QUALIFICATION TEST PROCEDURE

FOR THE

MULTI-OIL LEVEL INDICATOR

AUTOMATION OF THE OLS TEST BENCH

ALLEN AIRCRAFT PRODUCTS, INC.

REPORT #???

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Revision History

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1. Purpose of Test Procedure

The purpose of the Qualification Testing Procedure is to demonstrate how the Allen Aircraft Automated Oil Level Sensor Test Bench, aka Multi-Level Oil Indicator (MLOI) shall perform within the requirements of Technical Requirements for the Multi-Level Oil Indicator Automated OLS Test Bench, Report #250129 (ReqSpec).

* 1. Reference Documents:

ACCEPTANCE TEST PROCEDURE FOR ALLEN 8005571.05, Report# 200333

* 1. Notation
* Means Informative

1. **Means Test Case traceable to a Requirement**

LV LabVIEW

AAP Allen Aircraft Products

QUAM AAP AS9100 Quality Manual

ATP Acceptance Test Procedure

OLS Oil Level Sensor

CIP Custom Interface PCB

DUT Device Under Test

AI Analog Input

XL MS Excel

MLOI Multi-Level Oil Indicator, designation of the automated tester described herein.

Epic 1 Single DUT automated test

Epic 2 MLOI capability extended to accommodate other OLS product lines.

Epic 3+ Uses the Custom Interface PCB (CIP). Also, the MLOI capability may extended to accommodate multiple sensors DUT tested simultaneously

HW 1 Prototype phase where all items are COTS and custom configurations are achieved through breadboards or otherwise temporary connections.

HW 2 Production where custom interfaces have been designed and fit for purpose implemented, ie interface unit manufactured as a custom PCB.

1. Test Plan
   1. Requirements Cross Reference Summaries

Test cases and procedures are traceable to the requirements of the ReqSpec by being numbered with the corresponding requirement number.

Upon successful execution of this QTP, the MLOI Automated OLS Test shall be deemed suitable for ATP and production testing of the approved corresponding OLS product. The initial test shall cover EPIC 1 as defined in the ReqSpec for Elevate OLS sensor (PN 8005571.05).

* 1. Test

Verification that a requirement is met is by a thorough exercising of the item. This includes actual measurement of unit performance with calculations/analysis as required under controlled and/or recorded environment and in accordance with approved test procedures.

* 1. Analysis

The requirement is substantiated by Analysis. Analysis is the processing of accumulated results and conclusions to determine whether a requirement has been verified. The analytical results may be based on original study, or derived from lower-level examination, test, demonstration, or a formal analysis.

* 1. Inspection

Inspection is a visual examination, physical manipulation, weighing and/or measurements to verify that the hardware item conforms to the design requirements and includes review of documentation controlling configuration and requirements.

* 1. Test Results Record

The test cases shall provide space to record the results of that test case and an overall PASS/FAIL score shall be recorded. This will serve as the Test Results Record when completed and signed off by the designated stakeholders.

1. Description of Test Item

The Allen MLOI Automated OLS Test Bench is illustrated in Appendix II. The MLOI is an LabVIEW automated system intended to be a hands-free product test bench that minimizes human product evaluation by controlling the pump and data acquisition system used to precisely control the test tank oil level to a specified Test Point and measure and record the OLS response then determine if the Device Under Test response complies to the designated product ATP specification and report a PASS/FAIL status for that product at the completion of the test.

* 1. General Test Data Requirements

One MLOI Automated OLS test bench designed to comply with EPIC 1 of the ReqSpec, shall be evaluated. One or more designated and characterized OLS product will be used as DUT to evaluate the performance of the MLOI under test.

Data for each test shall be recorded on individual data sheets. Each sheet shall contain as a minimum the following:

1. Test Title: “QTP Results for MLOI Automated OLS Test Bench, EPIC 1”
2. Date of test
3. Test procedure paragraph reference
4. All pertinent environmental conditions
5. Type of fluid used and temperature (if applicable)
6. Name and signature of test operator(s)
7. Equipment, instruments, tolerances, and calibration
8. Input, output, and computed data

In addition, photographs of the test unit before and after testing, and of the test setup prior to testing must be taken and provided in the Test Report. Photographs shall be available for customer review prior to testing, if required.

Supporting data, such as a test log, a narrative history of the test and a data acquisition recording of the required test parameters (input and output), if applicable, per the test procedure, shall be made available for customer review.

* 1. Criteria for Retest

In the event of a test failure, the test shall be suspended and the cognizant <customer> representative shall be notified within 24 hours of the finding. The nature and amount of any redesign and retest shall be coordinated with and approved by <customer> prior to resumption of the test program.

1. Test Approach

Unless otherwise specified, the following general requirements shall apply to all Section 5 procedures.

* 1. Test Conditions

Unless otherwise specified, the tests shall be conducted at ambient temperatures between +70°F and +80°F and at local laboratory ambient pressure and humidity conditions up to 90% relative humidity. The ambient conditions at time of testing shall be provided on the test data sheet, as noted in Section 3.1.

* 1. Measurement Tolerances

The maximum allowable tolerance on test condition measurements shall be as follows:

1. Pressure: ± 2%
2. Temperature: ± 2°F
3. Flow: ± 2%

Other tolerances shall be as specified in the detailed procedure

* 1. Test Fluids

The MLOI test tank will use oil conforming to <test fuel spec (common name)>. The fluids for each test shall be recorded on all data sheets.

* 1. Test Setups/Equipment

Test setups are defined under the applicable sub-paragraphs of Section 5.1 herein. The Qualification Test Report shall include a complete equipment list identifying each specific instrument used for each test along with its corresponding range and accuracy.

Note: The setups illustrated are a guide. Equivalent instrument substitutes may be used as long as the measurement accuracy of the test parameter is not compromised.

* 1. Test Procedure Revisions

All test procedure revisions required during test – other than typographical errors that do not change the technical intent of the test - shall be approved in writing by the responsible AR at a minimum and included in the test report. These revisions include, but are not limited to, revisions where the initial stated objective of the procedure or method is not altered, and the means of achieving those stated goals are not altered.

* 1. Allen Aircraft Contacts:

The following list of Allen Aircraft personnel, unless otherwise noted, are responsible for the Design Testing and Quality verification of the product under test:

<name>, Project Design Engineer, email:

<name>, Test Engineer, email:

<name>, Director of Quality Assurance, email:

1. QTP Testing

Functional testing is based on an analysis of ReqSpec. Each Requirement of the ReqSpec shall be tested on a PASS/FAIL basis by the procedures described by test cases of Section 5.1, numbered corresponding to the functional Requirement being tested.

Non-functional testing includes, but is not limited to, performance testing such as Gage R&R, load testing, stress testing, usability testing, maintainability, reliability, portability will be described in Section 5.2 and may deviate from the functional requirement numbering system.

* 1. Functional Requirements Test Procedures

The following test cases describe the test procedures to be used to verify the functional requirement and the success (PASS/FAIL) criteria. The tester should mark the check box if they concur; the test case passed if all check boxes are marked then the test should circle PASS otherwise circle FAIL.

Preform the following steps to load the LabVIEW application (LV), which applies to nearly all the test cases, to conduct the test procedures that follow.

Test Initialization

1. Configure the system hardware as shown in Appendix I.
2. Verify both the LV application code and HW are version controlled.
3. Login to your favorite internet browser and navigate to <https://github.com/AllenAircraft/PWC-OLS/tree/main>. Contact AAP IT department for login information.

* On the code page, verify that the code under “Main” branch is populated and Release Notes are update.
* Under “Releases” to the right of the code block, verify the “Latest” release revision number corresponds to engineering documentation.

1. Verify the hardware drawings, including block diagram, schematic, assembly drawing and Gerber files are released.

* All hardware files are in the release folder at <Path file>

Tester \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ PASS FAIL

1. The system shall have distinct modes, Test and Maintenance.

*We have yet to validate this requirement nor determined how to implement it.*

Tester \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ PASS FAIL

1. The EPIC 1 System MAY be placed into production service with the HW1 (breadboard) hardware.
2. Inspect the Interface Board, check for loose wires, all components are reasonably secure, and strain reliefs are present on all wires that are regularly handled.

Type (circle one) Prototype PCB

* The Interface board is properly installed.

Tester \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ PASS FAIL

1. Hardware status shall be indicated as Green = Good to test; Red = Bad or Fault; Yellow = Needs attention or not automatic, i.e. in simulation mode.
2. Power on the instrument power and the motor power supplies. Verify the DataQ, Motor controller and Laser USB port are connected to the USB Hub and the USB Hub is connected to the Workstation USB port.
3. On the workstation, right-click the start bar and select Device Manager. Verify that each of the units is recognized by the Device Manager. If not see the installation procedure in Appendix 1.

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1. Open the LV app if the LV app is not running, click the run button.

* Verify all three status lights are GREEN.

1. Disconnect the USB hub from the Workstation.

* Verify all three status lights are YELLOW.

1. Turn OFF the simulated mode by pressing the SIM button

* Verify all three status lights are RED.

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Tester \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ PASS FAIL

Hardware Inputs:

1. ChA and ChB resistance measurement 0-1700Ω +/- 1%
2. ChA and ChB Current Source 14.7 mA +/- 0.05%
3. Resistance measurement calibration check shall be enforced monthly.
4. Level measurement (Process Variable PV) 2.5 to 8.5 inches +/- 0.0005”
5. Level measurement calibration check shall be enforced daily

Hardware Outputs:

1. Level control (Set Point SP) 2.5 to 8.5 inches +/- 0.002”
2. Level control shall be assessment shall be enforced annually.

HMI:

1. Shall provide a one-button means for starting the automated test.
2. Shall provide a means to manually control the Tank Level.
3. Shall display the current ChA and ChB measurement to 0.1Ω
4. Shall display the level measurement to 0.001”
5. Shall provide time-based plot of the resistance for both ChA and ChB, and tank Level.
6. Shall display instrument status.
7. Shall display the Pass/Fail status and progress of the test.
8. Shall provide a menu means to launch secondary methods.
9. Shall not require operator to enter redundant information.

Document management

1. The test plan shall be an XL workbook named to be traceable the test protocol implemented.
2. The test plan shall be version controlled in the Test repository per AAP QUAM.
3. There shall be a means to add/include the test plan path into the user prompt.

Enter the test bench configuration parameters into XL test plan.

1. The test plan shall contain the configurable test bench parameters as determined by the test bench design.
2. Tabular data should be a copy and paste operation from the reference Test Document (ATP) into the XL Test Plan document for loading as a LV parameter.

Enter DUT specific configuration parameters into XL test plan.

1. The test plan shall contain the referenced test protocol test bench parameters as determined by the test bench design.
2. It should be a copy and paste operation to include the Test bench parameters into the XL Test Plan document.
3. The Test Plan shall contain a template of each test report generated on a separate sheet in the test plan XL workbook.
4. The test plan shall be capable of containing multiple templates to accommodate recording multiple test points or variations of test protocol.

Calibration Procedure

1. There shall be a means to perform a 2-point linear calibration on each AI input.
2. There shall be a means to perform a 5-point linear calibration the Level Sensor.
3. These Bench calibrations shall be saved and linked to the Test Plan.

Troubleshooting Aids

1. There shall be a means for manually setting the tank level.
2. Each instrument (DataQ, Keyence) shall provide a health indicator.
3. There shall be a simulated mode that provides simulated instrument input and Level response to be used with debugging.
4. There shall be a test vector mode that reads and processes AEPS type test data to validate the system processing algorithm.

Use Case 3: Read Test Configuration -- Production Test User

1. LV program must launch from PC desktop ICON in application running mode.
2. Maintenance User exclusive controls and Indicators shall be hidden in Test mode.
3. All Test Parameters options must be presented in the form of a discrete choice (i.e. dropdown, pick list, radio button etc.).
4. Path to valid XL test plans shall be saved in a non-volatile means and presented as a choice by Test name configured by the Maintenance User.
5. The system shall be configured, initialized and shall report any NOT READY to test status: i.e. no functional instrument, out of calibration data, error reading test Plan etc.).

Load DUT identification information

1. Engineering shall provide an ATP Test report template that provides the reference for the required DUT Test Information.
2. There shall be a single dialog box to enter the required DUT test information.
3. The DUT information input shall be displayed and request conformation, in the form of an “are you sure?” type prompt with a YES, NO choice response. On NO reply, the user must be able to update that input which shall be retained but editable.

Load DUT into the test bench.

1. On YES reply, the system shall perform a continuity check to indicate ready to test if continuity is detected otherwise indicate not ready for test.
2. The test status indicator may provide a tool tip as to the not ready issue.

Use Case 5: Run DUT Test -- Production Test User

1. The Test protocol shall implement the ACCEPTANCE TEST PROCEDURE FOR ALLEN 8005571.05, Report# 200333. (attached)
2. The oil level shall be cycled from empty to full to empty prior to testing.
3. The oil level shall be filled from empty to the Target Test Point.
4. The Resistance shall be measured after any level variations subside to the specified criteria.
5. If the measured resistance is within the specified tolerance, the test at this level is PASS, else a FAIL Shall be logged.
6. The above three steps are repeated for each Low Fill Limit alternating between measuring ChA and ChB.
7. The oil level shall be drained from full to the Target Test Point.
8. The Resistance shall be measured after any level variations subside to the specified criteria.
9. If the measured resistance is within the specified tolerance, the test at this level is PASS, else a FAIL Shall be logged.
10. The above Three steps are repeated for each High Drain Limit, alternating between measuring ChA and ChB.
11. The DUT shall be recorded as PASS if no FAILs are recorded.
12. The test status shall graphically display Ch A & Ch B resistance in ohms and display the Level in inches.
13. All three traces shall be scaled so they are presented overlayed at a similar size. The Chart scale is a configurable test parameter.
14. A display shall indicate each Switch status as NOT TESTED (gray), PASS (green) or FAIL (red) or ERROR (yellow) for a detected procedural problem.
15. A display shall indicate the measured Target Test Point and the actual resistance measured there.
16. The User must have the means to monitor the Test bench health during testing.
17. Users must have a means to PAUSE the test.
18. Users must have a means to ABORT the test.
19. Users must have the option to RERUN the test.
20. Users must have the option to run the level in manual or automatic modes.
21. The default test mode is automatic.

Use Case 5: Generate DUT Test Report -- Production Test User

1. The Test results and the Product information for each test shall be saved in one XL workbook at the option of the operator.
2. The ATP Test Report shall be on one sheet labeled “ATP Report” as specified in the Report Template supplied by Engineering.
3. The time in 50ms intervals, ChA and ChB resistance in ohms and Level in inches shall be recorded and plotted on a sheet labeled “Raw Data.”
4. The third sheet shall be labeled “Analysis” and include the actual level at which the Switch Point occurred (LSWP refer to figure 2).
5. The sheet labeled “Analysis” shall include identification of “double actuations” (definition TBD) and slow “rise time” (definition TBD).
6. The values on the Analysis sheet may be calculated post-test execution.
   1. Non - Functional Requirements Test Procedures

Level Calibration Repeatability & Accuracy

Resistance Calibration Repeatability & Accuracy

Measurement Gage R & R

Drift

1. Hardware Installation
2. Instrument Initialization
3. LabVIEW Application Installation

The LabVIEW application is run in a LabVIEW Runtime environment that must be loaded on the target workstation. And each of the instrument driver must be loaded per Appendix II. The LabVIEW app is version controlled in GitHub Allen Aircraft account in the internet cloud and should be downloaded from there.

1. Contact AAP IT department for GitHub login credentials. Have the IT department load the LabVIEW Runtime on the target workstation.
2. Open an internet browser and navigate to <https://github.com/AllenAircraft/PWC-OLS/tree/main>. .
3. On the Code page, from the top left button, select the code revision to be evaluated. Note that the Main branch is always the latest release.

A screenshot of a computer

AI-generated content may be incorrect.

1. Scroll down and open the builds folder, select folder “PWC-OLS” and copy.
2. Paste the copied PWC-OLS folder to the target system. Open the new PWC-OLS folder on the target system and click on \_OLD\_Main2\_xxx.exe to run the program.

NOTE: It is convenient to make a shortcut to \_OLD\_Main2\_xxx.exe and place that shortcut on the target desktop.