



AEROSPACE STANDARD

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(R) Level of Repair Analysis (LORA)

RATIONALE

Estimating life cycle support costs can be problematic due to a lack of a standard analytical methodology in both government and industry. This SAE Aerospace Standard (AS) provides a standardized approach for implementing and conducting the Level of Repair Analysis (LORA) activities required by the SAE standard TA-STD-0017A to determine an effective maintenance and support system for a product. This document provides general requirements and descriptions of activities which, when performed in a logical and iterative nature, constitute the LORA process. These requirements are structured for maximum flexibility in their application.

FOREWORD

Level of Repair Analysis (LORA) is usually included in the supportability analysis work completed during the design and modification of a product throughout its life cycle. It is important to have a process that can be applied consistently in all applications. This standard is intended to assist one in determining the completeness of a LORA process by identifying and describing minimum criteria that any LORA should include. It does not attempt to define a specific LORA process nor does it provide an exhaustive set of equations to be used in a LORA model.

This standard establishes a process to implement the LORA activity identified in SAE TA-STD-0017A. The LORA process can also be applied to other similar supportability engineering processes. LORA is conducted commensurate with the level of design, operation, and support data available. The purpose of the LORA process is to determine the most effective maintenance and support system for a product through iterative evaluations of both economic and non-economic considerations. The LORA process is an analytical effort undertaken to influence decisions on the product's design, maintenance planning, cost, and integrated product support (IPS) element resources. As a consequence, the LORA process forms an integral part of the product support analysis (PSA) process by using results of, and feeding results to, various PSA activities and the logistics product data (LPD). The LORA process shall start early in the acquisition effort and then be reiterated as the product design and information about the product design becomes more refined throughout the product's life cycle to disposal.

This standard applies to all system acquisition programs, major modification programs, engineering changes, and applicable research and development projects through all phases of the product life cycle. This standard is for use by both industry and government activities performing LORA on products to which this standard applies.

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1. SCOPE

This SAE Aerospace Standard (AS) establishes general requirements and descriptions of specific activities for the performance of LORA during the life cycle of products or equipment. When these requirements and activities are performed in a logical and iterative nature, they constitute the LORA process.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP5580	Recommended Failure Modes and Effects Analysis (FMEA) Practices for Non-Automobile Applications
EIA-649C	Configuration Management Standard
EIA-836B	Configuration Management Data Exchange and Interoperability
GEIA-STD-0007C	Logistics Product Data
GEIA-STD-0009A	Reliability Program Standard for Systems Design, Development, and Manufacturing
TA-STD-0017A	Product Support Analysis

2.1.2 Associated SAE Engineering Standards

[Appendix D](#) of this document lists associated standards to the systems engineering, reliability analysis, configuration management, product data management, system safety, and product support analysis disciplines. These standards cover processes used to manage the development, production, and sustainment of systems, including products and services which will be useful to the LORA practitioner in understanding the characteristics of their system.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 U.S. Department of Defense Publications

Available from Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <https://assist.dla.mil>.

MIL-HDBK-502A	Product Support Analysis
MIL-HDBK-798	System Engineer's Design for Discard Handbook
MIL-STD-1388-2B	Logistics Support Analysis (Cancelled)
MIL-STD-1390D	Level of Repair Analysis (Cancelled)

2.3 Definitions

ACTIVITY: A unit of specific work behavior with a clear beginning and ending point. During the course of the product's life cycle, each activity may occur multiple times due to a variety of reasons, such as redesign, program schedule changes, life cycle extensions, etc. The activity should be directly observable or an otherwise measurable process, typically resulting in a product that can be evaluated for quantity, quality, or accuracy.

ADDITIVE MANUFACTURING (AM): Manufacturing or fabrication processes that involve the joining of materials to make objects from three-dimensional model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies. Examples of available additive manufacturing technologies are 3D printing, powder bed fusion, and cold spray.

AVAILABILITY: A measure of the degree to which a product is in an operable and committable state. Availability is typically expressed in terms of two components: (1) materiel availability, which is a fleet-wide measure, and (2) operational availability, which is an operational unit-level measure. Establishing an acceptable level of operational availability is an integral step in determining fleet-wide availability.

BREAKDOWN ELEMENT IDENTIFIER (BEI): A value that uniquely identifies a breakdown element or system/equipment. The value may be a generated identifier with no logical structure. The acquirer may specify additional rules and requirements for the structure of the identifier.

CONDITION BASED MAINTENANCE (CBM): A maintenance strategy based on equipment operational experience derived from analysis. CBM includes maintenance processes and capabilities derived from real-time or approximate real-time assessments obtained from embedded sensors or external tests and measurements using either portable equipment or actual inspection. The objective of CBM is to perform maintenance based on the evidence of need while ensuring safety, reliability, availability, and reduced total ownership cost.

COMPONENT: A subsystem, assembly, subassembly, or other major element of an end item.

CONSTRAINTS: Restrictions or key boundary conditions that impact overall capability, priority, and resources in system acquisition.

CONTRACTOR: The organization that provides goods or services as defined in a written agreement.

CORRECTIVE MAINTENANCE: All actions performed in order to restore a product to a specified condition after a failure has occurred.

CUSTOMER: An organization purchasing or requiring LORA activities.

DISCARD: A maintenance action in which no attempt is made to repair a failed item and that item is stored or thrown away (discarded). Before disposal, certain steps may be required such as destruction, reclamation of precious materials, or processing of hazardous materials.

ECONOMIC LORA EVALUATION: An analysis used to determine and identify the most cost effective maintenance concept for all products in the LORA candidates list.

END ITEM: A product that, when assembled or completed, will be considered ready for issue or deployment.

END USER: The organization or individual who actually uses a particular product.

ENVIRONMENT: The aggregate of all external and internal conditions (such as temperature, humidity, radiation, magnetic and electric fields, or shock vibration) either natural or manmade, or self-induced that influences the form, performance, reliability, or survival of a product.

FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS (FMECA): A quantitative reliability analysis by which each potential failure mode of a component, equipment or sub-system in a system is analyzed to determine the results or effects thereof on the overall system and to classify each potential failure mode according to its severity. FMECA leads to design improvement, mitigation of failure-caused hazards and identification of mission-critical functions.

GUIDANCE CONFERENCE: A conference used to ensure that the contractor and the customer have a firm understanding of the contractual requirements, establish funding and activity milestones, and formulate firm commitments for optional requirements in accordance with applicable data requirements. A vital aspect for any type of guidance conference is that the mutual agreements of all applicable contractual requirements are documented, dated and signed as agreed upon and accepted by both parties.

HUMAN FACTORS ENGINEERING (HFE): Is responsible for addressing the interplay of human interactions, abilities, limitations, behaviors, and processes with technology and environment.

HUMAN SYSTEMS INTEGRATION (HSI): A comprehensive management and technical approach applied to systems development and integration as part of a wider systems engineering process to ensure that human performance is optimized to increase total system performance and minimize the total system ownership cost. HSI efforts accomplish this by ensuring that the human is fully and continuously considered as part of the total system in the development and acquisition of all systems. HSI considerations comprise human factors engineering, safety and occupational health, habitability, force protection and survivability, manpower, personnel, and training. Refer to SAE6906 Best Practice Standard for Human Systems Integration for more information.

INTEGRATED PRODUCT SUPPORT (IPS) ELEMENTS: Those critical functions related to product readiness including, but not limited to, materiel management, distribution, technical data management, maintenance, training, cataloging, configuration management, engineering support, repair parts management, failure reporting and analysis, reliability growth tracking, and the logistics components (e.g., support equipment, spares) required to accomplish the functions. All of the IPS elements shall be considered during the development of the Product Support (PS) strategy. The IPS elements consist of the following: product support management; supply support; packaging, handling, storage and transportation; maintenance planning and management; design interface; sustaining engineering; technical data; IT systems continuous support; facilities and infrastructure; manpower and personnel; support equipment; and training and training support.

LEVEL OF REPAIR ANALYSIS (LORA): An analytical methodology used to assist in developing maintenance concepts, influencing design, and establishing the maintenance level at which components will be replaced, repaired, or discarded based on economic constraints, non-economic constraints, and operational readiness requirements.

LIFE CYCLE COST (LCC): Consists of research and development (R&D) costs, investment costs, operating and support (O&S) costs, and disposal costs over the entire life cycle.

LIFE CYCLE PHASE: One of a sequence of phases defining major stages in a product's life cycle.

LOGISTICS SUPPORT ANALYSIS CONTROL NUMBER (LCN): A code that represents a functional or physical hardware generation breakdown/disassembly sequence of system/equipment hardware including support equipment (SE), training equipment, and installation (connecting) hardware.

LOGISTICS PRODUCT DATA (LPD): That portion of product support analysis (PSA) documentation consisting of detailed data pertaining to the system and equipment design characteristics, including failure modes, reliability and maintainability, maintenance, supply support, human systems integration (HSI), packaging, handling, storage, and transportation (PHS&T), and environment, safety, and occupational health (ESOH) which contributes to the identification of the required Product Support resources and sustainment requirements of the products.

LORA CANDIDATES LIST: A list containing all of the selected items within the system architecture for which the LORA program is being established.

LORA INPUT DATA: LORA data elements and their corresponding values depicting the design, performance, cost, support characteristics, infrastructure, and features related to the product and its support alternatives.

LORA MODEL: A computer-based application designed to assist in conducting a LORA study. It accepts inputs, performs calculations, and provides reports toward completing an economic and non-economic LORA evaluation.

LORA PROGRAM PLAN: A description of how the LORA program will be conducted to meet the program requirements. These descriptions include a discussion of how LORA results are utilized as part of the PSA. The LORA plan may be included as a critical part of the PSA plan.

LORA REPORT: A report documenting the results of the LORA program which includes the LORA activities and evaluations performed, procedures used, and any subsequent recommendations made.

LORA PROGRAM STRATEGY: Identifies the proposed LORA activities to be performed and the organization responsible for each activity.

MAINTAINABILITY: The design characteristics that determine the ability to retain a product in, or restore a product to, a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources at each prescribed level of maintenance and repair.

MAINTENANCE CONCEPT: A brief description of maintenance considerations, constraints, and plans for operational support of the product under development.

MAINTENANCE LEVELS: The basic levels of maintenance into which all maintenance activity is divided. A “higher” level of maintenance typically implies the availability of more specialized personnel and equipment for the performance of more complex maintenance activities than “lower” maintenance levels.

MAINTENANCE PLANNING: The process conducted to evolve and establish maintenance/support concepts and requirements for the life cycle of a product.

MAINTENANCE TASK ANALYSIS (MTA): The identification of the steps, spares and materials, tools, support equipment, personnel skill levels as well as any facility issues that shall be considered for a given repair task. Also included in the MTA are elapsed times required for the performance of each task. MTAs cover both corrective and preventive maintenance tasks plus additional operational tasks (such as preparation for shipment) and, when complete, identify all physical resources required to support a product.

MANPOWER: A quantitative term referring to the number of people or amount of time required by a person or persons to perform an identified task, e.g., 20 personnel to operate and maintain a product, 100 man-hours to accomplish an inspection.

MANPOWER AND PERSONNEL: A term used to identify the amount of personnel resources and their specialized capability and experience required to operate, maintain, and support a product over its expected life cycle.

MATERIAL: Elements, constituents, or substances from which something is composed or can be made. Not to be confused with “materiel.”

MATERIEL: Equipment, apparatus, and supplies used by an organization or institution. Not to be confused with “material.”

NON-ECONOMIC LORA EVALUATION: An analysis addressing preempting considerations which override cost factors, or existing LORA decisions on similar products, to determine the maintenance level(s) where repair or discard can be performed. This evaluation is performed without consideration of costs. However, any recommendations or conclusions based upon this evaluation should also include an economic LORA evaluation which will assign economic value to the non-economic decisions.

OPERATING AND SUPPORT (O&S) COSTS: The cost of operation, maintenance, manpower, infrastructure and follow-on product support of the product and its associated support systems.

OPERATIONAL CONCEPT: A general description of the way in which an entity is used or operates.

OPERATIONAL ENVIRONMENT: An environment that addresses all operational requirements and specifications required of the final product, to include its platform and packaging. May include factors such as physical environment, operational or nonoperating use, operational scenarios, electromagnetic interference (EMI)/electromagnetic compatibility (EMC), electrostatic discharge (ESD), compatibility issues, interoperability issues, and geographical location.

OVERHAUL: The disassembly of a product as required to permit inspection of every component part. Component parts that, upon inspection, will not meet requirements as set forth in applicable specifications are restored or replaced by new parts so that after reassembly and test the product will meet the requirements set forth in the applicable specifications.

PART: An item which cannot normally be disassembled or repaired, or is of such a design that disassembly or repair is impractical (e.g., bracket, gear, resistor, toggle switch).

PERSONNEL: Individuals, identified by specialty or classification; skill; skill level; and grade, rate, or position, required to satisfy the manpower demand associated with a product.

POLICY: Standards, handbooks, bulletins, specifications, regulations, and other documents written by accepted authorities which prevent/restrict and provide guidance as to the maintenance level(s) at which repair/discard actions can be performed.

PREVENTIVE MAINTENANCE: All actions performed in an attempt to retain a product in specified condition by providing systematic inspection, detection, and prevention of incipient failures.

PRODUCT: The result of research, development, test, and evaluation (RDT&E) in terms of hardware or software being produced or manufactured; also known as an end item. A product is the item stipulated in a contract to be delivered under the contract (i.e., service, study, or hardware).

PRODUCT READINESS: A measure or measures of the ability of a product to undertake and support its designed function over its lifetime operational environment.

PRODUCT SUPPORT (PS): A unified and iterative approach to the management and technical activities needed to influence operational and materiel requirements and design specifications, define the support requirements best related to product design and to each other, develop and acquire the required support, provide required operational support at lowest cost of ownership, improve readiness and life cycle cost (LCC) in the product and support systems during the operational life cycle, and repeatedly examine support requirements throughout the service life of the product.

PRODUCT SUPPORT ANALYSIS (PSA): The selective application of scientific, engineering and logistics assessment activities undertaken throughout the life cycle, as part of the systems engineering design and sustainment process.

PROVISIONING: The process of determining and acquiring the range and quantity (also called “depth”) of spares and repair parts, and support and test equipment required to operate and maintain a product or materiel for an initial period of service.

RELIABILITY: The ability/probability of failure free performance of the system/product, over the expected service use profile and environmental conditions over a given period of time. Reliability is expressed in terms of operational reliability and non-operating reliability.

RELIABILITY CRITICAL ITEM: Items that have a relatively high impact in determining product reliability. Critical items can include hardware and software.

REPAIR PARTS: Individual non-repairable parts or non-repairable subassemblies required for the repair of spares or major products.

RESEARCH AND DEVELOPMENT (R&D): Includes all scientific study and experimentation directed toward increasing knowledge and understanding in the fields of the physical, engineering, environmental, and life sciences.

RESEARCH and DEVELOPMENT (R&D) COSTS: Those costs primarily associated with R&D efforts including the development of a new or improved capability to the point where it is appropriate for operational use.

RESEARCH, DEVELOPMENT, TEST AND EVALUATION (RDT&E): Activities for the development of a new product or to expand the performance of established products.

SENSITIVITY ANALYSIS: An analysis concerned with determining the amount by which model parameter estimates can be in error before the generated decision alternative will no longer be superior to others.

SPARES: Items kept in case another item of the same type is lost, broken, or worn out.

SUPPORT CONCEPT: A complete system-level description of a support system that meets the functional support requirements and is in harmony with the design, maintenance, and operational concepts.

SUPPORT EQUIPMENT: All equipment and tools (mobile or fixed), not integral to a product, but required to support its operation and/or maintenance.

SUPPORT ITEMS: Items subordinate to, or associated with, a product (i.e., spares, repair parts, tools, support and test equipment, and sundry materials) and required to operate, service, repair, or overhaul a product.

SUPPORT RESOURCES: The materiel, infrastructure, and personnel elements required to operate and maintain a product to meet readiness and supportability requirements.

SUPPORT SOLUTION: The integrated design and coherent support provided throughout the life cycle of a system that is realized in its integrated support system and the associated technical data. The support solution comprises the sum of the services, resources, and information required to effectively support the equipment throughout its in-service life.

SUPPORT SYSTEM: A composite of all the services and resources that shall be acquired for operating and maintaining a product throughout its life cycle.

SUPPORTABILITY: A key component of availability and suitability. It includes design, technical support data, and maintenance procedures to facilitate detection, isolation, and timely repair and/or replacement of product anomalies.

SUPPORTABILITY FACTORS: Qualitative and quantitative indicators of supportability.

SUSTAINMENT: The provision of personnel, training, logistics, and other support required to maintain and prolong operations or combat until successful accomplishment or revision of the mission or of the national objective.

SYSTEMS ENGINEERING PROCESS: A logical sequence of activities and decisions transforming an operational need into a description of product performance parameters and a preferred product configuration.

TECHNICAL DATA: Recorded information regardless of form or character (e.g., manuals, drawings) of a scientific or technical nature.

TRADEOFF: The determination of the optimum balance between product characteristics. Cost, schedule, performance and supportability are the most relevant characteristics for product support considerations.

TRAINING: The structured process by which individuals are provided with the skills necessary for successful performance in their job, slot, billet, or specialty.

TRANSPORTABILITY: The design characteristics determining the inherent capability to move materiel to specified locations with available and projected transportation assets to meet planned delivery schedules and/or mobility plans. It includes consideration of the limitations and restrictions of the transportation assets and modes in conjunction with the required product equipment and support items required to enable the movement of the materiel.

2.4 Acronyms

AM	Additive Manufacturing
BEI	Breakdown Element Identifier
BIT	Built-in Test
BITE	Built-in Test Equipment
CBM	Condition Based Maintenance
DMSMS	Diminishing Manufacturing Sources and Material Shortages
EC	Engineering Change
ECP	Engineering Change Proposal
EMC	Electromagnetic Compatibility

EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
ESOH	Environment, Safety, and Occupational Health
FMECA	Failure Modes, Effects, and Criticality Analysis
HMS	Health Monitoring System
HSI	Human Systems Integration
HUMS	Health and Usage Monitoring System
IPS	Integrated Product Support
LCC	Life Cycle Cost
LCN	Logistics Support Analysis Control Number
LDT	Logistics Delay Time
LORA	Level of Repair Analysis
LPD	Logistics Product Data
MTA	Maintenance Task Analysis
NPV	Net Present Value
O&S	Operating and Support
PdM	Predictive Maintenance
PIP	Product Improvement Program
PPMx	Prognostics and Predictive Maintenance
PHS&T	Packaging, Handling, Shipping, and Transportation
PS	Product Support
PSA	Product Support Analysis
R&D	Research and Development
RDTandE	Research, Development, Test, and Evaluation
SE	Support Equipment
SMR	Source, Maintenance, and Recoverability
TOA	Tradeoff Analysis

3. GENERAL REQUIREMENTS

3.1 General

LORA is an integral part of PSA as defined in SAE TA-STD-0017A. LORA decisions, which are based on economic and non-economic considerations and readiness objectives, influence the logistic support cost, total life cycle cost of ownership, and operational readiness of the product. Furthermore, LORA recommendations for new materiel shall be made as soon as the product's preliminary design has been determined and then updated, as required, throughout the life cycle.

3.2 Purpose

The purpose of LORA is to establish a cost effective, feasible repair or discard solution for performing maintenance actions. These analyses are based on economic and non-economic considerations and readiness objectives.

3.3 LORA Program

The LORA program shall be planned, developed, integrated, and conducted in conjunction with other design, development, production, and deployment functions to permit the most cost effective achievement of the overall program objectives.

3.3.1 A Managed Program

The LORA program is a managed program to provide LORA activities and is established as part of the PSA and called out in the Product Support Analysis plan per Activity A.2.1 of SAE TA-STD-0017A. The LORA program shall be conducted commensurate with the design maturity and life cycle phase of the program. Procedures shall be established to ensure the LORA program is an integral part of the systems engineering process. Interfaces between the LORA program and other related systems engineering analyses and design programs shall also be identified. The LORA program shall include the management and technical resources, plans, procedures, schedules, and controls for performance of LORA.

3.3.2 LORA Program Objective

The objective of the LORA program shall be to analyze product support solution and product design alternatives; use the results to influence product design and maintenance planning; and achieve a maintenance concept which is the most effective compromise between economic and non-economic considerations or characteristics related to the product and its support.

3.3.3 LORA Program in the Life Cycle

The LORA program aligns with the PSA activities and shall be applied throughout the life cycle of a product (see [Appendix E](#)). The primary use of LORA is during design and acquisition; however, it shall be applied for operational in-service reviews of the support solution and for optimal reduction in operational support costs through the disposal phase. The LORA program shall be included in Engineering Changes, commensurate to the level of technical detail and ability to change the support solution.

3.4 LORA Program Interfaces

Maximum use shall be made of analyses and data resulting from other systems engineering programs to satisfy the LORA input data requirements.

3.4.1 Detailed Interfaces

LORA, as part of the PSA process, interfaces with maintenance planning; reliability; and MTA in the following ways:

- a. Maintenance planning: LORA identifies the maintenance level and logistic support costs associated with an unscheduled maintenance task and influences product design and maintenance planning in producing an effective support solution. This information is provided by the LORA evaluations and is a key IPS element. These maintenance plans involve both engineering and supportability analyses to develop plans for product maintenance. Ultimately, maintenance planning identifies the support resources required to perform maintenance.

- b. Reliability: LORA is used to analyze reliability critical items to determine whether they are maintenance significant. LORA may be used as a design tool for conducting tradeoff analyses to determine whether to design an item for repair or discard. Multiple LORA and sensitivity iterations may be performed to verify the validity of a repair/discard decision.
- c. MTA: LORA uses MTA outputs, such as task time and resource requirements, to calculate the optimum maintenance solution for each item under analysis with consideration to cost and availability implication of the maintenance level and locations.
- d. Performance assessment: LORA is used to evaluate the effectiveness of the maintenance plan and to recommend changes based on the analysis of feedback data from actual events.

3.4.2 Products Delivered to the End User

LORAs conducted on products that have been delivered to the end user are used to evaluate the existing maintenance policy, support costs, use rates, capabilities, and other factors that may affect the support of a product and require adjustment to the support system in order to maximize the product's operational readiness or cost effectiveness. Data obtained from the use of these products during a follow-on LORA is more accurate than the engineering estimates used in earlier LORAs and increases confidence in the product's maintenance policy.

3.5 LORA Program Coordination

Activities and data required by this standard, which are also required by other standards and specifications, shall be coordinated and combined to the maximum extent possible to avoid duplication of effort. LORA input data and the information used and provided shall be based upon, and traceable to, other systems engineering data and activities where applicable. Maximum use shall be made of LORA data and information resulting from applicable activities in the LORA program to satisfy the PSA requirements detailed in SAE TA-STD-0017A.

3.6 LORA Process

The LORA program shall be implemented through a process of systematic and comprehensive LORA evaluations conducted on an iterative basis throughout the life cycle to arrive at a maintenance concept that is effective, yet affordable. The process shall integrate design, operation, performance, cost, and supportability characteristics or constraints to identify and update the support solution for the product. The level of detail of the evaluations and the timing of the activity performance shall be tailored to each product and shall be responsive to the LORA program's schedules and milestones.

3.6.1 Product Development

The LORA program shall be initiated as early as possible in the design and acquisition phase of the product's life cycle and be updated in subsequent phases as the product configuration becomes better defined. In the product's developmental stages, the LORA program shall aid in the evaluation of the design alternatives from a supportability standpoint. Also, the LORA program shall provide a basis for identifying items which should clearly be designed for discard at failure, from those that should be designed for repair at failure.

3.6.2 Product Production and Deployment

During product production and deployment, the LORA program is conducted to evaluate significant changes in supportability factors and to recommend modifications in the established maintenance concept of the product. The objective of the LORA program during this time is to:

- a. Review, refine, and revise the existing maintenance concept established for the product commensurate with changes in supportability factors (e.g., use rates, cost of repair parts, maintenance policy or capabilities).
- b. Propose enhancements to the maintenance concept as it is affected by product improvements or engineering changes to the product.
- c. Provide a basis of information on which to build a maintenance concept for a similar product.

3.7 LORA Input Data

The LORA input data and values shall be established through the use of data from other related systems engineering programs or from measured data and shall be traceable to their specific source (e.g., product specification, contract, regulations, reliability allocation report, maintainability predictions report, operational use plan, in-service support performance measurement). The quality and level of detail of the data evaluated shall be commensurate with the life cycle phase.

3.8 LORA Models

The LORA process should make use of computer based modelling to assist in defining supportability characteristics and in decision making for optimal repair levels of the product under analysis. The LORA model used must be approved for the LORA Program application. Guidance in the requirements for LORA models is provided in Section [10](#).

Any mathematical and statistical formula that are used in the application of LORA modeling shall be logically robust. The algorithms must be logical, well described, defensible, repeatable, and adaptable to various modeling scenarios. Analytical methods shall be available and approved by the owner or user of the asset and its support system. The LORA model used must comply with this standard.

4. ACTIVITY SECTIONS

4.1 General

The LORA activities are divided into five general sections: (1) program management, surveillance, and control; (2) data preparation and management; (3) evaluations; (4) use and implementation; and (5) operations and support reviews.

4.1.1 Program Management, Surveillance, and Control

The program management, surveillance, and control section contains the earliest planning activities in the development of an effective LORA program, in addition to providing an opportunity to review the progress of the LORA program and results. This section contains three activities: Activity 1 - Program Strategy; Activity 2 - Program planning; and Activity 3 - Program Reviews.

4.1.2 Data Preparation and Management

The purpose of the data preparation and management section is to identify the LORA input data which will be used in the LORA evaluations. This section contains one activity: Activity 4 - Input Data Compilation.

4.1.3 Evaluations

The evaluations section serves to optimize the benefits of the LORA while considering cost, schedule, performance, and supportability prior to the product design being finalized. This section contains one activity: Activity 5 - Evaluation Performance, Assessment, and Documentation.

4.1.4 Use and Implementation

The purpose of the use and implementation section is to provide a method for utilizing the results of the LORA to influence the product's design and support solution while deriving an optimal maintenance concept. This section contains one activity: Activity 6 - Using Results.

4.1.5 Operations and Support Reviews

The purpose of the operating and support reviews section is to establish a methodology and process including LORA for the assessment and improvement of the support solution performance during the in-service phase. This section contains one activity: Activity 7 - In-Service Support.

4.2 Activity Structure

4.2.1 Activity Description

Each LORA activity contains an objective statement in addition to detailed tasking statements (sub-activities) which constitute the overall activity.

4.2.2 Activity Input

The activity input tables identify the general information required to define the scope of, and perform, each activity. When an element of the activity input is only applicable to certain sub-activities, the applicable sub-activity numbers are identified. Where an element is applicable to all sub-activities listed under a specific activity input, the word “all” is used.

4.2.3 Activity Output

The activity output tables identify the expected results from performance of the activity. Each output is linked to the applicable sub-activity by identifying the sub-activity number.

4.3 Activity Selection

It is not intended that all LORA activities and sub-activities be accomplished in the sequence presented. The sequence of activities and sub-activity accomplishments shall be tailored to the individual acquisition program to exclude any unnecessary requirements. Consequently, for some activities, not all sub-activities may be required to be performed for a given contract period.

5. PROGRAM MANAGEMENT, SURVEILLANCE, AND CONTROL

5.1 Activity 1 - Program Strategy

Develop a LORA program strategy to identify the LORA activities to be accomplished as part of the LORA program. The LORA program strategy shall be incorporated into the PSA strategy established in SAE TA-STD-0017A, Activity A.1.

5.1.1 Activity 1.1 - LORA Program Strategy

Identify proposed LORA activities to be performed and the entity responsible for each activity. Propose any additional activities, modifications, or deletions to activities or requirements with supporting rationale for such additions, modifications, or deletions. The selection of LORA activities and the degree of their accomplishment shall be based on the following factors:

- a. The probable design, supportability, and operational approaches for the product undergoing LORA.
- b. The availability, accuracy, and relevance of LORA input data required to perform the proposed LORA activities.
- c. The potential design impacts of implementing, or not implementing, the LORA recommendations.
- d. LORA efforts conducted during previous phases of the product life cycle.
- e. Related systems engineering analyses planned and completed which are still relevant.

5.1.2 Activity 1.2 - Schedule

Develop a schedule to accomplish the LORA activities identified in Activity 1.1 and the delivery of LORA products based on the relationship of the LORA program with other IPS program requirements and associated systems engineering activities and programs (e.g., PSA per SAE TA-STD-0017A, reliability per SAE GEIA-STD-0009A, FMEA per ARP5580). The schedule shall provide estimated start and completion milestones for each LORA program activity. The schedule depicts the relative timing of the LORA program activities in relation to the PSA program. Included in the schedule shall be any requirements for program and design reviews identified under Activity 3.

5.1.3 Activity 1.3 - Manpower Estimate

Estimate the man-hours required to perform each activity identified under Activity 1.1 based on the schedule developed in Activity 1.2.

5.1.4 Activity 1.4 - LORA Candidates List

Develop a list of items to be included in the LORA. The LORA candidate items shall be in an order that represents the hardware breakdown relationship of the items within the product. The LORA candidate items shall be identified by a product breakdown identifier (e.g., BEI or LCN if assigned).

Table 1 - Activity 1, program strategy inputs

Activity Inputs	Activity
Previously conducted analyses and LORA evaluations pertinent to the product for which the LORA program is being established. This data shall include no proprietary data of any contractor.	All
Expected mission and functional requirements for the product for which the LORA program is being established.	All
PSA strategy outlining the proposed supportability objectives and proposed PSA activities and sub-activities to be performed for each phase of the acquisition program from SAE TA-STD-0017A, Activity 1.	All
Overall system program event and milestone schedule.	All
LORA review procedures, LORA review team, and LORA guidance conference and Review schedules from Activity 3.	All

Table 2 - Activity 1, program strategy outputs

Activity Outputs	Activity
A LORA program strategy outlining the proposed LORA activities to be performed, the entity responsible for each activity, and the schedule for accomplishing the activities identified.	1.1, 1.2
Manpower estimate for conducting the LORA activities identified.	1.3
LORA candidates list.	1.4

5.2 Activity 2 - Program Planning

Develop a LORA program plan detailing the approach for accomplishing the LORA activities identified in the LORA program strategy. The LORA program plan shall be incorporated into the PSA plan established by SAE TA-STD-0017A, Activity A.2.

5.2.1 Activity 2.1 - LORA Program Plan

Prepare a LORA program plan which describes how the LORA process will be conducted to meet the program requirements. These descriptions shall include a discussion of how the LORA results will be used in the PSA. The LORA program plan shall include the following elements of information, with the range and depth of information for each element tailored to the life cycle phase.

NOTE: The following list is not all encompassing. It is meant to serve as a representative sample only.

- Identification of each LORA activity to be accomplished under the LORA program and a detailed description of how each selected LORA activity shall be performed.
- Identification of the organizational unit with the responsibility for executing each LORA activity to be performed. This includes the identification and responsibilities of all parties involved.

- c. Description of how LORA activities and data will interface with the IPS elements and systems engineering program activities and data. The description will include analysis and data interfaces with the following programs, as applicable.
 - 1. Design program.
 - 2. Reliability program.
 - 3. Maintainability program.
 - 4. Human systems integration.
 - 5. Environmental, safety, and occupational health program.
 - 6. Parts management program.
 - 7. Test and evaluation program.
 - 8. Data management and configuration management programs.
- d. The method by which the LORA program requirements and data are to be obtained from, and disseminated to, personnel in all other related program areas.
- e. Description of the procedures which will be used for collecting, updating, and validating LORA input data and results. These descriptions shall include a discussion of how the LORA results shall be used in the PSA.
- f. The LORA candidates list as defined by Activity 1.4.
- g. Identification of the LORA model(s) to be used in conducting the LORA evaluations. See Section [10](#) for the requirements for a LORA model.
- h. A list of the LORA input data elements required to execute the LORA model(s) identified and the sources to provide that data (i.e., customer, contractors, subcontractors, vendors, and test agencies). See [Appendix B](#) for relevant data elements.
- i. Discussion of the sensitivity analysis requirements and proposed ranges of particular quantitative data elements so the uncertainty of design and program characteristics can be considered.
- j. Identification of major supportability and design tradeoffs or constraints to be evaluated under the LORA program. In particular, describe the support and support equipment alternatives to be evaluated.
- k. Identification of the required product data and any applicable rights that should be obtained.
- l. Discussion of how the application of advanced manufacturing solutions is a design and support alternative that should be considered (e.g., using additive manufacturing to create repair parts or tools where and when needed).
- m. A list of considerations (e.g., safety, environmental impacts, hazardous materials (HAZMAT), training requirements, facilities, security, policies) which will be examined in the non-economic evaluation. In particular, describe any considerations or characteristics related to the data elements identified which may impact, or shall be considered when conducting, the LORA evaluations.
- n. Identification of data from similar products, which will be used to establish a baseline maintenance concept for the product under analysis. This shall include the identification of the similar products and quantification of any data to be used from the similar products.