DIRECTOR, OPERATIONAL TEST AND EVALUATION STANDARD OPERATING PROCEDURE

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Title: Procedure for Assessment of Reliability Programs by DOT&E Action Officers

Purpose: To document the methodology and work flow for the assessment of reliability programs by Action Officers for programs under DOT&E oversight.

References:

(a) DOT&E Memorandum of April 2, 2009, Subject: Statement of Priorities

(b) GEIA-STD-0009, *Reliability Program Standard for Systems Design, Development, and Manufacturing*; Information Technology Association of America (ITAA); Arlington, VA; published 2008; http://www.itaa.org/

(c) *DoD Guide for Achieving Reliability, Availability, and Maintainability*; U.S. Department of Defense (OUSD(AT&L)DSS); published 2005; atl-ed@osd.mil

(d) DoDI 5000.02, *Operation of the Defense Acquisition System*; U.S. Department of Defense; published 2008, http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf

(e) DOT&E/OTA Memo on Design of Experiments https://internal.dote.osd.mil/docs/moa_doe_dote.pdf

Procedure:

I General Guidance. The Director, Operational Test and Evaluation, has established that the improvement of suitability is the number one priority (reference (a)). A key element of suitability is reliability. An action officer should:

- Report on whether that program has a reliability growth program
- Ensure that, in all cases, the TEMP incorporates reliability tests and evaluations as part of Integrated Testing during development
- Ensure that the test program in the TEMP tracks reliability growth during development
- Evaluate, or report the programs evaluation of, the reliability growth potential and expected reliability to be demonstrated during IOT&E as part of the Integrated Test process and the approved use of Design of Experiments (reference (e)).

To that end, guidance to the Department has been provided by the publication of references (b) and (c). All program managers are required by reference (d) to "formulate a viable Reliability, Availability, and Maintainability (RAM) strategy that includes a reliability growth program as an integral part of design and development." An operational evaluation of reliability is also part of the Integrated Test process, the milestone approval process, and the full rate production decision.

Action Officers will assess the reliability of all systems under DOT&E oversight and include results of the assessments in their reports.

This Standard Operating Procedure is intended to provide the essential tasks, tools, references, and guidance so that an Action Officer can effectively monitor and assess a reliability program to ensure adequate test and evaluation with respect to reliability.

Acronyms used in this Standard Operating Procedure are found in Appendix A.

II Timeline. The monitoring and assessment of program reliability measures will commence at the time DOT&E oversight is established and will continue until the conclusion of that oversight as signified by publication of the Beyond Low-rate Initial Production (BLRIP) report or Follow-on Test and Evaluation (FOT&E) report.

III Flowchart. Figure 1 is the Defense Acquisition Management System as presented in the 2008 version of DoDI 5000.02[1]. Figure 2 shows how testing fits into the acquisition process[2].

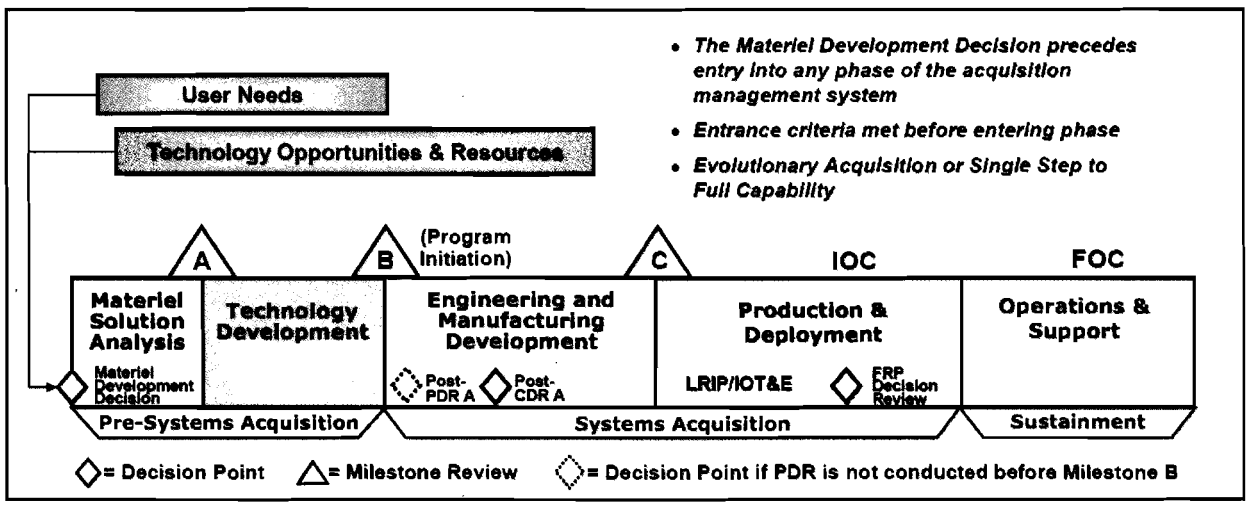

Figure 1. The Defense Acquisition Management System

[1] DoDI 5000.02, Operation of the Defense Acquisition System, U.S. Department of Defense, Washington, DC, December 8, 2008, http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf

[2] Adapted from: *Test & Evaluation Management Guide*, Defense Acquisition University Press, Ft. Belvoir, VA, January 2005, http://www.dau.mil/pubs/gdbks/test_evalu_guide.asp

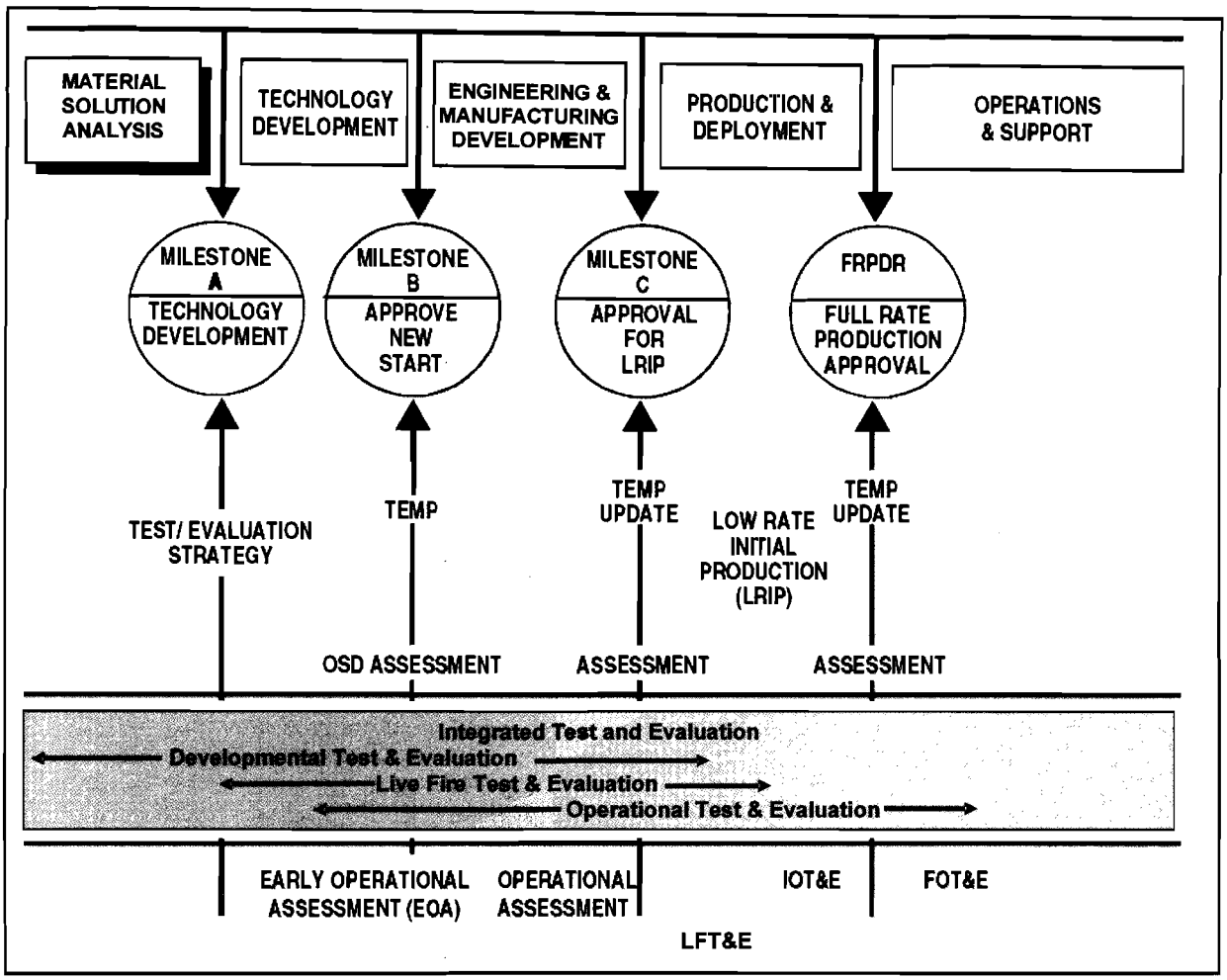

Figure 2. Testing in the Acquisition Process

With the introduction of the integrated testing concept[3] and the DOT&E participation in the JCIDS process, the DOT&E Action Officer is involved with projects under DOT&E oversight from the inception and through Developmental Testing. Accordingly. Therefore, there is opportunity to assess and influence the program from the development of the Test and Evaluation Strategy (TES) through the completion of Operational Testing. With respect to reliability, integrated testing enables the DOT&E Action Officer to require the test program to incorporate operationally representative environments and stresses as early as practical in developmental testing. Coupled with using representative operator personnel in DT, this approach will serve to identify many failure modes earlier.

[3] Ibid, Enclosure 6

IV Process Description.

1. Reliability evaluation begins at the point that DOT&E oversight begins. This may be in pre-milestone "A" activities (requirements definition, analysis of alternatives (AoA), acquisition strategy development, etc) as shown in Figure 2; or it may be at a later stage. The DOT&E action officer has responsibility to exercise leadership at the program level in the T&E WIPT. He must communicate the DOT&E/OSD expectations for implementing the reliability improvement policy. On occasion the Action Officer may have to volunteer to arrange for reliability expertise to assist the program office.

Appendix B is a checklist of items to evaluate and report on at each of the development reporting points. When oversight begins, the Action Officer must review all of the project documentation and test reports to determine the state of the reliability program. This is a hard process and, for programs begun before 2009, may often lead to disappointing assessments. These need to be documented, however, so that when the program is restructured (often for failing in reliability) the restructure can correct the deficiency. Appendix C is a specific check-list to help evaluate the plan for reliability in a program. Figure 3 shows the overall testing conducted during acquisition[4].

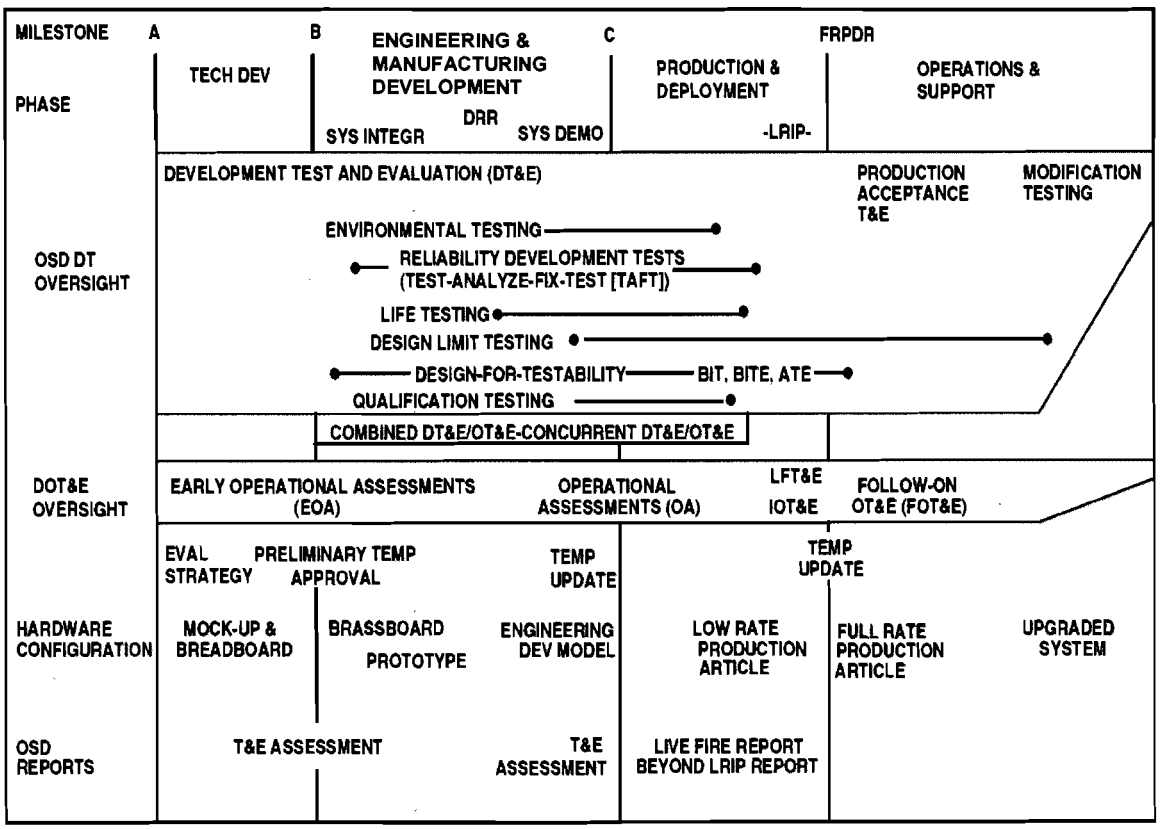

Figure 3. Testing during the acquisition process

[4] Ibid.: Chapter 6

2. At each step of the acquisition process, the Action Officer should:

- Ensure that reliability growth testing and evaluation is in the SEP and TEMP.
- Assess the planning process and the planning for the integration of reliability T&E with the systems engineering, and trade studies. Reliability of system elements (components or sub-systems) is often allocated to achieve overall system reliability goals. T&E measures the achievement of the planned reliability and confirms the validity of the reliability analyses and allocation.
- Work to ensure through DOT&E's participation in the JCIDS process that the RFPs and contracts at laboratories and contractors participating in the development implement reliability programs and that reliability T&E data is acquired from the outset. In particular, work to ensure the contractor data is available to the government and not proprietary.
- Make reliability an element of all DOT&E input to program reviews. This includes the presentation and analysis of all data acquired to date, an assessment of progress towards the design reliability criteria, and proposed actions to meet reliability goals and/or mitigate identified problems done by the program office or, if necessary, by DOT&E. The absence of data should be particularly noted.

3. For all integrated test events, critical experiments, developmental tests and operational tests, the Action Officer will ensure that

- Reliability is measured and assessed
- Test conditions for integrated developmental testing and operational testing incorporate operational realism as much as possible
- Observed performances should be compared to predicted performances
- Corrections and mitigations are analyzed to verify that they have addressed the identified deficiencies.

4. The findings and determinations with respect to reliability will be included in the suitability assessment for all operational testing reports.

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APPENDIX A
Acronyms and Abbreviations

AO	Action Officer
AoA	Analysis of Alternatives
BLRIP	Beyond Low-Rate Initial Production
CDR	Critical Design Review
DCACAS	Data Collection, Analysis and Corrective Action System
DoD	Department of Defense
DoDI	DoD Instruction
DOT&E	Director, Operational Test and Evaluation
DT	Developmental Test
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects and Criticality Analysis
FOT&E	Follow-on Operational Test and Evaluation
FRACAS	Failure Reporting, Analysis, and Corrective Action System
IPR	In-process Review
OA	Operational Assessment
OT&E	Operational Test and Evaluation
OTA	Operational Test Agency (ATEC, AFOTEC, OPTEVFOR, JITC)
PDR	Preliminary Design Review
PEO	Program Executive Office
PM	Program Manager
RMA (Or RAM)	Reliability, Maintainability and Availability
SEMP	System Engineering Management Plan
TAAF	Test, Analyze and Fix
TAFT	Test-Analyze-Fix-Test
TEMP	Test and Evaluation Master Plan
TES	Test and Evaluation Strategy

APPENDIX B
Reliability Check-list

Introduction

The objective of the check-list is to cue the Action Officer in his assessment of the reliability component of his suitability and effectiveness determinations for a program under DOT&E oversight. The checklist is divided into sections which are tied to events in the development cycle as viewed from the Action Officer's perspective. Some occurrences like In-process Reviews (IPRs) and test events may occur multiple times. Accordingly, the check list is generic and may be tailored to the specific event or development cycle by the Action Officer. Reliability concerns are suggested in Table 1. When appropriate these should be considered to track a program's progress in reliability growth.

Items to be Checked

The following list identifies the key events in system development and the reliability factors to be checked for each event. In addition to making a **YES/NO** determination, Action Officers should ensure that the response or documentation is adequate to support the ultimate determinations of suitability and effectiveness.

1. Initiation of DOT&E Oversight (Concern 1 in Table 1)
   - Does the program have reliability requirements? Are reliability criteria and metrics established in project requirements documents?
   - Have the reliability requirements been communicated to the contractor in an RFP, SOW, specification, contract, or similar vehicle?
   - Does the program have a systems engineering plan that includes efforts (modeling and simulation and/or component and subsystem testing) to evaluate and improve reliability during system design?
   - Has a Reliability Program Plan been developed (may be included in SEMP)? [Evaluation criteria are provided in Appendix C.]

2. TES & TEMP Approval (Concern 2 in Table 1)
   - Are reliability assessment activities and metrics included in TEMP for all test events? Are the reliability growth strategy and its supporting events documented in the TEMP?
     Are there an adequate number of dedicated integrated test events focused on reliability? Is the test time (miles, or rounds) adequate to grow reliability and test it?
   - Are adequate post-test periods in the test strategy to implement corrective actions?

- Does the test strategy include events to verify whether corrective actions addressed intended issues?
- Are operational and environmental stresses applied in DT as is required on policy for Integrated Test?
- Are system operators used in DT, as a means to discover induced failures early?
- Does the TEMP have evaluation criteria which are anchored to the planned reliability growth curve?
- A reliability growth program requires tracking of failure data (by failure mode) throughout the test program to support analysis of trends and changes to reliability metrics. Does the program have plans to collect and report reliability metric data as a function of test time in test events?
- Does the program management strategy include provisions for reviewing discovered problems (failure mode = problem and cause) and identifying their causes and corrective actions?
- Does the program have plans to implement a Failure Reporting, Analysis, and Corrective Action System (FRACAS or similar system) that tracks failure modes from first identification through verification of correction?

3. PDR, CDR, IPR (Concerns 3 and 4 in Table 1)
   - Is there a system reliability model?
   - Is a determination of reliability status based on DT events?
   - Does the program identify routine evidence to assure reliability growth is on track to achieve requirements?
   - Does the program identify routine evidence to assure reliability growth is on track to achieve requirements?
   - Does the program predict changes in reliability caused by implementation of corrective actions or design changes?
   - Do the predictions of reliability changes rely on use of fix effectiveness factors?
   - Is there consideration of analysis of current and projected reliability? Does the program have a process for calculating the reliability growth potential?

4. DT (Concerns 5, 6 and 7 in Table 1)
   - Does the test set-up accommodate the collection of reliability data in accordance with the test plan and the data collection plan?
   - Is reliability analysis included in the test report?

5. OT (IOT&E, FOT&E) and Operational Assessments (OAs) at Milestone B or C (Concerns 6 and 7 in Table 1)
   - Prior to OT/OA
     - Is achievement of design reliability demonstrated by test data and parametric analysis?

    - Does the test set-up accommodate the collection of reliability data in accordance with the test plan and the data collection plan?
- During OT/OA, were reliability data collected as required by the data collection plan?
- Does the assessment include whether the observed reliability conforms to the predicted reliability, and that any new failure modes observed were documented?

7. Action Officer Reports (BLRIP, EFR, OA)
    - Was the OT or IOT&E realistic with respect to stresses, operators, missions, maintenance?
    - Is there a determination of reliability performance and its contribution to System Suitability and Effectiveness? Are there mission limitations due to RAM?
    - What was the reliability compared to the requirement? What is the uncertainty in the measurement? What is the operational significance of the demonstrated RAM? (i.e., what is its effect on mission success, logistic support, spares…?) What has been the program's progress in accordance with its reliability growth plan?
    - Is the analysis and discussion of findings adequate and complete.

Table 1. Reliability Concerns

Number	1	2	3	4	5	6	7
Concern	Has reliability been considered during design?	Is the test time for RAM adequate in the TES and TEMP? Fraction Identified	Is the program going to find and fix problems? (Management Strategy)	What is the Reliability Program Effectiveness? (1)	Reliability Program Effectiveness (2) What is the prediction of reliability at IOT&E?	Growth Potential	The reliability at IOT&E. Operational Significance of demoed RAM. Rate of Occurrence of new Failure Modes.
Non-technical Description	Have potential failure modes been identified? Is there a FEMA, FMECA, or equivalent processes? How many design changes may be needed?	How much of the problem is management capable of improving, or impacting?	How much of the problem is management planning to address?	How much of the problem is management planning to address?	What is the current and/or projected MTBF / reliability of the system?	What is the highest possible increase in MTBF/Reliability the program could reach based on the current design and reliability growth management strategy?	Did the reliability meet requirement? How much of the problem remains to be uncovered?
Criterion	Is there a realistic estimate of reliability coming out of design? How much higher than the requirement is the designed-for reliability?	Is there a reliability growth curve? Is there enough time on test to reach the reliability requirement?	Fraction of initial system failure intensity to be addressed via corrective action, the effectiveness of the actions and the timing of their implementation	What is the fraction decrease in the failure mode's failure rate due to the corrective action? (Fix effectiveness)	What is the failure mode discovery rate? Expected system MTBF / reliability at test time ***t***.	The difference between the observed reliability and the theoretical upper-limit on system reliability.	Portion of system failure intensity at test time ***t*** associated with failure modes that have not yet been identified.
Importance	Provides insight as to how well the program has prepared for an effective design. Indicates that there has been effort to analyze the design for potential failure mechanisms. Identifies components that should be tested early.	Provides insight on management aggressiveness and insight on amount of failure intensity mitigated	Provides insight on management aggressiveness and portion of failure intensity that will not be mitigated. Sets the upper limit for reliability A good program will have as a goal to mitigate or fix at least 90% of the failures discovered.	Provides insight on how effective fixes have actually been. A good program will have a management's fix effectiveness goal for engineering design of >.9. During TAAF the FEF should be ~.85 (If the program has NOT used GEIA-STD-0009, use FEF of 0.9 and 0.7, respectively.)	Provides evidence that the program is tracking growth against a planned growth curve and provides evidence that the program is on track to be successful.	Indicates a "safety margin" to reach the requirement. Ensures that the growth curve has not leveled off (making growth difficult) as time of test.	Serves as a measure of programmatic risk

APPENDIX C
Checklist to help Assess Effectiveness of Reliability Programs

Purpose

This checklist was developed to aide in assessing the effectiveness of contractor reliability activities and procedures, and is provided to help the DOT&E AO to understand the scope of the effort needed for programs to achieve reliability expectations. It identifies elements that are characteristic of a structured, disciplined reliability growth effort. However, it should be tailored or adapted to the specific requirements of the program and the nature of the products being delivered. If the program does not appear to have a plan sufficient to deliver the required RAM, the AO should work with AT&L systems engineering and developmental testers to correct the situation.

1. **Does the program have a Reliability Program Plan as part of the TEMP or as a stand alone developer document?**

- Important because it:
    - Documents that developer understands the reliability requirements, has a plan to achieve the requirements that is reasonable and achievable, and tracks progress towards meeting the requirements.
    - Provides progressive assurance that the contractor is aggressively pursuing design practices and testing activities consistent with industry best practices for reliability growth.
    - Tracks and projects realistic timelines, testing, and product design activities that will produce a product that meets the reliability requirements. Realistic delays associated with incorporating corrective actions are identified and incorporated into the plan.
    - Reliability Program Plan should contain some or all of the activities described in item 2

2. **If the program does not have documented program plan, does the developer follow a structured, disciplined approach for reliability growth?**

- Important because the customer may have not required a reliability program plan, but he developer recognizes the importance and economic advantages of reliability. Approach should have some or all of the following activities depending on product complexity:

    - **System Reliability Model** that: (1) updates allocations, (2) aggregates reliability, (3) identifies single points of failure, and (4) identifies

reliability-critical items and the need for additional design or testing activities., (5) Results of closed loop data collection and failure analysis are routinely incorporated into the model.

- **Life Cycle Systems-Engineering Integration that: (1)** Develops and periodically updates assemblies, subassemblies, components and system-level operational & environmental life-cycle loads, (2) Uses estimates in reliability modeling, assessments, verifications.

- **Life-Cycle Process to Identify and Characterize Failure Modes & Mechanisms.** Some process examples are Failure Modes and Effects Analysis (FMEA); Failure Modes, Effects and Criticality Analysis (FMECA); and Fault Tree Analysis (FTA). These are presented in Section 4.5.2 of Reference (c).

- **Closed-Loop Failure-Mode Mitigation that: (1)** Monitors and tracks the implementation and effectiveness of corrective actions (2) provides access to all stakeholders. Some process examples are Failure Reporting, Analysis, and Corrective Action System (FRACAS) or a Data Collection, Analysis, and Corrective Action System (DCACAS) as discussed in Section 4.5.2 of Reference (c).

- **Reliability Assessments/Verifications** that :(1) Assess reliability requirements feasibility using the System Reliability Model in conjunction with expert judgment, (2) Make reliability projections of the system throughout the life cycle using life-cycle operational & environmental load estimates, and the customer-specified failure definition and scoring criteria, (3) Monitor and evaluate the implementation of corrective actions as well as other changes to the design or manufacture of the systems/product that may impact reliability, including commercial-off-the-shelf, non-developmental items, and government-furnished equipment, and failures due to user or maintainer errors

- **Technical Reviews** with customer/user that: (1) address identification, analysis, classification, and mitigation of failure modes, (2) assure progress towards achieving reliability requirements, (3) verify that planned Reliability Activities are implemented, and (4) compare status and outcomes of Reliability Activities.