Westinghouse Non-Proprietary Class 3

ALS V&V Plan

6002-00003-NP
Rev. 8

January 2013

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WESTINGHOUSE NON-PROPRIETARY CLASS 3

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REVISION HISTORY

RECORD OF CHANGES

a.c.e

REVISION HISTORY (cont.)

RECORD OF CHANGES (cont.)

DOCUMENT TRACEABILITY & COMPLIANCE

Created to Support the Following Document(s)	Document Number	Revision
N/A		

OPEN ITEMS

Item	Description	Status
None		

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ACRONYMS AND TRADEMARKS

Acronyms used in the document are defined in 6002-00040 - ALS Terms and Abbreviations, or included below to ensure unambiguous understanding of their use within this document.

Acronym **Definition**

a,c,e

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ACRONYMS AND TRADEMARKS (cont.)

All other product and corporate names used in this document may be trademarks or registered trademarks of other companies, and are used only for explanation and to the owners' benefit, without intent to infringe.

GLOSSARY OF TERMS

Standard terms used in the document are defined in 6002-00040 - ALS Terms and Abbreviations, or included below to ensure unambiguous understanding of their use within this document.

Term	Definition

a,c,e

REFERENCES

a,c,e

1.

REFERENCES (cont.)

a.c.e

REFERENCES (cont.)

a, c, e

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SECTION 1
PURPOSE

1.1 PURPOSE

As defined in the ALS (Advanced Logic System) Management Plan (reference 8), this document defines the techniques, procedures, activities, and methodologies used to provide Independent Verification and Validation (IV&V) for the ALS platform development project, as well as guidelines for subsequent ALS-based application projects [

]^{a,c,e}

The ultimate goal of the IV&V Plan is to ensure that the ALS platform boards perform their intended functions exhibiting a quality commensurate with the importance of the safety systems that will incorporate these components.

- -

A further purpose of this document is to provide guidelines for IV&V of ALS-based systems. Content falling below a dotted line in a section or subsection represents application-specific guidance.

(Last Page of Section 1)

SECTION 2
SCOPE

The ALS VV Plan describes Independent Verification & Validation efforts performed by the Independent V&V Team as they relate to the ALS platform FPGAs and boards. This includes IV&V through the applicable stages of development as defined in the ALS Management Plan, reference 8.

The Life Cycle of the ALS boards consists of two very distinct phases. In the first phase, designated platform development, [ ]^{a,c,e} Platform development is followed by a second phase which consists of multiple application development projects. Consequently, the Life Cycle of ALS boards spans multiple projects.

The platform development process of the ALS Life Cycle Model is described in the ALS Management Plan, reference 8. It is a typical waterfall model, [ ]^{a,c,e}

The following subsections outline the different development and verification flows which are associated with ALS boards.

2.1 DEVELOPMENT OF NEW GENERIC ALS BOARDS

This is where new ALS boards are specified, designed and tested. [ ]^{a,c,e} The objective of this flow is to end up with a complete design package including design data, assembly procedures, test procedures and other documents required for releasing an ALS design and later manufacturing an ALS board. [ ]^{a,c,e}

- -

2.2 DEVELOPMENT OF AN ALS-BASED APPLICATION

Development of an ALS-based application is initiated when a customer requests the development and manufacturing of a system to perform an application-specific task. A solution is designed based on ALS boards. ALS boards are configured to meet the customer-specific requirements and will be tested against those requirements as a part of system testing.

The method of providing IV&V on such application-specific systems is determined on a project by project basis. If supporting application-specific IV&V planning documents are necessary for the project, they will be identified in the application-specific project's Management Plan. In this case, a project-specific IV&V plan will have to include an analysis of the applicability of IV&V tasks and

activities required by IEEE Std. 1012-1998, and the results should be reflected in a table similar to Table 2-1 in this section.

Table 2-1. [ ][a,c,e]

a, c, e

a, c, e

a, c, e

a, c, e

[ ]a,c,e

SECTION 3
IV&V OVERVIEW

3.1 ORGANIZATION

The overall organizational structure of the ALS project, and the relationship of the Independent V&V team to the ALS development organization is shown in 6002-00000 - ALS Management Plan, reference 8. Figure 3-1 reproduces the relevant part of the organization chart, highlighting the organizational relationships. The responsibility and authority to resolve issues raised by IV&V rests with the ALS Project Manager. Approval of the IV&V products belongs to the IV&V Manager.

[

a,c,e

Figure 3-1. [ ]a,c,e

[

]a,c,e

]a,c,e

The IV&V organization fulfills the role of "Classical IV&V" as defined by IEEE Std. 1012-1998, Annex C, which requires strict technical, managerial and financial independence. This is further discussed in the next three subsections.

Regulatory Guide 1.168, reference 7, Clause 3, requires that verification personnel be composed of individuals other than those who performed the original design and that the responsibility for the adequacy of the V&V lies with the organization responsible for the V&V. The person accountable for V&V must also be independent of the person accountable for the design. This independence must be

sufficient to ensure that the V&V process is not compromised by schedule and resource demands placed on the design process. See Resource Responsibility Summary below for further discussion of compliance with independence criteria.

3.1.1 [ ]a,c,e

[a,c,e]

3.1.2 [ ]a,c,e

[a,c,e]

3.1.3 [ ]a,c,e

[a,c,e]

3.2 SCHEDULE

The master schedule for the ALS platform is identified in the ALS Management Plan, reference 8. The master schedule identifies all project milestones, including V&V milestones. IV&V activities are itemized in the overall project schedule to enable accurate tracking by the Project Manager. IV&V inputs are design outputs and are linked accordingly. In order to maintain schedule independence, IV&V determines its activities, the order in which they are executed, and the duration for each, providing this information as schedule input to the Project Manager. In addition, the IV&V team provides status updates to the Project Manager to facilitate tracking.

For an ALS-based system, the absolute milestone dates are agreed upon by the project and will be listed in the appropriate project Management Plan or other document. IV&V maintains schedule independence.

3.3 SOFTWARE INTEGRITY LEVEL

Per Regulatory Guide 1.168, reference 7, Clause 1, "Critical Software," all FPGA logic produced in this project is assigned integrity level 4, as defined in IEEE Std. 1012-1998, reference 1.

Applications of the ALS platform may assign a different integrity level for the scope of work of the individual project and define the appropriate subset of tasks and activities commensurate with that integrity level in the Management Plan or VV Plan for that application.

3.4 RESOURCE AND RESPONSIBILITY SUMMARY

This section identifies the resources required for carrying out the IV&V tasks, and the roles and responsibilities of the IV&V team and the design team resources that have a direct interface to the IV&V activity.

3.4.1 IV&V Resources

The organization of the V&V team is illustrated in Figure 3-1.

Staffing of the IV&V team is done by the IV&V Manager, who may augment the IV&V Team with resources from outside of the IV&V direct report organization if a lack of expertise or manpower exists within the IV&V Team. The IV&V Manager utilizes the Westinghouse Resource Allocation process, reference 39, to request and secure resources, who then matrix report to, and receive performance feedback from him/her for the duration of the engagement.

Facilities. Although most resources will be located at a Westinghouse facility, IV&V work can be performed at any location using a Westinghouse approved computer and the appropriate security access.

Tools are discussed in section 3.6.

Financial independence is discussed in section 3.1.3. Other aspects of project finances are beyond the scope of this plan.

Procedural requirements affecting IV&V include:

- **Security** aspects are discussed in document 6002-00006 - ALS Security Plan, reference 12.
- **Access rights**: IV&V engineers are granted access to the D002 CVS repositories on both the IDI and WEC networks as well as the Release Database which houses released configuration items.
- **Documentation control**: the project follows documentation control procedures specified in CSI document 9000-00600 - Document Control, reference 34.

3.4.2 Design Team Responsibilities

- The Design Team is responsible for the technical aspects of the design, requirements and specifications. [
  ]^{a,c,e}

[

a,c,e

]

3.4.3 ALS Project Manager Responsibilities

- The Project Manager is responsible for the general management of engineering and manufacturing efforts associated with ALS projects and is the primary point of contact to the IV&V team. The Project Manager operates under CS Innovations' Quality Assurance Program.

3.4.4 IV&V Team Responsibilities

The IV&V Team is responsible for implementing the ALS VV Plan and associated test plans and for performing IV&V in applicable stages of the ALS life cycle [

]^{a,c,e}

a,c,e

- [ ]^{a,c,e} IV&V Team may be responsible for subsystem and/or system integration testing of ALS-based systems, depending on criticality level. A project specific Test Plan will detail these activities.

3.5 IV&V TECHNIQUES AND METHODS

This section provides the general techniques and methodologies followed when performing verification and validation tasks. A single technique or a combination of techniques is used to perform a verification/validation task. These techniques are elaborated in the following sections.

3.5.1 Reviews

Reviews are conducted to determine whether established requirements, design concepts, and specifications have been met. Review findings are documented as stated in Section 5. Examples of planned reviews include, but are not limited to:

a,c,e

3.5.2 Testing

Testing is done at various levels to ensure that the product being tested satisfies its requirements as stated in the corresponding requirements documents. IV&V has the final responsibility for determining if sufficient testing has been performed on the product.

a,c,e

3.5.3 Traceability Analysis

A requirements traceability analysis (RTA) is performed utilizing the RTMs [ ]^{a,c,e} The requirements documented in the RTMs provide a method to cross-reference each specific requirement against documents, including test documents, and other development process products that satisfy the specific requirements. Traceability analysis ensures that lower level requirements and design features are derived from higher level requirements and that higher level requirements are allocated to lower level requirements. The RTM assists in assessing the completeness of the propagation of requirements through the lifecycle stages. The RTM identifies the documents being evaluated and their revisions. [

]^{a,c,e}

3.5.4 Checklists

Checklists are used to assist in both the design and verification and validation of a product. The items in a checklist provide a basic set of considerations that the reviewer must evaluate in the review. Refer to Appendix A for an example IV&V checklist being applied to this project. The IV&V checklists are living documents and are updated to include specific problem areas and incorporate lessons learned over time.

3.5.5 Inspection/Analysis

Inspections and Analyses consist of examining the product being verified. It is a formally documented evaluation or calculation to confirm some aspect of the design. The analysis includes an evaluation of completeness and correctness.

[

]^{a,c,e}

3.5.6 IV&V Regression (Change) Analysis

After a validation task has been completed and a change is made to the design or documentation, the change is reviewed to assess the impact on the completed task. The analysis examines the effects of modifications from the necessary starting point in the design process and considers the appropriate baseline. Impacted items are identified, followed by the necessary regression IV&V.

[

]^{a,c,e}

3.6 IV&V TOOLS

[

]a,c,e Design Tools are outside of the scope of the discussion of this document, but are listed for comparison. For more information on tools, see reference 20, ALS Design Tools.

- -

For ALS-based applications, testing will include Subsystem and/or System level testing and will be described further in project specific test planning documents.

a,c,e

Figure 3-2. [ ]a,c,e

3.6.1 [ ]a,c,e

[ ]a,c,e

3.6.2 [ ]a,c,e

[ ]a,c,e

3.6.2.1 [ ]a,c,e

[ ]a,c,e

3.6.2.2 [ ]a,c,e

[ ]a,c,e

3.6.2.3 [ ]a,c,e

[ ]a,c,e

[ ]a,c,e

3.6.3 [ ]a,c,e

[ ]a,c,

3.6.3.1 [ ]a,c,e

[ ]a,c,e

3.6.3.2 [ ]a,c,e

[ ]a,c,e

3.6.3.3 [ ]a,c,e

[ ]a,c,e

[ ]a,c,e

3.6.4 [ ]a,c,e

[ ]a,c,e

3.6.4.1 [ ]a,c,e

[ ]a,c,e

3.6.4.2 [ ]a,c,e

[ ]a,c,e

3.6.4.3 [ ]a,c,e

[ ]a,c,e

[ ]a,c,e

3.6.5 [ ]a,c,e

[ ]a,c,e

3.6.5.1 [ ]a,c,e

[ ]a,c,e

3.6.5.2 [ ][a,c,e]

[ ]a,c,e

3.6.5.3 [ ][a,c,e]

[ ]a,c,e

(Last Page of Section 3)

SECTION 4
IV&V PROCESSES

IV&V activities and tasks performed on an ALS project are organized by lifecycle stages and are described in terms of the platform development process and the project-specific system development process. The lifecycle stages are defined in the Project Creation Procedure, reference 31, and further discussed in the ALS Management Plan, reference 8, where applicability to this project is clarified.

Most of the activities are iterative in nature and will be repeated several times before the project is completed. IV&V reviews versions of the input products which are available under configuration management by doing a complete review or by reviewing changes from a previously reviewed version. Summary Reports are updated with the activities performed and the results of those activities.

As indicated in section 2, Table 2-1, ALS platform V&V activities end just prior to Installation and Checkout V&V activities, which are part of specific ALS-based application projects.

4.1 [ ]^A,C,E

4.1.1 [ ]^a,c,e

[a,c,e

---

a,c,e]

[a,c,e

a,c,e]

4.1.2 [ ]^a,c,e

[a,c,e

a,c,e]

Future individual ALS-based applications must perform their own hazard analysis based on the specifics of the application.

4.2 CONTINUOUS ACTIVITIES

4.2.1 Management of IV&V

Management of the IV&V process is necessary in all phases of the project life cycle. The applicable tasks are as follows.

(1) IV&V Plan Generation – The development, implementation, and maintenance of the IV&V Plan is the responsibility of the IV&V team. The initial IV&V Plan is issued in the Planning Stage. Each revision of the IV&V Plan is reviewed and approved by the IV&V management prior to issue.

(2) Baseline Change Assessment – When a change to a configuration item occurs due to revision, modification, corrective action, rework, or other iteration of the design process, it is necessary for the IV&V activities to be reiterated. A regression analysis is performed to determine which IV&V activities must be reiterated to assure that the design change in question has not caused adverse or unexpected effects, either in the behavior of the changed component, or in that of the other components or systems for which their integrated performance was previously validated.

(3) Management Review of V&V – Periodic reviews of the ALS V&V effort are conducted in the area of technical accomplishments, resource utilization, future planning, and risk assessment. The Management of V&V consolidates the V&V results to establish supporting evidence whether to proceed to the next phase and communicates this information to the Project Manager.

(4) Review Support – Support of project management reviews occurs throughout the project. Identification of key milestones in the IV&V plan and scheduling of the IV&V tasks to meet milestones will routinely occur. IV&V may study the review materials from technical Design Reviews, but V&V does not participate formally in these Design Reviews.

4.2.2 Risk Analysis

IV&V communicates project risks to the Project Manager via regularly scheduled meetings, e-mails and direct communications. In addition, project risks are a function of the anomalies reported, which are to be closely monitored by the project team. Because risk analysis is an ongoing activity throughout the life of the project, it will not be explicitly called out in the lifecycle activities below.

- -

Future individual ALS-based applications must perform their own risk analysis based on the specifics of the application.

4.3 PLANNING STAGE ACTIVITIES

The Planning stage includes Concept, Planning and Requirement Phases as discussed in the ALS Management Plan, reference 8.

4.3.1 Concept Phase Tasks

[a,c,e]

4.3.2 Planning Phase Tasks

4.3.2.1 Scoping the V&V Effort

This V&V task consists of the generation of this document, the V&V Plan, which is addressed in subsection 4.2.1 (1) above.

4.3.2.2 Review of Planning Documents

The ALS Management Plan, reference 8, identifies the following top-level planning documents to be reviewed by V&V.

ALS Management Plan, [

]a,c,e

Software Development Plan: The FPGA Development Procedure, reference 32, corresponds to the Software Development [ ]a,c,e This document is reviewed by IV&V as part of required QA training. It is also used to provide the IV&V engineer with an understanding of the design process outputs. [

]a,c,e

Software Quality Assurance Plan: This document (reference 9) is reviewed by IV&V to ensure functions of the QA Organization are defined and the techniques, procedures, and methodologies are identified to assure quality of the software.

Software Configuration Management Plan: IV&V reviews the ALS CM Plan, reference 10. The primary purpose of the review is to assess the adequacy of the CM provisions in place to control

configuration items under version control and overall CM baselines. [

]a,c,e

Software Maintenance Plan: [

]a,c,e

Software Safety Plan: [

]a,c,e

Software Integration Plan: [

]a,c,e

Software Installation Plan: [

]a,c,e

Software Operations Plan: [

]a,c,e

Software Training Plan: [

]a,c,e

4.3.3 Requirements Phase Tasks

4.3.3.1 Requirement Reviews

a,c,e

a,c,e

4.3.3.2 Requirements Traceability

Initiate requirements traceability by verifying that all platform and board requirements reviewed in section 4.3.3.1 above are [

]a,c,e

4.3.3.3 Integration IV&V Test Plan Generation and Verification

The Integration level Test Plan, otherwise referred to as the Test Plan, is prepared by qualified members of the IV&V Team and is released as 6002-00005 - ALS Test Plan, reference 11. [

]a,c,e

[

]a,c,e

4.3.3.4 Configuration Management Assessment

Configuration Management is reviewed to verify that the process is complete and adequate. [

]a,c,e

4.4 DEVELOPMENT STAGE ACTIVITIES

[a,c,e

4.4.1 Design Phase Tasks

4.4.1.1 Design Documentation Evaluation

[a,c,e

The following design specifications address primarily hardware design; they are reviewed for interface requirements and design:

[a,c,e

4.4.1.2 [ ]a,c,e

[ ]a,c,e

4.4.1.3 [ ]a,c,e

[ ]a,c,e

4.4.1.4 [ ]a,c,e

[ ]a,c,e

For ALS-based applications, the IV&V team is responsible for verifying the application specific functionality in the FPGAs. [

]a,c,e

4.4.1.5 Interface Analysis

Interfaces are analyzed as a part of test development, at which time the hardware and protocol interfaces are examined and tested. Proprietary interface protocols are reviewed for completeness, correctness and consistency. [

]a,c,e

4.4.1.6 Traceability Analysis

Requirements Traceability Analysis (RTA) is done continuously throughout the Platform development stage. IV&V reviews the Requirement Traceability Matrix (RTM) to assure that requirements are met by design, and that the matrix is accurate and complete.

[

]a,c,e

- -

The customer requirements are translated into requirements tracked via a project-specific RTM, which is reviewed by IV&V to verify that ALS System specifications meet the customer requirements.

4.4.1.7 Component IV&V Test Plan Generation and Verification

As a parallel effort to the FPGA simulation performed by the design team, [

]a,c,e

The component level Test Plan, otherwise referred to as the FPGA VV Test Plan is prepared by qualified members of the IV&V Team [

]a,c,e

4.4.1.8 IV&V Test Design Generation and Verification

Test design is documented as follows:

[ ]a,c,e

4.4.2 Implementation Phase Tasks

4.4.2.1 [ ]a,c,e

[ ]a,c,e

4.4.2.2 Traceability Analysis

IV&V reviews the Requirement Traceability Matrix (RTM) to assure that all FPGA designs meet higher level requirements and design specifications, and that the matrix is accurate and complete.

IEEE Std. 1012-1998, reference 1, defines the traceability analysis task at this point in the lifecycle as follows: "Trace the source code components to corresponding design specification(s), and design specification(s) to source code components. Analyze identified relationships for correctness, consistency, and completeness."

[a,c,e]

4.4.2.3 IV&V Test Case Generation and Verification

IV&V test case generation is found in the following documents:

[a,c,e]

4.4.2.4 IV&V Test Procedure Generation and Verification

[a,c,e]

4.4.2.5 [ ]a,c,e

[a,c,e]

4.4.3 Test Phase Tasks

4.4.3.1 [ ]a,c,e

[a,c,e]

4.4.3.2 Traceability Analysis

This task continues the traceability analysis from previous phases.

[a,c,e]

[a,c,e]

4.5 MANUFACTURING STAGE

In this stage, the hardware is assembled in the factory and tested. Post-manufacturing acceptance testing at board level is identified in 6002-00005 - ALS Test Plan, reference 11.

4.6 SYSTEM TEST STAGE

System Integration Testing. [

]a,c,e

4.7 INSTALLATION STAGE

Installation activities are determined on a project by project basis. The extent of involvement with the customer is defined in project-specific plans.

(Last Page of Section 4)

SECTION 5
IV&V REPORTING

IV&V activities are documented in a series of IV&V Summary Reports. [

]a,c,e The IV&V Reports are used to document the ongoing efforts taking place on the product and describe both positive and negative results. [

]a,c,e

5.1 IV&V SUMMARY REPORTS

The VV Summary Reports summarize the results of the IV&V tasks performed in support of each project lifecycle phase. The report includes an embedded VV Activity Summary Report for each life cycle phase within the scope of the project and identifies the tasks that were completed. [

]a,c,e

a,c,e

Each ALS system is documented in a separate VV Summary Report.

5.2 ANOMALIES

An anomaly report and/or ticket is created for each anomaly found by the IV&V efforts. [

]a,c,e

SECTION 6
IV&V ADMINISTRATION

IV&V Activities are recorded and archived to allow for independent checking.

a,c,e

(Last Page of Section 6)

APPENDIX A
SAMPLE OF V&V REVIEW CHECKLIST

a,c,e

(Last Page of Appendix A)

APPENDIX B

[ ]A,C,E

a,c,e

Figure B-1. [ ]a,c,e

[ ]a,c,e

Table B-1. [ ]a,c,e

a,c,e

[

]a,c,e

Table B-2. [ ]a,c,e

a,c,e

a.c.e

(Last Page of Appendix B)