the RIG, the RIG will be checked for restoration of application functionality and its ability to reconnect to the CAISO EMS after power failure.

3.4.2 Restart

The RIG will be safely shut down, and restarted to check for reliability.

Section Complete **RIG Owner______________** **Date______________**

CAISO_______________________ **Date______________**

Comments:____
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3.5 CONNECTIVITY TESTING

3.5.1 Tracking

During the 5 days of testing the CAISO will track lost and reestablished connectivity occurrences. At the end of the 5 day test the CAISO will total the amount of time that connectivity was lost. This time divided by the total time for 5 days will represent a "percent availability".

3.5.2 Failure Rate

Communication between the EMS test system and the RIG must be active for 99.7 percent of the time and not have a single communication failure lasting greater then 5 minutes. The RIG will only be allowed a reasonable number of communication drops during the tracking period. CAISO engineers have the responsibility to track, analyze, and amend any test procedure as they see fit, to test the functionality and reliability of the test device.

Section Complete **RIG Owner______________** **Date______________**

CAISO_________________ **Date______________**

Comments:____

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REVISION HISTORY

Date	Version	Description
01/31/02	1.0	• Initial version taken from other Project SATs
02/25/02	1.1	Edited for formatting and removal of optional requirements
04/09/02	1.2	Editing changes with regards to required tests
08/01/02	1.3	Changes made based on the type of SSL implementation
08/22/02	1.4	Implemented sign off section for vendors regarding hardware/software changes that require re-certification.
10/27/08	2.1	Review and update to reflect shift to basic assurance requirements for RIGs.
11/4/08	2.2	Updated to remove unnecessary and infeasible test cases

Author: CUDA Technical Team

1 PURPOSE

The purpose of this document is to define the RIG Validation Test plan for the security subsystem. The CAISO test team can use these test cases to ascertain that the RIG meets the requirements as stated in the RIG Technical Requirements, ISO Information Security section.

Note: The sample tests included in this document suggest a few of many ways that this testing can be accomplished. Without developing specific test cases on an individual basis, it is impossible to provide a single test that will encompass all technologies.

2 REQUIRED TEST CASES

The test cases below require device-based certificates and keys. The CAISO Information Security group will provide the necessary certificates to be installed onto the RIG for testing.

2.1 CERTIFICATE RENEWAL

This tests the ability to request and install a new certificate on the RIG.

Prerequisites:
The complete certificate chain and a certificate for the RIG must be loaded prior to beginning this test.

Procedure:

1. Issue a certificate request from the RIG, utilizing a new key pair file, and extract the request from the device.
2. CAISO Information Security will process the CSR and return a certificate.
3. Install the certificate onto the device.
4. Delete the old certificate and corresponding key (if it is not overwritten in the process of generating a new key pair/ CSR).
5. Attempt to establish a new session with the client device.
6. Verify that a session can be established, and note the certificate serial number has changed in relation to the new certificate.
7. Verify that the appropriate serial number is recorded in the device’s audit log.
8. Provide CAISO with an instruction manual on how to perform a Certificate Renewal.

Acceptance:
Changing the keys and the certificate of a high assurance certified device is possible. After successful re-keying, the device will use its new key and certificate to communicate with other high assurance devices.

Section Complete **Vendor**______________ **Date**______________

ISO_________________ **Date**______________

2.2 NEW CA

Note that there are two tests in this procedure:

1) This is a stand-alone test that ensures if the client device has a certificate from a new issuing CA, the RIG can still communicate with it as long as it ultimately chains to the same root CA. This test involves the following steps:

   - Generate a certificate request from the RIG device.
   - CAISO Information Security will process the request, and return a new certificate
   - Ensure you are using the new issuing CA certificate located on our website under:

     http://www.caiso.com/participate/Pages/MeteringTelemetry/Default.aspx
   - Install the CyberTrust ISO Issuing Root Certificate, CyberTrust ISO Issuing Certificate and the Device Certificate into the client device in the proper location.
   - Establish a secure session with the RIG.
   - Note that this proves successful.

2) Repeat the test entitled **2.1 Certificate Renewal**, but issue the certificate from a new CA for the RIG being tested.

   - Generate a new certificate request from the RIG.
   - CAISO Information Security will process the certificate request from the new CA, and return it along with the CA certificate to the vendor.
   - Once the new certificate and CA certificates are received, the Vendor should install the certificates in the RIG.
   - Attempt to connect to the client device certified from the old CA.

Acceptance:
In the first scenario, the RIG can securely communicate with the client device whose certificate was issued by a new authorized CA. In the second scenario, the RIG can communicate with the client device after going through the certificate renewal process involving a new CA.

Note:
The CA in this configuration represents an issuing CA.

Section Complete **Vendor______________** **Date______________**

ISO_________________ **Date______________**

2.3 NEW ROOT CA

This test demonstrates that units with different root CAs can securely communicate with each other when trusted certificates are implemented in both devices.

Procedure:

1. Ensure a valid certificate, issuing and root certificate is installed on the RIG device being tested.
2. Load the root certificate of the CAISO’s system onto the RIG.
3. On CAISO’s system, ensure a valid certificate, issuing and root certificate is installed.
4. Load the root certificate of the RIG system onto CAISO’s system.
5. Attempt to establish communication between the RIG and CAISO’s system and verify that it succeeds.

Acceptance:

The RIG software can communicate with other devices that are certified by other trusted root CAs.

Section Complete Vendor______________ Date______________

ISO_________________ Date______________

2.4 ENCRYPTION VERIFICATION

This test demonstrates that the communication between the RIG being tested and CAISO’s system is encrypted.

Procedure:

1. Using valid certificates, establish a secure session between the RIG being tested and CAISO’s system.
2. Read and write data between the two units.
3. Use a tcpdump of the communication between the two RIGs to ensure that the communication is encrypted.   Use the following syntax:

   Tcpdump –X –s 2048 –i <interface number, i.e. tu1> host <IP address of RIG>

   The interface number can be obtained by running a infconfig –a on the client system

   *Also note the agreed ciphers logged in the Audit file at the time of the initial connection

Acceptance:
The snooping of the communication line must show valid encrypted data, and only approved ciphers available for negotiation.

Section Complete **Vendor______________** **Date______________**

ISO_________________ **Date______________**

2.5 SESSION KEY RENEWAL: EXPIRED OR REVOKED CERTIFICATES

This test demonstrates that sessions will not be renewed if the client's certificate is expired or revoked. This test may require some manipulation of renegotiation time on one of the units participating in the test in the best interest of time.

Note: This test case may not be possible if the EMS system disables the session.

Procedure:

1. Using a valid certificate in the client device that is scheduled to expire within 25 hours (noting the date and time of expiration), establish a session with the RIG.
2. Note the interval period and determine the interval at which renegotiation occurs (i.e. every hour, every half hour, ten minutes, etc.)
3. Read and write data between the units (heartbeat counter)
4. Maintain the session, and once renegotiation has occurred after the certificate's expiration, confirm that the session is terminated as part of the automatic session renewal process (renegotiation). (Note: Forcing renegotiation to occur once you know the certificate is expired will expedite this process.)
5. Confirm that the RIG shows the appropriate messages regarding the failure to renew the session in its audit logs.

The remaining test cases are OPTIONAL and not required:

6. Install a certificate on the client device that is contained on a certificate revocation list (CRL).
7. Install the CRL containing the revoked certificate on the RIG, and confirm that a session cannot be established after session renegotiation occurs.

Acceptance:

The RIG should terminate sessions due to an invalid certificate (either expired or revoked). The audit log must show a message regarding failure to renew the session.

Section Complete **Vendor______________** **Date______________**

ISO_________________ **Date______________**

2.6 OPTIONAL TEST CASE: CAISO CRL

Procedure:

1. Issue a CRL that does not include a revocation for the certificates of the two communicating parties.
2. Establish a session between the two parties (RIG and the CAISO client device).
3. Verify that a session is successfully established.
4. Terminate the session.
5. Issue a CRL that contains the serial number of the CAISO client device's certificate.
6. Load the CRL into the system of the RIG.
7. Establish a session between the two parties.
8. Verify that a session cannot be established.
9. Verify an audit log entry of the failed attempt.

Acceptance:
In step 3, the communicating parties successfully establish a session. In step 7 the session cannot be established and the reason for failure is noted as *revoked certificate*. An audit record shows a failed attempt to establish a session using a revoked certificate.

Section Complete **Vendor______________** **Date______________**

ISO_________________ **Date______________**

APPENDIX A

RTU OWNER VALIDATION REQUEST FORM

Contact Information

Company Name:	Request Date:
Main Contact:	Name of Test Device:
Phone number:	Type of Device:
Email address:	

Pre-test information

□	Test Remotely	□	Test at CAISO
	Device IP		
	ECN IP		

Testing Schedule

Initial Meeting Data	Test Database Due Date
Block Diagram Due Date	Testing Date

RTU Owner Comments

Questions:

Device Exceptions:

Section	List the section and Description of exception

.

[redacted]

Return to:

Energy Data Acquisition Specialists (EDAS) EDAS@caiso.com 916-608-5826

APPENDIX B

DISCREPANCY REPORT

A-1 Discrepancy Tracking Classifications

The following is a description of the Discrepancy Classification. Each discrepancy **MUST** be assigned a classification and a number.

Emergency – Class 1
Testing is stopped due to a fundamental issue that needs to be corrected before re-testing.

High Priority – Class 2
Testing can continue but with workaround(s) and/or reduced functionality. The supplier/ RTU Owner must evaluate the discrepancy and correct it before the solution can be validated. The CAISO will determine the need to re-test prior to validation.

Medium Priority – Class 3
Testing can continue but with minimal workaround(s) and/or operator intervention. The system can be validated once the issue is resolved. The CAISO will determine the need to re-test prior to validation.

DISCREPANCY REPORT Form

California Independent Systems Operator

Project No. _______________

Author ____ Variance No. ____________

Software □ Hardware □ Communications □ RTU □

Variance Class

Emergency □ High □ Medium □ Low □

Description of Problem:

Resolution:

______________________________ Corrected/Repaired By

__________________ Date

______________________________ Author's Concurrence

APPENDIX C

The testing database will be sent electronically through email or pick up from the CAISO.