LIGO

LIGO Laboratory / LIGO Scientific Collaboration

LIGO- M1100282-v2   13 Nov 2012

Acceptance Deliverables and Criteria
for Advanced LIGO

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Introduction

This document provides guidelines for the Advanced LIGO deliverables required for acceptance of a subsystem. The objective in providing this acceptance package is to permit the Observatories, greater Lab, and LSC to tune, operate, and improve the performance of the instruments as built. It will also facilitate repairs, and incremental improvements. Fabrication of additional or replacement units will be rendered possible, whether for LIGO or other installations. It will form the basis of training for a wide range of technical persons, including operators, instrument scientists, and analysts.

The primary deliverable categories of the acceptance package are

1. Requirements
2. Design
3. Assembly
4. Installation
5. Test
6. Safety
7. Guides

Subsystem acceptance events are keyed to completion of the installation and check-out for each associated vacuum chamber. While we would like all subsystems to have completed all activities by the time of the first chamber, some staging of the information is possible so long as it leads to a safe, well understood installation.

Note that Systems handles the acceptance review with two teams. One team reviews and approves test rationales, plans, procedures, and test reports (the scope of M1000211); another team handles review/approval of all other acceptance data.

1 Acceptance documentation

1. **Requirements** documentation: The design requirements document must be brought up to date, and pointers to background material, analyses, etc. added to the Requirements document. Pointers to prototyping endeavors should be included here.
   a. **Design Requirements Document (DRD)**
   b. **Supporting documents (models, analyses, …)**
2. **Design** overview and detailed design documentation: The Final Design Document must be brought up to date, and the detailed design made available via a tree structure pointing to the DCC and design vaults. Lower-level software (control laws, basic machine state and reporting) should be documented in this way, pointing to a software version control system.
3. **Materials** and Fabrication specifications: Any special materials, or treatment of materials including preparation for in-vacuum use; this may be integrated into the Design documentation.
4. **Parts** and spares inventoried: All elements of aLIGO must be recorded in the ICS or in the DCC using the S-number scheme. As-built modifications for parts or assemblies should be found here.
5. **Assembly** procedures: All assembly procedures must be in the DCC and annotated or updated for lessons learned. Storage, if used, should be described here along with procedures to maintain the equipment in good condition (e.g., purge frequency). Transportation

procedures and cautions must be noted.
6. **Installation** procedures: All installation procedures must be in the DCC and annotated or updated for lessons learned.
7. **Test** rationale, plans, and data for each unit must be documented as described in M1000211. That tree structure should be pointed to by the overall tree structure laid out in this Acceptance prescription. The top-level objective is to make clear how the measurements performed, which often will not directly measure a required performance parameter, give confidence that the subsystem will fulfill the requirements.
8. **User interface software**, and the test routines indicating proper functioning of the software, must be described in words and have code under configuration control (SVN). Watchdog and Guardian routines must also be treated in this way.
9. **Operation Manual:** A manual appropriate for operators, written in accordance with M1200366, covering setup/initialization, check-out, operating instructions, calibration, maintenance, storage/transport and troubleshooting. It must be accessible from standard user screens.
10. **Safety** documentation must be in the DCC for all phases of the subsystem development, including any needed for normal use or foreseen maintenance/repair scenarios.

2 Document Tree

The LIGO Document Control Center (DCC)[1] is the official archive for all LIGO project documentation. The hyperlinking, "related documents" feature of the DCC must be used to associate all relevant document data together in a tree; these data may be in the DCC and/or in an SVN. The root entry for this tree is a DCC entry entitled "aLIGO <subsystem name>". From this DCC entry all principal documentation for the subsystem can be reached. Note that this DCC entry is likely to not have any files directly associated with it (uploaded under this DCC number); it serves as an index, or list of hyperlinks.

The tree should take the following form

Subsystem
　Subsystem major element (e.g., Quad, HLTS, HSTS)

1. Requirements
2. Design
3. Materials
4. **Parts** inventory
5. **Assembly** procedures
6. Installation procedures
7. **Test** rationale, plans, and data for each unit
8. User interface software
9. Operation manual
10. Troubleshooting guide,
11. **Safety** documentation

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[1] See https://dcc.ligo.org/wiki/index.php/Getting_DocDB_Help

The next level in the branched, hierarchical structure consists of DCC entries for the major subsystem assembly types for the subsystem. As an example for the Seismic Isolation (SEI) subsystem, the major assembly types are HAM-ISI, BSC-ISI, HAM-HEPI and BSC-HEPI. For the Suspension (SUS) subsystem, the major assembly types would be each suspension type (ETM/ITM Quad suspension, BS/FM triple suspension, HLTS and HSTS). This DCC entry is also likely to not have any files directly associated with it (uploaded under this DCC number); it serves as an index, or list of hyperlinks.

Documents 1-11 above for each component/device, module/unit, or subassembly of a single type should be collected under separate DCC entries; clearly if multiple types are supported by one document set, that may be exploited to reduce the number of separate entries. Each DCC entry at this level is likewise usually an index or list of hyperlinks to the documentation for each component/device, module/unit, or subassembly (unless a single document suffices).

The DCC entries for the specific major subassembly elements, on a single assembly unit (instance), should have the documents filed as Adobe Acrobat (*.pdf) files. In addition the source file(s) for the report (e.g. *.doc, *.tex, etc.) should be filed as an "other file" associated with the test report. Additional files (such as the raw data, associated spreadsheet files, Matlab files, etc.) should also be files as "other files" if/as appropriate.

"Related Document" links for each major subassembly entry in the DCC should be provided for each specific serial numbered units which comprise the assembly (i.e. tests of component/device, module/unit, or subassemblies used to build the major assembly).

E1nnnnnn-X0
aLIGO, SYSTEM,
ACCEPTANCE

All aLIGO System and Subsystem acceptance documentation can be reached from this "root" DCC entry by following the links. Remains a -X0 entry with no files, just links

All subsystem #1 acceptance documentation can be reached from this "root" DCC entry by following the links. Remains a -X0 entry with no files, just links

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
ACCEPTANCE

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #2>,
ACCEPTANCE

E1nnnnnn-X0
SUBSYSTEM
TEST RESULTS

See M1000211 for the DCC test documentation tree structure. (All subsystem test results can be reached from this "root" DCC entry by following the links. Remains a -X0 entry with no files, just links)

For each major Assembly Type provide links to the acceptance documents

Each Major Assembly Type (e.g. Quad Suspension, HAM-ISI, etc.) has a top-level DCC entry for all acceptance documentation

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
ACCEPTANCE

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #2>,
<MAJOR ASSY TYPE 2>,
ACCEPTANCE

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #N>,
ACCEPTANCE

E1nnnnnn-X0
SYSTEM-LEVEL
ACCEPTANCE
DOCUMENTS

DOCUMENTS

DOCUMENTS

System level acceptance documents are organized in similar fashion

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
REQUIREMENTS

T1nnnnnn-Vn
DESIGN
REQUIREMENTS
DOCUMENT (DRD)

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #2

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #n

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
INSTALLATION

E1nnnnnn-v#
INSTALLATION
SPECIFICATION
DOCUMENT #1

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #2

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #n

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
FINAL DESIGN

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #2

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #n

D1nnnnnn-v#
TOP ASSEMBLY
DRAWING (as-built)

Dnnnnnnn-v#
Subassembly or Part
Drawing (as-built)

Dnnnnnnn-v#
Subassembly or Part
Drawing (as-built)

Dnnnnnnn-v#
Subassembly or Part
Drawing (as-built)

E1nnnnnn-v#
SPECIFICATION
DOCUMENT #1

E1nnnnnn-v#
SPECIFICATION
DOCUMENT #2

E1nnnnnn-v#
SPECIFICATION
DOCUMENT #N

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
SAFETY

E1nnnnnn-v#
ASSEMBLY
HAZARD ANALYSIS

E1nnnnnn-v#
OPERATIONAL
HAZARD ANALYSIS

E1nnnnnn-v#
INSTALLATION
HAZARD ANALYSIS

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

DOCUMENT #2

1nnnnnn-v#
NG

DOCUMENT #n

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
GUIDES

E1nnnnnn-v#
USER'S MANUAL

E1nnnnnn-v#
STANDARD
OPERATING
PROCEDURE (SOP)

E1nnnnnn-v#
TROUBLESHOOTING
GUIDE

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

DOCUMENT #2

1nnnnnn-v#
NG

DOCUMENT #n

E1nnnnnn-X0
aLIGO,
<SUBSYSTEM #1>,
<MAJOR ASSY TYPE 1>,
ASSEMBLY

E1nnnnnn-v#
ASSEMBLY
SPECIFICATION

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #1

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #2

<E,T,G,…>1nnnnnn-v#
SUPPORTING
DOCUMENT #n