

DATA ITEM DESCRIPTION

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 110 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. TITLE RELIABILITY BLOCK DIAGRAMS AND MATHEMATICAL MODELS REPORT		2. IDENTIFICATION NUMBER DI-RELI-81496	
3. DESCRIPTION / PURPOSE 3.1 This report documents data used to determine mission reliability and support reliability allocations, predictions, assessments, design analyses, and trade-offs associated with end items and units of the hardware breakdown structure.			
4. APPROVAL DATE (YYMMDD) 951030	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) N/AIR-4.1.6	6a. DTIC APPLICABLE X	6b. GIDEP APPLICABLE X
7. APPLICATION / INTERRELATIONSHIP 7.1 This Data Item Description contains the format and content preparation instructions for the data product generated by the specific and discrete task requirement as delineated in the contract. 7.2 This DID is applicable during the Conceptual, DEM/VAL, and E&MD phases. 7.3 This DID supersedes DID DI-R-7094. 7.4 This DID is not applicable to the production phase unless warranted by significant design changes associated with improvement programs. 7.5 Defense Technical Information Center (DTIC), Cameron Station, Attn: DTIC-FDAC, Alexandria, VA 22304-6145.			
8. APPROVAL LIMITATION		9a. APPLICABLE FORMS	9b. AMSC NUMBER N7166

10. PREPARATION INSTRUCTIONS

- 10.1 Content. The report shall include reliability block diagrams, mathematical models, and supplementary information suitable for allocation, prediction, assessment, and failure mode, effects and criticality analysis tasks related to the end item and units of hardware breakdown structure. The report shall contain sufficient detailed information to preclude separate special effort, modification, or adaptation of the diagrams or models for other reliability tasks.
- 10.1.1 The type of reliability model (mission reliability or logistics reliability) and the modeling method shall be identified in the report.
- 10.1.2 Reference designation list. The report shall include a reference designation list when warranted by item complexity. The list shall be provided when block diagrams include elements which require correlation between block diagram reference numbers, hardware breakdown structure identification, Work Unit Code (WUC) identification numbers, or location of specific elements on a diagram set or diagram sheet. The list shall be a composite cross-reference and item element locator (both by name and designation).
- 10.1.3 Excluded equipment list. An excluded equipment list which describes item elements not shown on the block diagram shall be included. Rationale for each item exclusion shall be provided.

(Continued on Page 2)

DISTRIBUTION STATEMENT

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Block 10, Preparation Instructions (Continued)

10.1.4 Conclusions and recommendations. The report shall contain contractor conclusions and recommendations based upon the data developed. ~~Contractor interpretation and comments concerning diagrams, models, and courses of action to resolve reliability problems shall be included.~~ Consideration should be given to data deficiencies, Government Furnished Equipment (GFE) problems, tradeoffs, assumptions, risks, interpretations affecting reliability planning, qualitative or quantitative information affecting the program, and other pertinent factors related to the diagrams or models.

10.1.5 Item coverage. Reliability block diagrams shall represent the item specification and be segmented to represent variables such as: mission type, mission phase, functional mode(s) of operation, duty cycle, stores mix, maintenance concept, or other factors. Block diagrams developed for feasibility purposes shall include separate models reflecting differing reliability requirements, hardware configuration, and mission application. When complexity warrants, charts, tables or other methods may be used to indicate which segments, diagrams, or sets of diagrams apply to specific mission(s) or other variables.

10.1.5.1 Government furnished equipment (GFE), Non-developmental Items (NDI), and Commercial Off The Shelf equipment (COTS). Reliability block diagrams shall include and identify blocks representing GFE, NDI and COTS items. Information shall be included to reflect the integration of designated GFE, NDI, and COTS into the design.

10.1.5.2 Alternative configurations. The report shall include block diagrams prepared during feasibility estimation to compare alternative configurations or design concepts.

10.1.6 Diagram partitioning. Reliability block diagrams shall be partitioned to agree with the hardware breakdown structure of the end item. Partitioning shall provide diagrams for each end item subdivision which reflect and emphasize interfaces with the next smaller units of the breakdown structure. In this manner, the block diagram consists of a series of models which are logically derived and capable of being combined to any level of hardware complexity (see sample provided as Figure 1).

10.1.7 Diagram interfaces. Block diagrams included in the report shall indicate interfaces both external to the physical boundary of the item and internal to the item. An interface may be functionally dependent on another item(s) and vice versa, or one which is functionally independent of other items but is an element of a higher level model. Particular attention should be paid to interfaces of functional significance including GFE, NDI, and COTS. Interfaces shall be consistent with the end item specification, intended purpose, mission use, or higher order functions when the item is used in conjunction with other items.

10.1.8 Assumptions. All assumptions relating to the reliability block diagrams shall be documented in the report. The assumptions shall include technical assumptions prepared as part of the diagram statement of conditions and general assumptions for diagram interpretation, and report completeness or reliability understanding. Assumptions shall be consistent with the phase of item definition. Typical assumption considerations include:

- a. Service use profile, mission profile, environmental profile
- b. Operational and maintenance concepts and requirements
- c. Item data deficiencies
- d. Redundancy, alternate modes of degraded operation
- e. Tradeoff considerations
- f. Human reliability
- g. Software reliability

10.1.9 Functional level diagram option. When information is limited in the early phase of item development, functional level block diagrams shall be constructed. Diagrams constructed at this level shall contain blocks representing the lowest identifiable function consistent with item definition.

10.1.10 Reliability block diagrams.

Block 10, Preparation instructions (Continued)

10.1.10.1 Redundancy. The report shall include redundant configurations identified during redundancy studies, allocations, or tradeoff studies related to item reliability improvement. Reliability problems leading to the inclusion of redundant elements shall be identified. The degree, level, and other features related to redundant elements included in block diagrams shall be identified. Additional information describing redundancy features not obvious from the block diagrams shall be included. Typical redundancy considerations include:

- a. Level (e.g., subsystem, part)
- b. Type (e.g., automatic, switchable, alternative mode)
- c. Element monitoring (e.g., continuous, interval monitored)
- d. Rationale (e.g., repair without downtime, prolong operating life)
- e. Alternatives with/without redundancy
- f. Elements which can be checked
- g. Elements which can be inspected
- h. Elements whose failure stresses alternate path elements
- i. Elements whose failure degrades performance

10.1.10.2 Automatic test equipment. Reliability block diagrams shall include and identify Automatic Test Equipment (ATE) for on-line testing peculiar to the item to permit reliability impact assessment. Built-in test equipment (BITE) shall be diagrammed to show function(s) being tested. When BITE is diagrammed separately, interface points shall be included at blocks being tested to reflect sensor isolation or other elements which degrade its reliability. BITE usage of item elements as part of test equipment, features incorporated to detect or predict impending failure and features which interrupt the normal operational function shall be identified. ATE which is separate from the item shall be diagrammed in a similar manner when it is included in the same specification. Source of ATE reliability requirement, either as part of item requirement or as a separate requirement, shall be identified.

10.1.11. Mathematical models. Reliability mathematical models shall reflect the level of detail incorporated into block diagrams and be suitable for use in allocation, feasibility estimation, and prediction. Each block in the diagram shall be flexible to accommodate substitution of model parameter values of calculation of item subdivision reliability and to permit changes in failure rate and repair time distributions or any other factors consistent with assumptions and configuration alternatives.

10.1.11.1 Item coverage. Reliability mathematical models shall represent the item specification and be organized consistent with the reliability block diagram. Charts, tables, or other methods may be used to indicate which equation, model, or sets of models apply to specific mission(s) or other variables. The method used shall be the same used for block diagrams, and may include provisions for both the diagram and mathematical model.

10.1.11.2 Mathematical symbols. Mathematical models shall use symbols, terms, expressions, notations, or other elements of the reliability equation consistent with the block diagram and reference designation list (see 10.1.2 of this DID). The report shall identify and define each separate constant, variable, or other element of the mathematical equation(s) represented by mathematical shorthand, alpha-numeric designators, or other methods.

10.1.11.3 Assumptions. All assumptions relating to development and preparation of mathematical models shall be documented in the report. The assumptions may be included with block diagram assumptions (see 10.1.8 of this DID). Assumptions shall include those necessary for model interpretation, model completeness, and model clarity. The assumptions shall be consistent with reliability block diagram assumptions and phase of item development. Typical assumption considerations include:

- a. Frequency distributions (failure rate, time to repair)
- b. Mathematical approximations
- c. Statistical techniques
- d. Single mode/multimodal failure

Block 10, Preparation instructions (Continued)

- c. Wearout factors/characteristics
- f. Failure independency
- g. Operating time

10.1.11.4 Numerical results. Reliability mathematical models based upon approximations, truncations, or other factors which affect numerical results of item reliability or maintainability shall be identified.

10.1.11.5 Computer programmed model. The report shall contain a summary description of Computer Program Models including programming approach, essential data required for operation, program verification, operational details, etc.

10.1.11.6 Alternative configurations. Mathematical models shall have provisions for computation of alternative configurations when the block diagram includes alternatives (see 10.1.5.2 of this DID).

10.1.11.7 Reliability mathematical model.

10.1.11.7.1 Reliability mathematics. Reliability mathematical models, depending upon the phase of development, configuration, or other factors may utilize various techniques (e.g., classical reliability, Boolean algebra, etc.) for use in the analysis, calculation, and presentation of item reliability. The possibility of misinterpretation of the reliability mathematical model and its mathematics shall be minimized by the inclusion of supplementary information in the report. Supplementary information necessary for proper understanding and use of the model shall be included when specific method(s) of mathematics employed extend beyond the basic rules, practices, and procedures of reliability mathematics (e.g., rules of Boolean algebra, classical laws of reliability, etc.). Truth tables, Boolean matrices, Karnaugh maps or other reliability mathematical techniques used in the development or presentation of item reliability as a mathematical equation shall be included in appendices of the report. Operations for series, parallel, series-parallel, parallel-series redundancy or combinations thereof may be included as part of higher order item equations or included separately in an appendix. Mathematical derivations for complex redundant configurations (networks, T-bridge, lattice, etc.) shall be included in an appendix. The use of multimodal (e.g., open, short, tolerance) or single mode redundancy analysis in the mathematical model shall be consistent with the reliability block diagram.

10.2 Format. Contractor format is acceptable.

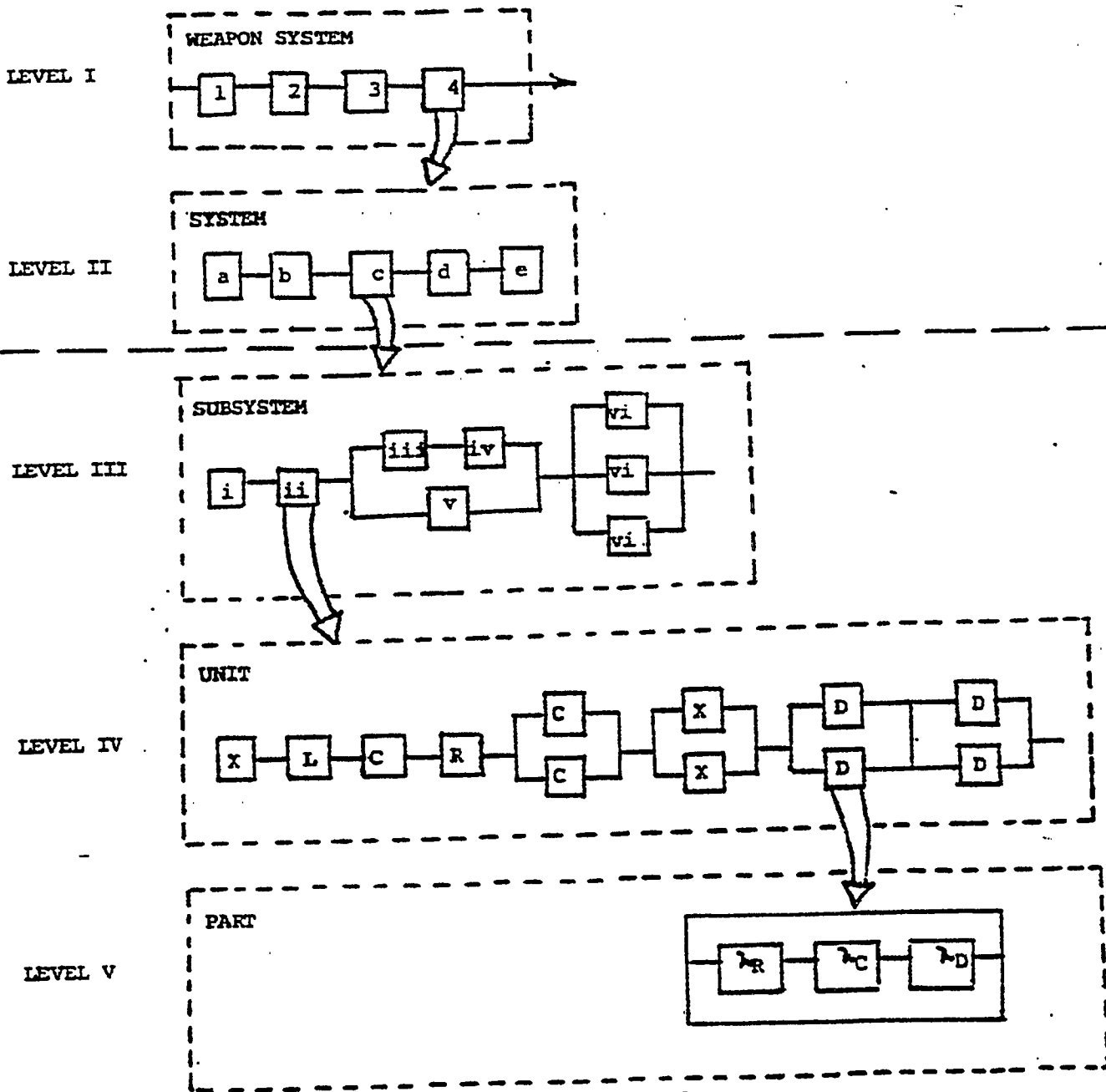


Figure 1. Block Diagram Model Partitioning